

***Ex situ* collections and the Nagoya Protocol:  
A briefing on the exchange of specimens  
between European and Brazilian *ex situ* collections,  
and the state of the art of relevant ABS practices**

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## 1. Introduction

This paper seeks to lay the ground for discussions towards more effective cooperation between *ex situ* collections in Brazil and the European Union, by exploring the history of collection in Brazil, interactions between Brazilian and European collections, and the distribution of collections and important networks in Brazil and Europe. Having provided those contexts, it will focus on access and benefit-sharing practices that were developed in response to the Convention on Biological Diversity, and how such practices may be suitable or adaptable to the new realities of the Nagoya Protocol and related national legislation, with a view towards enabling discussion on viable solutions for facilitating research and cooperation.

The diversity of types of *ex situ* collections is considerable: plant, animal and microbial resources, maintained in preserved or living form, utilised for non-commercial or commercial purposes, by public or private bodies. This paper will focus predominantly on publicly-held scientific collections and non-agricultural collections and their relation to the Protocol, with the understanding that the International Treaty on Plant Genetic Resources for Food and Agriculture provides sector-appropriate measures for many exchanges via the Multilateral System. Information from private and corporate collections and informal university in-house collections is more difficult to collect, and it is hoped that the results of the discussion between public collections will be made widely available and serve to inform other collections.

## 2. Brief history of European collections in Brazil

### 2.1 Origins of European *ex situ* collections

During the Age of Discovery and European expansion, explorers brought back novel objects and creatures that were eagerly received by and exchanged between princes and grandees. The trend for accumulating ‘cabinets of curiosities’ gradually spread to scholars, doctors and other members of the bourgeoisie. Herbaria and botanical gardens were both first developed in the early 16<sup>th</sup> century in Italy, and then proliferated across Europe. The Muséum national d’Histoire naturelle (MNHN) arose from the ‘King’s Drugs Cabinet’ in 1633, which gave rise to the Jardin royal des plantes médicinales, while the origins of the Natural History Museum (NHM), London lie in Sir Hans Sloane’s cabinet of curiosities, which included dried plants and animal and human skeletons, acquired through his interest in natural history and travels as a doctor and scholar.

With the Scientific Revolution and the rise of taxonomy as pioneered and expanded by Linnaeus and Buffon, interest shifted towards natural history and the investigation of natural forms and variations of plants and animals, rather than curious deformities, which were often popular in earlier collections. Specimens were typically obtained from four

main sources: travelling scholars, expeditions, diplomatic exchanges (especially for exotic animals), and merchants<sup>1</sup>.

## 2.2 Early colonial-era collection in Brazil

Brazilian biodiversity attracted intense European interest from the very start of the colonial era and has continued to do so through centuries of geopolitical change. Soon after the Portuguese claimed Brazil in 1500, samples of flora and fauna of potential commercial interest were shipped back to Portugal, including trunks of pau-brasil, or brazilwood (*Caesalpinia echinata*, the species that gave Brazil its name). The French sought footholds for brazilwood exploitation, but were expelled in 1567, from which time Portugal held a long monopoly on brazilwood supply. The Dutch invaded north-eastern Brazil in 1630 and in 1637 sent out two scholars, Wilhelm Piso and Georg Marcgraf, to conduct the first scientific study of Brazilian zoology and botany, published as *Historia Naturalis Brasiliae* in Leiden in 1648. The Dutch were expelled in 1654 and direct scientific research was paused for over a century<sup>2</sup>.

Portugal conducted little exploration of Brazil and its vast biodiversity until the early nineteenth century, focusing instead on establishing sugarcane plantations, cattle grazing, and then mining the major gold and diamond deposits that were discovered at the end of the 17<sup>th</sup> century and early 18<sup>th</sup> century. To guard these valuable resources, foreign contacts were kept to a minimum; fewer than ten accounts of Brazil and its natural wonders were written during the 16<sup>th</sup> and 17<sup>th</sup> centuries<sup>3</sup>. However with the flowering of science in northern Europe, European scientists (and governments and companies) were increasingly eager to gain access to new specimens from unknown territories.

A few foreign explorers and naturalists did succeed in penetrating the barrier, without permission from Portuguese authorities. Charles-Marie de la Condamine entered Brazil via the Amazon River in 1743, on his way home to France after ten years on an expedition to Quito, and published an account of his Amazonian voyage<sup>4</sup>. The French naturalist Philibert Commerson visited briefly during a supply stop in 1767 for Louis Antoine de Bougainville's voyage of circumnavigation, and managed to collect specimens on the lands of local gentry to whom he offered his services as a physician, despite tense relations between Bougainville and the local Viceroy (due to conflicting French and Portuguese colonial maritime interests)<sup>5</sup>. In 1768, the *Endeavour* stopped to resupply in Rio de Janeiro on its voyage to the South Pacific; the local Viceroy forbade anyone but Captain Cook to set foot ashore for the twenty-four days of the stop, but the English naturalist

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<sup>1</sup> Baratay, E. & Hardouin-Fugier, E. (2002) *Zoo: a History of Zoological Gardens in the West*. Reaktion Books, London, UK

<sup>2</sup> Barman, R.J. (1971) *The forgotten journey: Georg Heinrich Langsdorff and the Russian Imperial Scientific Expedition to Brazil, 1821-1829*. *Terrae Incognitae* 3 pp.67-96.

<sup>3</sup> *Ibid.*

<sup>4</sup> de la Condamine, C.M. (1751) *Journal du Voyage fait par l'ordre du Roi à l'équateur, servant l'introduction historique à la Mesure des trois premiers degrés du Méridien*. Paris. (Google ebook; p. 193)

<sup>5</sup> Including the species he named *Bougainvillea spectabilis*. Allorge, L. (2003) *La fabuleuse odyssée des plantes: Les botanistes voyageurs, les Jardins de Plantes, les Herbiers*. J.C. Lattès, Paris, France.

Banks and fellow expedition members made illicit forays to the shore to collect specimens<sup>6</sup>. In 1803-04, when the expedition led by Adam Johann von Kruzenstern dropped anchor off the coast of Santa Catarina (where the orders to exclude foreigners were less well-observed), the botanist Georg Langsdorff was able to spend two months in the area<sup>7</sup>.

In the late 18<sup>th</sup> century the Portuguese government recognised the potential benefits of scientific study of its colony, and authorised a scientific expedition to Brazil, led by Brazilian-born Alexandre Rodrigues Ferreira. The ten year expedition (1783-1792) explored the Amazon basin and Mato Grosso; specimens and Ferreira's writings were taken back to the Museum of the Palácio Nacional da Ajuda in Lisbon<sup>8</sup>.

### 2.3. 19th century collection in Brazil

Napoleon Bonaparte's invasion of Portugal in 1808 impelled the Portuguese royal family to flee to Rio de Janeiro, where they lived for thirteen years and changed the policy of exclusion towards foreigners to one of welcome. Naturalists, artists and scientists arrived from across Europe and begin to describe Brazil's vast resources, and important expeditions were mounted from several countries. They sought scientific knowledge and economically useful resources, but also exotic plants for ornamental horticulture and animals for zoos and menageries. Some collectors conducted their work via expeditions supported by governments and national academies, while others financed their explorations by selling their collections to Victorian enthusiasts building their cabinets of curiosities. Huge numbers of specimens were sent to European collections, to the growing dismay of Brazilian scientists, but some of the visitors took up residence in Brazil and became key figures in the development of Brazilian scientific institutions and endogenous science<sup>9</sup>.

A few key 19<sup>th</sup> century expeditions and collectors should be mentioned, due to their contributions to European *ex situ* collections and their importance to the foundations of Brazilian botany and zoology<sup>10</sup>.

#### 2.3.1. Major expeditions

One of the first major expeditions was that of Auguste de Saint-Hilaire, following a diplomatic reconciliation between Louis XVIII and Jean VI of Portugal, Emperor of Brazil. The expedition (1816-1822) collected vast numbers of plant and animal specimens,

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<sup>6</sup> See Joseph Bank's journal entry for 26 November 1768, <http://gutenberg.net.au/ebooks05/0501141h.html#nov1768>

<sup>7</sup> *Ibid.* 2 (Barman 1971)

<sup>8</sup> Bastos, F.I. & Sá, M.R. (2011) The scientist as historian: Paulo Vanzolini and the origins of zoology in Brazil. *História, Ciências, Saúde – Magalhães*. 18(4): 1021-1038. Available from [www.ncbi.nlm.nih.gov/pubmed/22281957](http://www.ncbi.nlm.nih.gov/pubmed/22281957)

<sup>9</sup> *Ibid.*

<sup>10</sup> Except where noted, collector information is drawn from the Global Plants Initiative webpages (<http://plants.jstor.org/person...>)

many species described for the first time, and Saint-Hilaire published a number of important volumes on Brazilian natural history, including the *Flora Brasiliae Meridionalis*. The expedition's collections are largely deposited at MNHN, Paris.

The Austrian Expedition to Brazil (1817-1821) carried out comprehensive studies of Brazil's natural resources and culture. Its two missions were led by Austrian-Czech botanist/zoologist/entomologist Johann Christian Mikan, and by German zoologist Johann Baptist von Spix and botanist Carl Friedrich Philipp von Martius. The Spix and von Martius collections are largely deposited in Munich, though von Martius's private collection was obtained by the government of Belgium. Other naturalists involved include Johann Baptist Emanuel Pohl, whose collections are now chiefly held in Naturhistorisches Museum Wien (Vienna Natural History Museum) and the National Herbarium of the Netherlands; Austrian botanist Heinrich Wilhelm Schott; Italian botanist Giuseppe Raddi; and Austrian zoologist Johann Natterer. All of these scientists made important contributions to the literature on Brazilian biodiversity.

Other major expeditions include that by German prince and naturalist Maximilian Alexander Phillip, Prinz du Wied-Neuwied (to southeastern Brazil in 1815-1817), whose resulting volume *Reise nach Brasilien* was another major contribution to knowledge of Brazil; the Russian Imperial Scientific Expedition to Brazil (1821-1829) led by German physician and naturalist Georg Heinrich Langsdorff and his deputy the German botanist and horticulturist Louis (or Ludwig) Riedel<sup>11</sup>; the Hassler expedition (1871-1872), mounted by Harvard University's Museum of Comparative Zoology, from which Austrian zoologist Franz Steindachner took back material for the Naturhistorisches Museum Wien<sup>12</sup>; and the Castelnau expedition to South America (1843-1845), coordinated by François Louis de la Porte, comte de Castlenau for the duc d'Orléans and the MNHN, which travelled through Brazil from Rio de Janeiro to the Brazil-Bolivia border, then returned through the Amazon rain forest. A critical reevaluation of this particular expedition's findings and interpretations led to the first Brazilian scientific expedition, the Comissão Científica do Império (Imperial Scientific Commission, 1859-1861)<sup>13 14</sup>.

### 2.3.2. Smaller expeditions and independent collectors

Institutions and companies also sent collectors to Brazil – for example the Royal Botanic Gardens, Kew (Kew) sent plant collectors out around the world with a mandate to discover new plants that could be useful to the British Empire – and some collectors were part-financed or fully financed by the selling of their specimens to wealthy collectors in Europe. Allan Cunningham and James Bowie collected for Kew in Brazil between 1814 and 1816 on their way to Australia. Scottish botanist George Gardner funded his 1836-

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<sup>11</sup> *Ibid.* 2 (Barman 1971)

<sup>12</sup> Steindachner went on to coordinate the Austrian Expedition of 1903; [www.nhm-wien.ac.at/en/research/zoology/vertebrates/fish\\_collection/history](http://www.nhm-wien.ac.at/en/research/zoology/vertebrates/fish_collection/history)

<sup>13</sup> *Ibid.* 8 (Bastos & Sá 2011)

<sup>14</sup> Guimarães, M.R.C. (2013) A primeira viagem científica brasileira: a Comissão Científica do Império, *História, Ciências, Saúde – Maguinhos* 20(1): p.332-336, [www.scielo.br/pdf/hcsm/v20n1/19.pdf](http://www.scielo.br/pdf/hcsm/v20n1/19.pdf)

1841 collections in the north and east of Brazil by selling duplicates to wealthy collectors through a London agent (many of his collections are now at NHM and Kew, among others)<sup>15</sup>; similarly, British naturalists Alfred Russel Wallace and Henry Walter Bates sold insect and bird specimens to support their 1848 expedition to Amazonian Brazil. Richard Spruce set out for the Amazon and the Andes in 1849 for Kew (in search of quinine and rubber), but again his main financial support came from ‘subscribers’ at home<sup>16 17</sup>.

Important horticultural collectors include William Lobb, who collected living plants and seeds and herbarium specimens in South America including Brazil over the course of two four-year voyages for the firm of James Veitch and Sons. His herbarium specimens are deposited in a number of major collections in Europe and the US.<sup>18</sup>.

### 2.3.3. European collectors who remained in Brazil

Several prominent European-born collectors made Brazil their home. While they maintained scientific links to Europe, they also helped to build the strength of scientific institutions in the Empire of Brazil.

German botanist Louis (Ludwig) Riedel spent most his life in Brazil, collected important material for von Martius’s *Flora Brasiliensis*, and was the first foreigner to be appointed within the National Museum of Rio de Janeiro, as director of the Herbarium and botanic garden. Danish zoologist and palaeontologist Peter Wilhelm Lund collected in and subsequently stayed in Brazil, where he hosted visiting naturalists (such as Peter Claussen in 1834) and contributed to Brazilian science, although his huge collection was donated to Denmark. The Swedish physician Anders Frederik Regnell immigrated to Brazil in 1840 and collected avidly in Minas Gerais until his death in 1884. He donated specimens to Swedish institutions, collected with visiting botanists (such as Gustaf Anders Lindberg in 1854-1855), and acquired other naturalists’ collections; his personal collections were examined by Martius for *Flora Brasiliensis* and were eventually bought by the Swedish government.

French naturalist Auguste François Marie Glaziou lived in Brazil between 1858 and 1895, and as General Director of Public Gardens for Rio de Janeiro he collected widely across Brazil, and published *Plantae Brasiliae Centralis a Glaziou lectae*. His collections are deposited in major European herbaria and Rio de Janeiro, and he also sent live seeds and plants to European botanic gardens. The German biologist and physician Johann Friedrich Theodor (Fritz) Müller immigrated to the state of Santa Catarina in 1852, where he conducted botanical research, published papers on southern Brazilian zoology and evolutionary biology, and advised farmers. In 1876 he was appointed as Travelling Naturalist to the National Museum in Rio de Janeiro (then the Museu Imperial e Nacional), one of several foreign-born naturalists employed there, as well as Swiss

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<sup>15</sup> [www.kew.org/science/tropamerica/gardner/index.html](http://www.kew.org/science/tropamerica/gardner/index.html)

<sup>16</sup> [www.nhm.ac.uk/research-curation/research/projects/spruce/INTRODUCTION/introduction\\_spruce.dsm1](http://www.nhm.ac.uk/research-curation/research/projects/spruce/INTRODUCTION/introduction_spruce.dsm1)

<sup>17</sup> Gribbin, M. & Gribbin, J. (2008) *The Flower Hunters*. Oxford University Press, Oxford, UK.

<sup>18</sup> *Ibid.*

zoologist Emil Goeldi and German zoologist Hermann von Ihering<sup>19</sup>. Ihering went on to found and become the first director of the Museu Paulista in São Paulo in 1894, while Goeldi went on to reorganise the Pará Museum of Natural History, now known as the Museu Paraense Emílio Goeldi.

#### 2.3.4 Shared and conflicting interests

The actions of these and many other foreign collectors served to expand and enrich collections in Europe (and the US), but also to build knowledge of the immense complexity of Brazilian biodiversity at a time when Brazilian institutions were only just becoming established. Increasingly, European-born scientists were involved in developing and contributing to those institutions rather than returning to Europe.

However, the chief support for science and exploration came from commerce and intense competition between empires and nations to secure markets. The study, conservation and sustainable use of biodiversity was set back by overreaching actions taken by some institutions to secure valuable resources explicitly for their own nation's economic goals in direct opposition to those of Brazil. The most famous case involved the taking of rubber seeds by Henry Wickham for Kew and Britain's Indian Office, for establishment in British colonies in Asia and to thwart Brazil's near-monopoly on rubber export. The seeds were moved quickly and without declaration of their prized identity through Brazilian customs controls, where authorities were led to believe that the shipment was of delicate specimens for Cabinets of Natural History<sup>20</sup>.

#### 2.4 20<sup>th</sup> century exchange

Due to many factors, the mode of exploration and collection by large European expeditions declined after the 19<sup>th</sup> century. Most 20<sup>th</sup> century and recent collecting in Brazil has been carried out by individual collectors or for research projects, generally, though not necessarily, linked to Brazilian institutions.

For much of the 20<sup>th</sup> century, until the development in the 1960s of laws regulating the collection of material and the activities of foreign scientists, and the ABS regulations developed in 2000 in response to the CBD, private law covered most specimen collection and exchange. The concepts of national sovereignty over biological resources and prior informed consent had not yet been formally developed, and collectors were not required to negotiate benefit-sharing terms. Until 1969, there were no laws for the deposit of Brazilian material in national institutions, and consequently many taxonomic types were deposited abroad. Loans from foreign collections material allowed for some access to vital

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<sup>19</sup> [www.bbk.ac.uk/ibamuseum/texts/Andermann01.htm](http://www.bbk.ac.uk/ibamuseum/texts/Andermann01.htm)

<sup>20</sup> Jackson, J. (2008) *The Thief at the End of the World: Rubber, Power, and the Seeds of Empire*. Penguin Books.

historic and type material (depending on those institutions' loan policies and the perceived historic value and fragility of the specimens), but in general Brazilian scientists wishing to consult historic and type specimens needed to find the resources to visit the foreign *ex situ* collections where the specimens were deposited - an expensive impediment to taxonomic research on Brazilian biodiversity.

The 'Law for protection of fauna' no. 5.197, of 3 January 1967, regulated the permissions for Brazilian and foreign scientists to collect zoological material. Botany and microbiology did not have any laws regarding collection of such material, or its import into, or export from, Brazil.

In 1968, the National Council for Scientific and Technological Development (CNPq) was determined by Decree 62.203 to be the responsible body for authorisation of collecting and research by foreigners. CNPq is an agency of the Ministry of Science and Technology and is still, even after the CBD, the responsible body for such authorization.

In 1969, Decree 65.057 defined CNPq as the responsible body for the authorization and supervision of scientific expeditions or any other activities involving the exploration, survey, collecting, filming or recording of scientific material, effected by foreign or national private institutions or individuals. This Decree also establishes the decision that the material collected and associated collecting data must be sorted by the parties working on the project and deposited by agreement in a national institution, and a subsample may be taken by or sent to the international collection involved. When a new taxon is described, the holotype shall be kept in Brazilian official institutions.

In 1990, Decree 98.830 revoked the Decree from 1969, and provided a more complete regulation on collection of scientific data and material by foreigners in Brazil, and with a retrospective ordinance (Portaria 55, March, 14th) the regulation of the deposit of taxonomic material was also added, with the following determination: '*The Ministry of Science and Technology, through the Brazilian institution co-participant and co-responsible, will retain the material collected for disposal in the Brazilian scientific institutions, the following items: a) holotypes or syntypes and 50% of the paratypes, animals or plants; b) all plant unicates; c) neotypes that may be chosen; d) collections, specimens and ethnographic pieces that are rare or that are not represented in national institutions; e) all of the type material fossils; f) at least 30% of the copies of each taxon is identified at any time; g) other specimens, data or materials considered of national interest should stay.*'

Information on the Brazilian regulatory response to the 1992 United Nations Convention on Biological Diversity will be provided in a separate paper.

### 3. Development of Brazilian collections

Biological collections in Brazil started in 6 June 1818, when the Museu Real (Royal Museum) was created by decree - with the aim of spreading knowledge and studies of natural sciences in the country. Today, the Royal Museum, the first Museum of Natural History in South America and also in Brazil, is known as the National Museum of Quinta da Boa Vista<sup>21</sup>.

After the second half of the nineteenth century, museums and collections emerged that encompassed activities related to the natural history, and today constitute the following institutions: Goeldi Museum (1866), Museu Paranaense (1883), and Museu Paulista (1895), which became, in 1969, the Museum of Zoology, University of São Paulo. Nowadays, the most important collections in Brazil are held in those museums and also at the National Institute for Amazonian Research (INPA), Botanical Garden in Rio de Janeiro, Butantan Institute, Fundação Instituto Oswaldo Cruz, Fundação Zoobotânica, in public and private universities and at the Brazilian Agricultural Research Corporation (Embrapa). The university-held collections are responsible for the majority of research and capacity-building on taxonomy and systematics in Brazil. Embrapa's collections are especially important for agricultural research and also seed and germplasm collections (see Section 6).

In general, for many years, collections grew in a haphazard manner, depending on the interests and preferences of successive curators. Following the CBD, more initiatives have arisen and the collections have been treated as the core of the biodiversity studies. The best examples are the Research Program in Biodiversity (PPBio)<sup>22</sup> and the Biota Fapesp<sup>23</sup>. Other initiatives have concentrated their effort towards gathering the collections into networks and releasing the biological information via the internet, such as SpeciesLink<sup>24</sup> and Taxonline - Network of Biological Collections in Paraná State<sup>25</sup>.

As a result of the international requirements of the CBD and the need for a National Program on taxonomy and collections, in 2005-2006, under the coordination of the Ministry of Science, Technology and Innovation (MCTI), the project 'Guidelines and Strategies for the Modernization of Brazilian Biological Collections and Consolidation of Integrated Biodiversity Information Systems' was carried out by the Brazilian Societies of Botany, Microbiology, and Zoology and the Reference Center on Environmental

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<sup>21</sup> Nascimento Junior, J. do & Chagas, M. De S. (2008) Panoramas dos Museus no Brasil. Iberus 1. Panoramas museológicos da Ibero América. IPHAN, Brasília

<sup>22</sup> <http://ppbio.inpa.gov.br/colecoes>

<sup>23</sup> [www.biota.org.br/](http://www.biota.org.br/)

<sup>24</sup> <http://splink.cria.org.br>

<sup>25</sup> [www.taxonline.ufpr.br](http://www.taxonline.ufpr.br)

Information (CRIA). 29 documents and technical notes were produced and presented in two workshops with more than 80 participants, including international specialists<sup>26</sup>. The specific objectives included: carry out a critical analysis of the transformations that biological collections, taxonomy, and informatics for biodiversity are undergoing; make recommendations that will lead to an increase in our capacity to answer the challenges presented associated with the use of natural resources and its impacts to biodiversity; recommend guidelines and strategies to modernize and consolidate an integrated network of biological collections associated to an infrastructure for data and information sharing. The results were published and presented at the COP-8 in Curitiba by the MCTI<sup>27</sup>.

As a result of this initiative, in 2005 the Technical Chamber of Biological Collections (CTCB) was established under the National Biodiversity Commission (CONABIO/MMA) to be the responsible body for proposing actions regarding Brazilian collections. In 2008 the CTCB sent CONABIO a new format of the Project 'Guidelines and Strategies for the Modernization of Brazilian Biological Collections and Consolidation of Integrated Biodiversity Information Systems' for approval and it was published as Deliberation number 53<sup>28</sup>.

Two important programs arose from these actions: PROTAX - Project for capacity building in taxonomy, and SiBBr - Information System on Brazilian Biodiversity, the latter intended to integrate information on biodiversity in Brazilian ecosystems and to support researchers and decision-makers in the creation and implementation of public policies. PROTAX is a joint program of the MCTI and Ministry of Education, launched in 2005. SiBBr launched in 2012 and is a program of MCTI responsible for the project in cooperation with the United Nations Program for Environment and the Global Environment Facility. It is still in its initial phase of implementation: more than 220 institutions, including universities, research centres and other scientific organisations were invited to join it.

It is still very difficult to give a precise figure for the number of collections in Brazil and consequently the number of specimens deposited. The Brazilian Network of Herbaria (RBH), established by the Botanical Society of Brazil holds data on Brazilian collections; currently 218 herbaria are recorded<sup>29</sup>. There is no specific formal list or catalogue for zoological collections.

The only formal list of Brazilian collections (across all areas of biodiversity) is the one of 'Instituições Fiéis Depositárias' (Trustee institutions), maintained by the Ministry of

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<sup>26</sup> See [www.cria.org.br/cgee/col/](http://www.cria.org.br/cgee/col/)

<sup>27</sup> <http://www.sbzoologia.org.br/subcategoria.php?idsubcategoria1=25>

<sup>28</sup> Marinoni, L. & Peixoto (2010). As Coleções Biológicas Como Fonte Dinâmica e Permanente de Conhecimento Sobre a Biodiversidade. *Ciência e Cultura*, 62(3)

<sup>29</sup> [www.botanica.org.br/rede\\_herbarios.php](http://www.botanica.org.br/rede_herbarios.php)

Environment<sup>30</sup>. Accredited by CGEN, these are the institutions authorised to conduct activities and to receive subsamples of genetic resource accessed under art. 16, § 3 of the Medida Provisora 2.186-16/2001.

This situation will change when Project SIBBr begins to gather all the collections and biodiversity information in Brazil into one system. By providing access to a national register of biodiversity, this initiative will enable Brazilian scientists and policymakers to expand and organise biodiversity research and also plan the future of the biological collections in Brazil.

#### 4. Collections communities in Europe and Brazil

Centuries of exploration, empire-building and scientific research have produced a multitude of diverse institutions. A more recent focus on biodiversity conservation and civic engagement continues to drive the worldwide creation of new museums, gardens and zoos, the needs of a growing global population are driving the creation and expansion of agricultural and forest genebanks, while advances in science and industry are rapidly widening an array of collections of microbes, biological compounds and extracts, and increasingly, synthetic forms.

Given that range, it is extremely difficult to provide a definitive figure for the number of *ex situ* collections in the EU and Brazil, especially in the case of private or corporate collections. Few EU ABS national focal points are able to provide comprehensive information on the extent of *ex situ* collections in their countries, although the NP and the discussions around the draft European Regulation on ABS are prompting new assessments<sup>31</sup>. A very rough indication of the number of natural history museums, herbaria, university collections and public research institutes holding preserved collections can be obtained from the Biodiversity Collections Index<sup>32</sup> (BCI), which draws from the Index Herbariorum, the Insect and Spider Collections of the World and Biorepositories.org. Larger institutions may hold very diverse types of collections beyond those currently recorded in BCI<sup>33</sup>.

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<sup>30</sup> [www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes\\_fieis\\_depositarias\\_04-2013.pdf](http://www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes_fieis_depositarias_04-2013.pdf)

<sup>31</sup> Pers. comm.; attempts to contact all EU ABS national focal points were made during the preparation of this paper.

<sup>32</sup> The BCI was accessed via [www.biocol.org](http://www.biocol.org) during this paper's preparation (April 2013) but is in transition to a full merger with Biorepositories.org. BCI both overestimates the number of collections institutions (a single institution may contain several collections listed under separate acronyms), and underestimates the number (e.g. in the UK, where collections other than herbaria are not included).

<sup>33</sup> For example, in addition to its plant and fungal herbaria and economic botany collections, Kew holds living collections, plant tissue cultures, a seed bank and a DNA bank.

Many, though not all, public and university *ex situ* collections are members of global, regional and/or national networks, whose websites and databases provide some information as to numbers of individual collections, and such networks are also integral to the successful dissemination of relevant sectoral information on ABS, so this section will identify and focus on those networks.

#### 4.1 Botanic gardens

There are over 3000 registered botanical living collections globally, including botanic gardens, arboreta, research institutes, and zoo gardens<sup>34</sup>. Around 800 of these collections are in the EU, and 40 in Brazil. Botanic garden governance systems vary widely: there are very many small municipal and private collections, although the majority of the prominent historical and international collections are held in national or state institutions, or associated with universities. Networks often include arboreta, zoo gardens and large estates. Many gardens also have associated herbarium collections – and herbaria are also maintained by a huge range of societies, universities and conservation agencies, as well as natural history museums. An increasing number of gardens are employing other *ex situ* conservation techniques, such as seed banks, field genebanks, and tissue banks for micropropagation. BGCI GardenSearch data indicate that, in EU countries, 98 botanical institutions hold seed banks<sup>35</sup> and 33 have plant tissue culture facilities; a few gardens also maintain DNA banks (see 5.1).

There are two major international botanic garden networks, the International Association of Botanic Gardens (IABG)<sup>36</sup>, and Botanic Gardens Conservation International (BGCI)<sup>37</sup>. BGCI is a global membership organisation that supports the delivery of conservation objectives by botanic gardens and is a key nexus for botanical collections. There are 203 BGCI member institutions in the EU and 5 in Brazil<sup>38</sup>.

Most EU countries have established garden networks. Convened by BGCI, the European Botanic Gardens Consortium<sup>39</sup> links national networks and promotes initiatives such as the International Plant Exchange Network. In Brazil, the national network is the Rede Brasileira de Jardins Botânicos (RBJB).

The key European botanic gardens with herbaria that hold important Brazilian historical material are largely also part of, or linked to, institutions in the Consortium for European

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<sup>34</sup> BGCI GardenSearch database, [www.bgci.org/garden\\_search.php](http://www.bgci.org/garden_search.php)

<sup>35</sup> Many have a focus on native plant species; the ENSCONET (European Native Seed Conservation Network) Consortium coordinates native seed plant conservation in Europe <http://ensconet.maich.gr/>

<sup>36</sup> There is currently no website for IABG with information on membership numbers (Apr-Jun 2013)

<sup>37</sup> [www.bgci.org](http://www.bgci.org)

<sup>38</sup> Although 17 Brazilian institutions are International Agenda registrants

<sup>39</sup> [www.botanicgardens.eu](http://www.botanicgardens.eu)

Taxonomic Facilities (CETAF; see 4.2 and Table 2), although others can be identified via their participation in the Latin American Plants Initiative, now part of the Global Plants Initiative. Although some institutions acquire material directly from fieldwork projects and active partnerships with provider countries, traditional seed exchange between botanic gardens is the principal source of material for most small European gardens. An active European horticultural trade has also served to disseminate living plants widely. Table 1 shows the distribution of botanic garden collections in the EU.

#### 4.2 Natural history museums

A precise figure for the number of natural history museums is difficult to obtain, as there is considerable overlap with university research collections and museums with wider mandates. There is no overarching association or network for the majority of European natural history museums, although many projects link them. The Consortium of European Taxonomic Facilities (CETAF)<sup>40</sup> is a network of scientific institutions that promotes training, research and understanding of systematic biology and palaeobiology, and access to its members' information and expertise. Its 33 members from 18 countries together hold very substantial collections and include almost all of the major repositories for historic Brazilian material<sup>41</sup>, and CETAF members are committed to cooperate on objectives that include the digitisation of collections, development of information services, training for systematists and improvement of access to collections for visiting researchers. CETAF members are also engaged with ABS issues and discussions towards European regulations.

The founding membership of Scientific Collections International (SCICOLL), a new global interdisciplinary coordinating mechanism, includes a small subset of the major CETAF institutions<sup>42</sup>. Table 2 lists current CETAF and SCICOLL members in the EU (as well as other EU collections that have contributed data from Brazilian specimens to the Global Plants Initiative).

#### 4.3 University research collections and research institutes

Many museums and botanic gardens are associated with universities, but university departments may also maintain their own living and/or preserved collections of plants, animals, fungi and microbes. Short-term research specimens may also be accessioned into

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<sup>40</sup> [www.cetaf.org](http://www.cetaf.org)

<sup>41</sup> The V.L. Komarov Botanical Institute in St. Petersburg Russia is the largest exception.

<sup>42</sup> SCICOLL's 10 founding members include 6 EU institutions (see Table 3) and 1 Brazilian institution (Fundação Oswaldo Cruz), although many other institutions and countries are represented on the steering committee. See [www.scicoll.org](http://www.scicoll.org) and [http://scicoll.org/sites/default/files/Sci\\_Coll\\_Brochure.pdf](http://scicoll.org/sites/default/files/Sci_Coll_Brochure.pdf).

larger museum, botanic garden or microbial collections after their primary use, for permanent storage. Boundaries are hence difficult to draw, but university collections and research institutes are considered together as a collections community in this paper, following the approach of two UK reports on ABS<sup>43 44</sup>. The 2005 review of UK access and benefit-sharing stakeholders indicated that within the publicly-funded sector, research institutes and universities are collectively the most prominent users of genetic resources, carry out both academic research and commercially-oriented research, and often act as intermediaries for industry by collecting material. A 2006 Belgian federal ABS survey found that a division between public and private sector stakeholders was not very meaningful, but noted that the research sector involves many private collections, acquisition of material from countries of origin and ex-situ sources, and exchange between research organisations<sup>45</sup>.

The BCI listed 290 collections (preserved botanical/zoological/mycological specimens) linked to universities in EU countries (likely an underestimate). No single network connects the many activities of university collections and research institutes across Europe.

#### 4.4 Culture collections

Microbes of one kind or another have been used for millennia, but culture collections were first established in the late 19th century. The term ‘culture collections’ can refer to collections of bacteria, viruses, microscopic fungi and algae, and other microorganisms, as well as animal and plant cell lines. The world’s many collections are used for a vast range of purposes and an extensive array of sectors, including health services, environmental bioremediation, biological control, and fermentation industries. Types of collection include research collections, service collections, patent collections (collections established as International Deposit Authorities for patent cultures) and safe deposits (where a

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<sup>43</sup> Defra (2012) UK Implementation of the NP: Assessment of the Affected Sectors. Final Report to Defra from ICF GHK. UK Department for Environment Food and Rural Affairs. <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17827>

<sup>44</sup> Latorre, F. (2005) Review of the Experience of Implementation by UK Stakeholders of Access and Benefit sharing Arrangements under the Convention on Biological Diversity. UK Department for Environment, Food and Rural Affairs.

<sup>45</sup> Frison, C. & Dedeurwaerdere, T. (2006) Belgian Federal Survey: Public infrastructure and regulations on access to genetic resources and the sharing of benefits arising out of their utilisation for innovation in life sciences research – access to, conservation and use of biological diversity in the general interest. Federal Public Service of Public Health, the Safety of the Food Chain and the Environment – Directorate General of the Environment, Belgium.

culture can be deposited by a laboratory to be maintained under conditions of secrecy), as well as public deposits, and one collection can fulfill several of these roles<sup>46</sup>.

Culture collections have high ABS relevance, as the major trend in natural product research is towards microorganisms for a number of reasons, including that: they are easier to source (they can be grown in culture rather than collected from the wild or cultivated, as the case for plants); their genomes can be more easily sequenced; even 'backyard' species can be profitably mined for secondary metabolites (avoiding many ABS issues); and their DNA can be extracted from environmental samples via metagenomic technology. Compounds produced from the complex interactions of symbiotic microbial species with other organisms are also of high interest<sup>47</sup>.

The parent organisations of culture collections may be public or private, governments, universities, or industries, but as a sector there is relatively good communication. Many microbial collections are members of The World Federation for Culture Collections (WFCC). The WFCC is concerned with the collection, authentication, maintenance and distribution of microbial and cell line collections, and it helps to support, link and foster information exchange between collections and users<sup>48</sup>. The WFCC World Data Centre for Microorganisms (WDCM) compiles and provides online access to data on culture collections world-wide; its CCINFO database, a world directory of all registered collections, lists 162 culture collections in EU countries and 65 in Brazil<sup>49</sup>.

In Europe, the European Culture Collections' Organisation (ECCO, established in 1982) promotes regional collaboration. Currently there are 61 members from 22 European countries (52 from 19 EU countries)<sup>50</sup>. The Microbial Resources Research Infrastructure (MIRRI) is a new pan-European research infrastructure to provide microorganisms and facilitate access to high quality microorganisms (and derivatives and associated data) for research development and application. The project currently includes 16 European public microbial culture collections and resource centres<sup>51</sup>, as well as collaborating parties from 18 other ECCO members. The European Consortium of Microbial Resources Centres (EMbaRC) is another network (EU-funded, involving 10 institutions), aiming to improve,

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<sup>46</sup> Dedeurwaerdere, T., Iglesias, M., Weiland, S. & Halewood, M. (2009) The use and exchange of Microbial Genetic Resources for food and agriculture. Commission on Genetic Resources for Food and Agriculture Background Study Paper no. 46, <ftp://ftp.fao.org/docrep/fao/meeting/017/ak566e.pdf>

<sup>47</sup> Secretariat of the Convention on Biological Diversity (2008) Access and Benefit-Sharing in Practice: Trends in Partnerships Across Sectors. Technical Series No. 38. Montreal. See also [www.cbd.int/abs/policy-brief/default.shtml/](http://www.cbd.int/abs/policy-brief/default.shtml/)

<sup>48</sup> [www.wfcc.info/about](http://www.wfcc.info/about)

<sup>49</sup> [www.wfcc.info/ccinfo](http://www.wfcc.info/ccinfo)

<sup>50</sup> [www.eccosite.org](http://www.eccosite.org); member collections provide a professional public service on demand and without restriction, accept cultures for deposit, provide catalogues and are housed in countries with microbiological societies affiliated to the Federation of the European Microbiological Societies and registered with the WFCC.

<sup>51</sup> [www.mirri.org](http://www.mirri.org)

coordinate and validate microbial resource centre delivery to researchers (European and international) from public and private sectors through standardised practical approaches to compliance with international standards, national policies and biodiversity-related national legislation.<sup>52</sup>

The Brazilian Ministry of Science, Technology and Innovation (MCTI)-funded capacity building program for biological collections infrastructure is implementing quality management procedures in selected microbial service collections and consolidating a distributed network of centres. The Reference Center on Environmental Information (CRIA) is developing the network information system (SICol), with the adoption of internationally agreed standards and protocols to allow dynamic access to the Brazilian Virtual Catalogue of Biological Materials<sup>53</sup>.

The Global Biological Resource Centre Network (GBRCN)<sup>54</sup> is a demonstration project that aims to provide an infrastructure to support more collaborative globalised research and development, with high quality biological material and related data, working to best practice and commonly agreed procedures and principles. There are currently 23 global partners, 9 in the EU and one in Brazil (CRIA). Table 3 lists the EU members of ECCO, MIRRI, EMbaRC and GBRCN.

#### 4.5 Zoos and aquaria

Zoos and aquaria are traditionally involved in maintaining living wild species for public display, and increasingly for conservation, education and research. Although animals were originally commonly collected from the wild, and often acquired via wildlife traders, supply is now normally from managed breeding programmes and exchange between collections, often as part of international conservation programmes<sup>55</sup>. The genetic resources in animals in zoos and aquaria are not typically 'utilized' for research and development in the sense of the NP, and this sector was largely absent from the ABS negotiations leading to the Protocol. However a few zoos (largely outside Europe) do hold important cryo-preserved collections of embryos, semen, oocytes, blood and tissue samples, cell cultures and DNA (see 5.1), for conservation and research purposes.

The major global network for zoos and aquaria is the World Association of Zoos and Aquaria (WAZA), which helps to link regional and national associations. The European

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<sup>52</sup> [www.embarc.eu](http://www.embarc.eu)

<sup>53</sup> [www.gbrcn.org](http://www.gbrcn.org)

<sup>54</sup> *Ibid.* and [www.gbrcn.org/fileadmin/gbrcn/media/downloads/GBRCN\\_Final\\_Report/GBRCN-FinalReport2012.pdf](http://www.gbrcn.org/fileadmin/gbrcn/media/downloads/GBRCN_Final_Report/GBRCN-FinalReport2012.pdf). Partners include Centro de Referência em Informação Ambiental (CRIA), Campinas.

<sup>55</sup> *Ibid* 44 (Latorre 2005)

Association of Zoos and Aquariums (EAZA, a WAZA member) represents 345 institutions (including national associations) in 41 countries, including 299 institutions in EU countries<sup>56</sup> (an underestimate of zoo numbers, since national associations also include institutions that are not EAZA members). The Asociación Latinoamericana de Parques Zoológicos y Acuarios (ALPZA, also a WAZA member) has 4 Brazilian members<sup>57</sup>.

## 5. Agricultural collections

Global and national food security is a high priority for governments, and consequently they have relatively good knowledge of their public collections holding plant, animal, aquatic, forest, invertebrate and microbial genetic resources, for food and agriculture, and sectoral cooperation is strong.

European countries hold a vast range of *ex situ* collections. European national genebanks hold approximately one quarter of the world's *ex situ* plant germplasm accessions, and are also involved in the conservation of crop wild relative diversity. The majority of recent acquisitions of germplasm by European countries was collected nationally or from nearby countries. Most European states have long-, medium- and short-term seed storage facilities as well as field genebanks<sup>58</sup>. The Nordic countries (Denmark, Finland, Iceland, Sweden and Norway) coordinate their efforts via NordGen, the Nordic Genetic Resource Centre<sup>59</sup>.

The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative programme involving national institutes in most European countries (including all EU countries but Luxembourg), contributing to national, sub-regional and regional programmes in Europe. ECPGR is coordinated by a secretariat hosted by Bioversity International and structured into Crop and Thematic networks; national coordinators link back to each country's national institutes. ECPGR also offers web access to crop and multi-crop databases<sup>60</sup>. The EURISCO web catalogue receives data from the national inventories<sup>61</sup> and provides access to all public *ex situ* plant genetic resources information in Europe. Countries vary widely in the number of accessions that they hold<sup>62</sup>

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<sup>56</sup> [www.eaza.net](http://www.eaza.net)

<sup>57</sup> [www.alpza.com/index.php](http://www.alpza.com/index.php)

<sup>58</sup> Commission on Genetic Resources for Food and Agriculture (2010) The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome. <http://www.fao.org/docrep/013/i1500e/i1500e.pdf>

<sup>59</sup> [www.nordgen.org](http://www.nordgen.org)

<sup>60</sup> including those maintained at the National Botanic Garden of Belgium and the Millennium Seed Bank at Kew; [www.ecpgr.cgiar.org](http://www.ecpgr.cgiar.org)

<sup>61</sup> [http://eurisco.ecpgr.org/about/the\\_network/online\\_national\\_inventories.html](http://eurisco.ecpgr.org/about/the_network/online_national_inventories.html)

<sup>62</sup> Germany reports 155,000 accessions of more than 3000 species, held in 11 institutes, while Slovenia's 3 institutes hold 3100 accessions of 40 species

and the extent to which the focus is on native plant genetic resources or resources from other countries.

The European Forest Genetic Resources Programme (EUFORGEN) is a platform for European cooperation to promote conservation and sustainable use of forest genetic resources; Bioversity International also hosts its secretariat<sup>63</sup>. Focus in EU countries is on agriculturally and horticulturally important species and conservation of native forest species – resources that can be maintained in outdoor gene reserve forests in European climates, so of rather less relevance to Brazil than many other types of *ex situ* collection.

The regional platform to support conservation and sustainable use of animal genetic resources for food and agriculture is the European Regional Focal Point for Animal Genetic Resources<sup>64</sup>. However, unlike plant genetic resources, few livestock animal genetic resources are held in the public domain, transfer tends to take place using private contracts between companies or individuals, and the transfer of genetic material from the developed ‘North’ to the developing ‘South’ between regions of the North, and South to South is currently much more significant than transfer from South to North<sup>65</sup>.

In Brazil, the national organisation for pure and applied agricultural research is Embrapa<sup>66</sup>, the Brazilian Agricultural Research Corporation, affiliated with the Ministry of Agriculture. Embrapa’s mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. Embrapa contains many different research centres, including the Genetic Resources and Biotechnology Centre.

Until 2008, Brazil’s National Network of Genetic Resources (RENARGEN), created in 1984, helped to coordinate the activities of Embrapa research centres, state agricultural research institutions and universities to support more efficiently their research on and conservation of food and agriculture. RENARGEN was made up of eleven research projects. RENARGEN’s major activities concern: (a) enrichment: germplasm collection, introduction, exchange and quarantine; (b) conservation *in situ* (either in nature or on-farm) and *ex situ* (*in vitro* plant cultures; microbial cultures; cryopreservation of seed, semen, embryos and oocytes); (c) phenotypic and genetic characterization; and (d) information exchange. The network maintained a Curatorship System and an

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<sup>63</sup> [www.euforgen.org](http://www.euforgen.org)

<sup>64</sup> [www.rfp-europe.org](http://www.rfp-europe.org)

<sup>65</sup> Commission on Genetic Resources for Food and Agriculture (2009) The use and exchange of Animal Genetic Resources for food and agriculture. Commission on Genetic Resources for Food and Agriculture Background Study Paper no. 43, <ftp://ftp.fao.org/docrep/fao/meeting/017/ak222e.pdf>

<sup>66</sup> [www.embrapa.br](http://www.embrapa.br)

Information System called Sibrargen (Brazilian Information System for Genetic Resources)<sup>67</sup>.

In early 2009, Brazil launched an innovative structure for the conservation and sustainable use of its genetic resources, known as the Brazilian Platform of Genetic Resources, under the leadership of the National Research Centre for Genetic Resources and Biotechnology (Cenargen), one of the 47 Research Centres of the Brazilian Agricultural Research Corporation (Embrapa). This Platform replaced RENARGEN.

This Platform comprises four networks. The first one is responsible for the utilization and conservation of plant genetic resources; the second one for animal genetic resources, and the third for genetic resources of microorganisms. The fourth one is a horizontal network, and comprises six research projects that are integrated with the other three networks. Among these six projects, the first one deals with the management of the Platform as a whole, while the others are research projects: Germplasm Curatorship System; Documentation of Genetic Resources; Germplasm Exchange; Germplasm Quarantine; and Implementation of ABS.

The Plant Network comprises one Management project, with 10 projects that deal with the conservation, characterization and utilization of the different products (Cereals, Oily Crops, Vegetables, Forages, Fruits, Medicinal, Ornamental, Forests and Palm Trees, Industrial Crops, and Roots and Tubers), as well as three cross-cutting projects (Base Collection, Germplasm Collection, and *In Situ* On Farm Conservation). Currently, the base collection has almost 110,000 accessions, making it the 7<sup>th</sup> largest world collection.

The Animal Network comprises six research projects: Management of the Animal Network; *Ex situ* Conservation; *In situ* conservation of Large Livestock Species; *In situ* conservation of Small Livestock Species; Genetic Characterization; and Conservation of Wildlife with Economic Potential. This network is composed of Conservation Nuclei of locally adapted livestock breeds of eight different species (cattle, horses, buffaloes, sheep, goats, pigs, donkeys and chickens), that are distributed all over the country. The Animal Gene Bank stores over 65,000 semen samples and about 500 embryos, as well as 12,000 DNA samples.

The Microorganisms Network comprises five research projects: Management of the Network; Multifunctional Microorganisms; Biological Control Agents; Phytopathogenic Microorganisms; and Microorganisms of Importance to the Agro-industry and to Animal

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<sup>67</sup> Mariante, A.S., Albuquerque, M.S.M., Egito, A.A., McManus, C., Lopes, M.A. & Paiva, S.R. (2009) Present status of conservation of livestock genetic resources in Brazil. *Livestock Science* 120:204-212; <http://plataformarg.cenargen.embrapa.br/pnrg/rede-animal/publicacoes/Artigo%20Presente%20Status%20of%20Conservation-2008.pdf>

Production. This network is formed by 34 collections with an approximate total of 45,000 accessions.

The Brazilian Genetic Resources Platform, as a whole, includes 31 research projects and 170 action plans, being developed at 35 Embrapa Research Centres as well as in 70 partner institutions, by a total of 520 researchers. Such a structure shows the high priority that the country gives to the conservation and sustainable use of its genetic resources.

## 6. Collections of derivatives, extracts, and genetic information: DNA and tissue banks, compound libraries and genetic sequence databases

### 6.1. DNA and tissue banks

Storage in DNA banks allows for DNA to be readily available to researchers for the characterisation and utilization of biodiversity. DNA banks are not yet commonplace in gardens, zoos and agricultural genebanks due to the expensive requirements for equipment, supplies and trained personnel<sup>68</sup>. However their numbers are growing worldwide, especially with the development of the International Barcode of Life (IBOL) project<sup>69</sup>, which necessitates the extraction and isolation of DNA. A 2004 global survey of the Plant Genetic Resources community found that only 20% of 243 respondents stored DNA, and 98% of those institutions stored DNA in order to ensure its availability for research activities, rather than as a gene/genome conservation measure (29%) or duplicate safety measure (8%)<sup>70</sup>.

New networks for tissue and DNA banks are being created to coordinate efforts and increase their availability, representing a large range of organisation types and research foci. The International Society for Biological and Environmental Repositories (ISBER)<sup>71</sup> aims to address harmonisation of scientific, technical, legal and ethical issues relevant to repositories of biological and environmental specimens. Its European regional chapter, the European, Middle Eastern & African Society for Biopreservation and Biobanking (ESBB), currently has 37 members, 33 in the EU<sup>72</sup>. ESBB members are chiefly health-care related institutions, although the intended scope of ISBER and ESBB includes

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<sup>68</sup> Although these costs vary, depending on whether DNA is isolated and stored in aliquots in -80C freezers, or more simply stored as plant samples in silica gel at -20C, as at Missouri Botanical Garden

<sup>69</sup> [www.ibol.org](http://www.ibol.org). Brazil participates in IBOL via the BrBOL Project (Brazilian Barcode of Life), a Brazilian consortium of almost one hundred institutions: see [www.brbol.org](http://www.brbol.org).

<sup>70</sup> Andersson, M.S., Fuquen, E.M. & de Vicente, M.C. (2006) State of the art of DNA storage: results of a worldwide survey. In: de Vicente, M.C. & Andersson, M.S. (eds) DNA banks – providing novel options for genebanks? Topical Reviews in Agricultural Biodiversity. International Plant Genetic Resources Institute, Rome, Italy. [http://cropgenebank.sgrp.cgiar.org/images/file/learning\\_space/dna\\_banks.pdf](http://cropgenebank.sgrp.cgiar.org/images/file/learning_space/dna_banks.pdf)

<sup>71</sup> [www.isber.org](http://www.isber.org)

<sup>72</sup> [www.esbb.org/biobanks.html](http://www.esbb.org/biobanks.html)

environmental specimen and museum biobanks. There is currently no regional ISBER chapter for South America.

Closer to the focus of this paper and the workshop, several CETAF institutions hold important DNA banks, such as BGBM, Kew and the Royal Botanic Garden Edinburgh<sup>73</sup>. Five Polish institutions have established the National Plant, Fungi and Animal DNA Bank<sup>74</sup>. BGBM coordinates the DNA Bank Network, which currently includes the DNA banks of 5 German collections, the Austrian Institute of Technology and the New York Botanical Garden, representing all kingdoms of life. The network can accept the deposit of samples after project completion or data publication, and enables other researchers to use material remaining from previous studies<sup>75</sup>.

In Brazil, the Rio de Janeiro Botanical Garden holds a DNA Bank of Brazilian Flora Species, storing DNA from the garden's collections, special taxonomic groups, flagship and endangered species, and species from endangered ecosystems (especially Atlantic rainforest species)<sup>76</sup>. In the field of food and agriculture, Embrapa's Laboratory of Animal Genetics (LGA) maintains a DNA bank of native breeds of major domestic animal species in the country. Many of the breeds sampled are at risk of extinction and have been preserved in Cores of Conservation under RENARGEN<sup>77</sup>. Several Brazilian universities also hold important and diverse DNA and tissue collections<sup>78</sup>, principally the University of São Paulo, the Federal University of Amazonas, São Paulo State University (UNESP), University of Campinas (UNICAMP) and the Federal University of Espírito Santo. EMBRAPA amongst its other collections maintains a DNA bank for Pantanal fish diversity.

The Global Genome Biodiversity Network (GGBN) is new network of 'well-managed cryopreserved collections of genomic tissue samples from across the Tree of Life.' It currently involves over 20 collaborators including the DNA Bank Network, the Natural History Museum of Denmark, and the Natural History Museum, as well as institutions in the US, Colombia, China, Australia and South Africa<sup>79</sup>.

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<sup>73</sup> [www.bgbm.org/bgbm/research/dna/](http://www.bgbm.org/bgbm/research/dna/); <http://apps.kew.org/dnabank/homepage.html>;  
[www.rbge.org.uk/science/scientific-and-technical-services/molecular-laboratory-facilities](http://www.rbge.org.uk/science/scientific-and-technical-services/molecular-laboratory-facilities)

<sup>74</sup> [www.bankdna.pl](http://www.bankdna.pl)

<sup>75</sup> <http://wiki.bgbm.org/dnabankwiki>; see also its non-exhaustive list of other non-human DNA banks

<sup>76</sup> [http://www.jbrj.gov.br/pesquisa/div\\_molecular/bancodna/sobre\\_ing.htm](http://www.jbrj.gov.br/pesquisa/div_molecular/bancodna/sobre_ing.htm)

<sup>77</sup> <http://plataformarg.cenargen.embrapa.br>

<sup>78</sup> See CGEN list of Instituições Fiéis Depositárias (Trustee institutions):  
[www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes\\_fieis\\_depositarias\\_04-2013.pdf](http://www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes_fieis_depositarias_04-2013.pdf)

<sup>79</sup> <http://ggbn.org/>

## 6.2. Extracts and compounds

A wide range of organisations use and store extracts and isolated compounds derived from genetic resources, though these ‘collections’ are predominantly held in the private sector, and are not the focus of this *ex situ* collections workshop. They include collections of extracts used in many products (such as cosmetics, medicinal products, health foods and other health products), and compound libraries of stored chemicals for use in high-throughput screening for drug discovery.

Raw material for the natural personal care and cosmetics sector is generally supplied via trade networks (with varying levels of ABS-awareness, using wild-harvested or cultivated sources), and various companies then develop and test the extracts and products. In some cases the supply chain is very short, but more often larger companies use intermediaries, such as for-profit brokers and research institutions. The lists of ingredients used and supplied by this sector are most often derived from already well-known species (on health authorities’ approved lists), but the industry is characterised by its secrecy towards its ingredients and sources<sup>80</sup>. The botanical medicines sector can be similarly summarised. European-based companies have been very dominant in the botanical supply industry, and within Europe the trade is dominated by a few wholesalers<sup>81</sup>.

The Union for Ethical BioTrade (UEBT)<sup>82</sup> is a relatively new (2007) association that promotes the ‘Sourcing with Respect’ of ingredients that come from biodiversity and has members in the food, cosmetics and pharmaceutical sectors. A significant proportion of UEBT’s 10 provisional, 31 trading and 18 affiliate members globally to date are Brazilian companies and organisations. Few European companies are involved at this stage; of those, most are from France.

Pharmaceutical companies have greatly reduced their reliance on in-house collections of natural products and extracts for their research due to the development of mass-produced compound libraries produced via combinatorial chemistry and the manipulation of biosynthetic pathways in microbes using combinatorial biosynthetic techniques, as well as the increased legal uncertainty related to ABS. Most pharmaceutical companies closed their natural products research programmes. However the industry is looking again to natural products, using genome mining (often in microbes), and solving some supply issues by using advanced synthetic chemistry technology – and effectively outsourcing the

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<sup>80</sup> ten Kate, K. & Laird, S.A. (1999) *The Commercial Use of Biodiversity: Access to Genetic Resources and Benefit-Sharing*. Earthscan, UK.

<sup>81</sup> *Ibid.*

<sup>82</sup> [www.ethicalbiotrade.org](http://www.ethicalbiotrade.org)

discovery of hits and leads to universities, public institutes, and smaller discovery companies<sup>83</sup>.

Many compound libraries are held by European pharmaceutical companies represented by the European Federation of Pharmaceutical Industries and Associations (EFPIA)<sup>84</sup>, which has participated actively in European ABS discussions and the NP negotiations. EFPIA members include 33 national pharmaceutical industry associations (in all EU countries) and 40 leading research-based pharmaceutical companies. Also in Europe, EuropaBio (the European Association for Bioindustries) around 1800 small and medium sized biotech enterprises across Europe (56 corporate and 14 associate members and 19 national biotechnology associations)<sup>85</sup>.

At the global network level, the International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)<sup>86</sup> has 13 European pharmaceutical association members and 12 member companies. There are no Brazilian IFPMA member companies, but the Brazilian association member, INTERFARMA (the Brazilian Research-based Pharmaceutical Manufacturers Association)<sup>87</sup> currently has 47 member companies, many of which are Brazilian subsidiaries of Europe-based multinationals.

### 6.3. Genetic sequence databases

Genetic (and increasingly, genomic) information is now a central tool for identification, taxonomy, conservation, environmental monitoring and many other areas of biodiversity research, and is becoming integral to the activities of all the *ex situ* collections communities detailed above. Permanent storage of such information is important, and required by publishers of genetic research, and patent authorities.

The many partners and projects involved in the IBOL initiative are generating DNA barcode data, which can then be submitted to the Barcode of Life Database (BOLD)<sup>88</sup>. The BOLD platform is a bioinformatics workbench aiding the acquisition, storage, analysis and publication of DNA barcode records. BOLD is not itself a primary repository: it makes block transfers to GenBank using a high-throughput database-to-database protocol<sup>89</sup>.

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<sup>83</sup> Secretariat of the Convention on Biological Diversity (2008)

<sup>84</sup> [www.efpia.eu](http://www.efpia.eu)

<sup>85</sup> [www.europabio.org/members](http://www.europabio.org/members)

<sup>86</sup> [www.ifpma.org](http://www.ifpma.org)

<sup>87</sup> [www.interfarma.br](http://www.interfarma.br)

<sup>88</sup> [www.boldsystems.org](http://www.boldsystems.org)

<sup>89</sup> [www.barcoding.si.edu/CBOLDatabasesBOLD.htm](http://www.barcoding.si.edu/CBOLDatabasesBOLD.htm)

GenBank (under the US National Institutes of Health) is one of the three giant genetic sequence databases for long-term storage of genetic information, as well as the DNA DataBank of Japan (DDBJ), or the European Molecular Biology Laboratory (EMBL). All three cooperate via the International Nucleotide Sequence Database Collaboration (INSDC)<sup>90</sup> and exchange data on a daily basis, although they use slightly different data submission and retrieval tools. All three have agreed to the data standards of the Consortium for the Barcode of Life (CBOL) for barcode records<sup>91</sup>.

The European Bioinformatics Institute (EBI) is part of EMBL, and maintains the world's most comprehensive range of freely available molecular databases; it also conducts basic research, and trains scientists in academia and industry on bioinformatics. The databases and tools span the full range of molecular biology, covering DNA and RNA sequences, protein sequences, gene expression, chemical biology and metabolomics, and full systems<sup>92</sup>.

## 7. Collections and the Nagoya Protocol

Many *ex situ* collections from the diverse communities described above have gradually developed or are developing responses to the CBD's core provisions on ABS – particularly the needs for prior informed consent, mutually agreed terms and benefit-sharing. However the NP presents new challenges that current policies and systems may not yet address. The NP establishes a framework (more detailed than that of the CBD) for actions by countries, and also a clearing house that will share ABS information internationally, including information on permits. This section identifies some of the new terms and provisions that have particular relevance for collections.

It is still too early to know how individual countries' Nagoya implementation measures will affect collection management, but European implementation will certainly be shaped by the draft European regulation on ABS, and Brazilian implementation will be shaped by Brazilian legislation. The European draft proposes measures to address user compliance, identifies collections as potential intermediaries and assigns to them key responsibilities to undertake due diligence.

This paper will then survey the standards, codes and tools that are currently used by different collections sectors, to provide a background for discussion of their suitability or

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<sup>90</sup> [www.insdc.org](http://www.insdc.org)

<sup>91</sup> [www.barcoding.si.edu/PDF/DWG\\_data\\_standards-Final.pdf](http://www.barcoding.si.edu/PDF/DWG_data_standards-Final.pdf)

<sup>92</sup> [www.ebi.ac.uk](http://www.ebi.ac.uk)

otherwise to meet the requirements of the NP and enable stronger cooperation between European and Brazilian collections.

## 7.1 New Nagoya implications for collections

### 7.1.1 Utilisation

The NP to a certain extent uncouples ‘access’ from ‘benefit-sharing’ and focuses on benefit-sharing arising from the ‘utilisation’ of genetic resources, which also includes the benefits from derivatives (Article 2). Collections will need to examine the Protocol definition of ‘utilisation’ and decide how it may affect their policies and practices. Taxonomy – at least the growing field of molecular systematics – is included, as a form of research: the investigation and study of the genetic and/or biochemical composition of genetic resources in order to establish facts and reach new conclusions<sup>93</sup>, while some other uses such as conservation, and propagation and cultivation in the form received, which do not necessarily involve research (or development) on the *genetic* aspect of genetic resources, are somewhat less clearly covered by the ‘utilization’ concept.

### 7.1.2 Temporal scope and other ABS instruments

Collections must already consider how they will handle material acquired pre- and post-CBD, but will also need to consider how to handle material collected post-CBD but before the entry into force of the NP, as well as, potentially, the date of ratification of the Protocol by the particular country providing the resource. In the case of resources on Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture held in public collections in ITPGRFA Parties and requested for food- and agriculture-related purposes, the date of acquisition and access are irrelevant – but collections managers will still have to be able to navigate the patchwork of ABS regulations for the various potential situations.

### 7.1.3 Non-commercial research and changes in intent

Countries are expected to create conditions to promote and encourage research related to conservation and sustainable use, and may use simplified measures on access non-commercial research purposes, while also addressing possible changes in intent (Article

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<sup>93</sup> See Greiber, T., Peña Moreno, S., Åhrén, M., Nieto Carrasco, J., Kamau, E.C., Cabrera, J., Oliva, M.J., & Perron-Welch, F., in cooperation with Ali, N. & Williams, C. (2012) An Explanatory Guide to the NP on Access and Benefit-sharing. IUCN, Gland, Switzerland.

8(a)). To some extent ‘the need to address a change of intent’ is simply a re-stating of the general CBD/NP requirement for prior informed consent (PIC) and mutually agreed terms (MAT), but where simplified measures are developed, collections acquiring material under these terms will need to record the limits of the terms and remain alert to any changes in researchers’ and subsequent users’ interests.

#### 7.1.4 Monitoring, certificates and checkpoints

The Protocol introduces specific requirements to monitor the utilisation of genetic resources (Article 17), and these provisions have high relevance to collections. Documentation of basic scientific information is neither new nor difficult. Scientific collections almost always necessarily maintain information relating to original collection (such as collector’s name, date and location). However, not all have developed fail-safe, user-friendly means to keep track of evidence of PIC and MAT and to pass this information to other users – let alone means to track individual uses of specimens. As more specimens are databased and digitised, and electronic means of annotating specimens are developed<sup>94</sup>, the capacity to track their use and movements (including of samples and extracts) will increase, but currently there is a very wide range of practices, and despite intensive efforts in the last decade, few of even the relatively well-resourced major collections are well-digitised at the specimen unit level.

Institutions currently use a huge range of different database systems for collections management, some developed in-house, some by third parties. Database designers across the board will need to work with collections personnel to create interfaces that will allow the easier input of (and user access to) links to relevant CBD-related data and documents, such as internationally recognised certificates of compliance, and agreements that set out mutually agreed terms.

Certificates of compliance, if well- implemented, may prove helpful for collections: a document that pulls together all of the ABS-relevant information on PIC and MAT and is assigned a unique identifier that can be easily added to labels and database fields will be much simpler to keep linked to specimens as they are used and transferred than a mass of separate documents.

The NP also requires Parties to designate checkpoints to receive and provide information on prior informed consent, source, mutually agreed terms and/or utilization. Some countries may decide to involve *ex situ* collections as checkpoints, which in most

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<sup>94</sup> For example via the FilteredPush network project, <http://wiki.filteredpush.org/wiki/>

institutions would require the development and maintenance of new mechanisms to cope with high levels of information exchange.

#### 7.1.5 Associated traditional knowledge

Traditional knowledge associated with genetic resources is thoroughly knit into the substance of the NP (Articles 5, 7, 11, 12, 16). Many *ex situ* collections do hold specimens that are accompanied with some information relating to their traditional use, either on specimen labels, or in specialised ethnobotanical collections. However, very few *ex situ* collections have policies or practices that address how TK is handled, shared or used, and a huge amount of capacity-building is needed for users. It is to be hoped that NP Parties will work actively to support indigenous and local communities to develop community protocols, and are also supportive of efforts by user and provider communities to develop model contractual clauses and practical advice that can assist collections to handle and curate this information appropriately.

#### 7.1.6 Codes of conduct and model contractual clauses

On a very positive note, the NP recognises that different sectors access, use and supply genetic resources in very different ways, and Parties should encourage sectors to themselves develop appropriate model contractual clauses and voluntary codes/guidelines/best practices to meet the requirements of the Protocol and their own practical needs and constraints (Articles 19 and 20). Section 6.3 explores the range of ABS codes and models that have so far been developed and/or used by European collections.

#### 7.1.7. Cooperation, technology transfer and capacity-building

The CBD contains provisions on technology transfer, exchange of information and technical and scientific cooperation (CBD Articles 16-18), many of which are highly relevant to *ex situ* collections. The NP reiterates and re-emphasises the importance of such cooperation: Article 23 emphasises the importance of collaboration and cooperation in technical and scientific research, and access to technology by, and transfer of technology to, developing countries, for the development of a viable scientific base for the attainment of CBD and NP objectives.

The NP also identifies key areas for ABS-related capacity-building (Article 22) that countries may need to address, again with relevance to *ex situ* collections, such as capacity to negotiate MAT and capacity to develop endogenous research capabilities, as well as numerous possible measures such as bioprospecting, associated research and taxonomic

studies; technology transfer and capacity to make technology transfer sustainable; and enhancement of the contribution of ABS activities to conservation and sustainable use. The NP encourages the sharing of information on capacity-building initiatives via the ABS Clearing-House to promote synergy and coordination.

## 7.2 Draft European Regulation on ABS and its implications for collections

Exchange between collections in the European Union and those in other countries is currently affected by national and regional regulations relating to endangered species and trade (e.g. CITES regulations), animal and plant health, and transportation of dangerous goods, but European governments have not yet developed specialised ABS regulations relating to use and exchange of genetic resources in collections. A proposal for a 'Regulation of the European Parliament and of the Council on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union' is presently being discussed by EU member states and the Council, with the aim of agreeing commitment in time for the next CBD COP in 2014. The current draft Regulation puts a strong emphasis on the role of *ex situ* collections, proposing a system of 'Union Trusted Collections'<sup>95</sup>.

The European participants of this workshop are aware of the substance of discussions and the possible implications for their institutions. In brief, a register of such trusted collections will be kept by the European Commission, and to be considered as a trusted collection, a collection will need to (a) apply standardised procedures for exchange; (b) only supply material and related information with documents providing evidence that they were accessed legally, with PIC and MAT as appropriate; (c) keep records of all samples and information supplied to third parties; (d) use unique identifiers for samples supplied; and (e) use appropriate tracking and monitoring tools for exchanging samples with other collections. When users acquire material from 'trusted collections', they will be considered to have exercised due diligence with respect to ABS. The draft Regulation's preamble notes that collecting of genetic resources in the wild is mostly undertaken for non-commercial purposes, and that in the majority of cases and across user sectors, access to newly-collected resources is gained via intermediaries, collections or other agents. In effect, the draft Regulation positions EU collections firmly between providers and users. Consequently *ex situ* collections in all sectors are in the process of determining whether, and how, they will need to change their practices to account for a possible increase in demand from commercially-orientated users, and whether the costs (of implementing comprehensive monitoring mechanisms, and of negotiating with providers terms that

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<sup>95</sup> [http://ec.europa.eu/environment/biodiversity/international/abs/index\\_en.htm](http://ec.europa.eu/environment/biodiversity/international/abs/index_en.htm)

might need to extend to later commercialisation) involved in being a ‘trusted collection’ outweigh the benefits.

Once the Regulation is adopted, it will have effect in member states, which will each then need to decide on what changes are needed at the national level. However, the draft Regulation provides no prescription as to exactly how collections should implement ABS, as long as those that are registered as ‘trusted’ can fulfill the legal and tracking requirements, and (like the NP) suggests complementary measures, such as the development of sectoral codes of conduct, model contractual clauses, guidelines and best practices. Hence ABS measures will likely continue to be developed and implemented on a voluntary sector-specific basis.

### 7.3 ABS measures developed by collections communities

Recognising that they need to understand and comply with the CBD in order to continue and build their international activities, *ex situ* collections sectors have developed an extensive array of voluntary responses, ranging from awareness-raising and guidance tools, to institutional policies and policy frameworks, to model agreements, to multilateral systems with standard documentation. Sectors and collections differ in the extent to which they maintain documentation that allows material to be tracked (followed up from the end user back to the provider) or traced (where every single movement of a resource is registered), in part depending on the level of perceived risk of misappropriation of the specific material, and the resources available to invest in tracking systems and personnel.

#### 7.3.1 Botanic gardens

The botanic gardens sector was one of the first to recognise the importance of developing ABS policies and implementation measures, and European gardens have led these efforts. A four-year pilot project coordinated by Kew and funded by the UK Department for International Development brought together 28 botanical institutions (including the Jardim Botânico do Rio de Janeiro) from 21 developed and developing countries, and agreed on Principles on Access to Genetic Resources and Benefit-Sharing and Common Policy Guidelines to assist with their implementation<sup>96 97</sup>. Several model agreements were also developed. The one-page Principles cover acquisition, use and supply of genetic resources, use of written agreements, curation, and benefit-sharing, and are intended to be

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<sup>96</sup> [www.bgci.org/resources/abs\\_principles/](http://www.bgci.org/resources/abs_principles/); [www.kew.org/conservation/principles.html](http://www.kew.org/conservation/principles.html)

<sup>97</sup> Latorre, F., Williams, C., ten Kate, K. & Cheyne, P. (2001) Results of the Pilot Project for Botanic Gardens: Principles on Access to Genetic Resources and Benefit-Sharing, Common Policy Guidelines to assist with their implementation and Explanatory Text. Royal Botanic Gardens, Kew.

used by gardens to structure an institutional policy that covers all of their ABS-relevant activities and collections (including any commercial activities such as plant sales). The North-South nature of the pilot project helped to build trust and awareness in biodiverse developing countries, and the Principles on ABS have been formally endorsed by 22 institutions, from 13 countries (5 developed countries, though only 2 in the EU, and 8 developing countries), including several of the world's major biodiversity collections such as Kew, BGBM, the Royal Botanic Garden Edinburgh, the Missouri Botanical Garden, the New York Botanical Garden, Jardim Botânico do Rio de Janeiro and the South African National Biodiversity Institute<sup>98</sup>.

However, the more detailed Common Policy Guidelines were perceived by many European institutions as being overly cumbersome, especially for the many small gardens with few staff, as was the Principles' requirement for gardens to develop their own institutional policy. Institutions vary widely in their capacities and resources for monitoring, and the Principles do not prescribe how resources should record terms and conditions, or track resources, or record supply. There is currently no requirement to make publicly available the policies or practices that are developed under the Principles, and there is no organisation that assists endorsing institutions to put them into practice, or monitors compliance, so although the Principles on ABS can provide helpful guidance, it is not clear how effective an implementation measure they have proved to be.

The International Plant Exchange Network (IPEN) is a registration system developed by the Verband Botanischer Gärten (association of gardens in German-speaking countries) to facilitate the exchange of living plant material for non-commercial use between member gardens while respecting the CBD provisions on ABS<sup>99</sup>. It has been formally endorsed by the European Botanic Gardens Consortium and has a Task Force for its implementation.

IPEN member gardens sign and abide by a Code of Conduct that sets out gardens' responsibility for acquisition, maintenance and supply of living plant material and associated benefit-sharing. Each plant put into the IPEN system receives an IPEN number from the garden that first accessions it. The IPEN number contains four elements – a code for the country of origin, a code to indicate restrictions for transfer, the first garden's code, and an identification number, the accession number of the garden – and is a unique identifier for that material. The accession's full information (including scientific data and permits) is maintained by the first institution (the 'maximum documentation'), but the plant and its descendants, with the same IPEN number, can be exchanged between IPEN

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<sup>98</sup> [www.kew.org/conservation/endorsements.html](http://www.kew.org/conservation/endorsements.html)

<sup>99</sup> [www.bgci.org/resources/ipen/](http://www.bgci.org/resources/ipen/)

members without using Material Transfer Agreements (MTAs), and only the ‘minimum documentation’. Acquisition or supply of material with extra terms and conditions or any use for commercial purposes is outside the scope of IPEN and requires the use of the IPEN MTA. Herbarium material, DNA extracts and other non-living specimens are not covered by IPEN, so the IPEN MTA is used to transfer them. In the case of commercialisation, new prior informed consent must be obtained from the original provider by the prospective user before any material is supplied from an IPEN garden<sup>100</sup>.

There are currently 157 IPEN members, from 25 countries (140 members from 21 European countries, including 135 members from 17 EU countries). IPEN awareness and membership in the US is likely to expand now that Missouri Botanical Garden has joined. IPEN has not yet been taken up by gardens in any developing countries, possibly due its European grass-roots origins, or perhaps to the difficulty of accommodating more restrictive terms from permits, or to providers’ concerns about relatively free exchange within a multilateral system with less direct ‘personal’ links to the provider country – although the IPEN system ensures that the original link to provider countries is maintained during all transfers.

IPEN cannot be used for material collected with very restrictive terms, and does not cover other types of collections often found in European botanic gardens, such as herbaria (or, increasingly, DNA and tissue banks), except to the extent that the MTA is used. Thus, the full range of an IPEN member’s activities and collections may not be carried out within IPEN’s multilateral, facilitated-access system – but the tracking system itself, with its unique identifiers, could certainly be extended for use with all collections (as is the intention at Missouri Botanic Garden<sup>101</sup>).

Regardless of their membership or endorsement of particular ABS systems, several botanic gardens have made available their institutional policies on ABS, including Kew<sup>102</sup>, the National Botanic Gardens Glasnevin, Ireland<sup>103</sup>, Royal Botanic Garden Edinburgh<sup>104</sup> and BGBM (which sets out how IPEN is used to implement the Principles on ABS)<sup>105</sup>.

MTAs are commonly used for transfer of specimens (hence the development of IPEN for gardens that struggled with the amount of documentation involved in traditional seed exchange), enabling some tracking, although MTAs themselves do not necessarily

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<sup>100</sup> [www.bgci.org/resources/Description\\_of\\_IPEN/](http://www.bgci.org/resources/Description_of_IPEN/)

<sup>101</sup> A. Wyatt, pers. comm. (2012)

<sup>102</sup> [www.kew.org/conservation/docs/ABSPolicy.pdf](http://www.kew.org/conservation/docs/ABSPolicy.pdf)

<sup>103</sup> [www.botanicgardens.ie/educ/accnosho.pdf](http://www.botanicgardens.ie/educ/accnosho.pdf)

<sup>104</sup> [www.rbge.org.uk/assets/files/science/Herbarium/Destructive\\_sampling\\_policy.pdf](http://www.rbge.org.uk/assets/files/science/Herbarium/Destructive_sampling_policy.pdf);  
[www.rbge.org.uk/assets/files/databases/RBGEcond.pdf](http://www.rbge.org.uk/assets/files/databases/RBGEcond.pdf)

<sup>105</sup> [www.bgbm.org/BGBM/research/colls/garden/CBD.HTM](http://www.bgbm.org/BGBM/research/colls/garden/CBD.HTM)

communicate all of the original terms and conditions of acquisition. To handle large flows of specimens, Kew, among other institutions, uses MTAs with standard terms of use and transfer, including non-commercialisation, which may sometimes be more restrictive than the provider's original terms (though where original terms are more restrictive, those terms are recorded and respected). Furthermore, such institutions routinely handle preserved specimens (perceived as having lower risk of misappropriation) in batches<sup>106</sup>, without recording individual specimen movements, except in the case of type or historic material, so responsibility falls onto collectors and researchers to ensure that provider country details and any restrictive terms are clearly recorded on labels/database fields that travel with the specimens.

Given that individual curators, researchers and horticulturalists have the responsibility to ensure that specimens are acquired, used and supplied appropriately and that specimens and terms are kept linked, awareness-raising is extremely important at all levels of an institution. The botanic gardens sector has developed a range of CBD guidance tools materials that provide user-friendly information on ABS, such as the CBD for Botanists, a plain-language guide and training tool (with a focus on ABS) for people working with botanical collections<sup>107</sup>, and the CBD Manual for Botanic Gardens<sup>108</sup>, which contains a practical ABS checklist.

BGCI has recently updated the International Agenda for Botanic Gardens in Conservation, a policy framework for botanic gardens to contribute to biodiversity conservation, to include post-Nagoya information on ABS and a list of key tasks for consideration by gardens developing their implementation plans<sup>109</sup>. Currently there are 110 International Agenda registrants in EU countries<sup>110</sup>, though this number does not indicate ABS activity. BGCI also maintains ABS webpages that provide information on the Principles on ABS and IPEN, case studies and useful resources<sup>111</sup>.

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<sup>106</sup> See case study by K. Davis, P. Middlemiss, A. Paton & C. Tenner: The Royal Botanic Gardens, Kew: Herbarium and Millennium Seed Bank. In Tobin, B., Cunningham, D. & Watanabe, K. (2004) The feasibility, practicality and cost of a certificate of origin system for genetic resources : preliminary results of comparative analysis of tracking material in biological resource centres and of proposals for a certification scheme. UNEP/CBD/WG-ABS/3/INF/5, [www.cbd.int/doc/meetings/abs/abswg-03/information/abswg-03-inf-05-en.pdf](http://www.cbd.int/doc/meetings/abs/abswg-03/information/abswg-03-inf-05-en.pdf)

<sup>107</sup> Williams, C., Davis, K., & Cheyne, P. (2003 and updates) The CBD for Botanists: an introduction to the Convention on Biological Diversity for people working with botanical collections. Royal Botanic Gardens, Kew, UK. [www.kew.org/data/cbdbotanists.html](http://www.kew.org/data/cbdbotanists.html)

<sup>108</sup> Davis, K. (2008) A CBD Manual for Botanic Gardens. Botanic Gardens Conservation International, Richmond, UK. [www.bgci.org/resources/cbdmanual](http://www.bgci.org/resources/cbdmanual)

<sup>109</sup> BGCI (2012) International Agenda for Botanic Gardens in Conservation: 2<sup>nd</sup> edition. Botanic Gardens Conservation International, Richmond, UK. [www.bgci.org/files/Worldwide/News/SeptDec12/international\\_agenda\\_web.pdf](http://www.bgci.org/files/Worldwide/News/SeptDec12/international_agenda_web.pdf)

<sup>110</sup> BGCI GardenSearch database

<sup>111</sup> [www.bgci.org/resources/abs](http://www.bgci.org/resources/abs)

### 7.3.2 Natural history museums

To date there is no overarching set of ABS-related standards, codes or guidance tools for natural history museums, although general policy frameworks such as the Principles on ABS and guidance tools such as the CBD for Botanists and the Swiss Academy of Sciences Good Practice Guide (see 6.2.3) are quite applicable. Generally, individual institutions have developed their own collections policies and loan agreements, and these are increasingly likely to cover ABS. Documentation such as loan agreements allows for a certain amount of tracking of basic information, if the transaction is recorded in sufficient detail.

Based on the loan policies of 13 European natural history museums, the European Distributed Institute of Technology (EDIT) project<sup>112</sup> developed common loan principles, which have been since been adopted by the wider array of institutions involved in the Consortium of European Taxonomic Facilities as ‘CPB principles for research loans between natural history collections’<sup>113</sup>. The principles aim to facilitate access to collection material through loans while maximising their long-term preservation. The general policy statements include the provision that the signatory institution is committed to abiding to all international and national agreements covering the transfer of biodiversity specimens and products such as CBD, CITES and other agreements on access and benefit-sharing, e.g. the Bonn Guidelines. There are five key principles: (1) the availability of all specimens for research loan (but institutions reserve the right to refuse to lend any material at its discretion for transparent reasons, including unacceptable risk to items such as type and figured specimens, and specimens of high historical significance); (2) no charge for research loans; (3) the institution where the loan is to be housed must be safe and secure; (4) material will only be used for research, not for commercial purposes without prior agreement; and (5) the borrowing institution accepts that title to and ownership of loaned items remains with the lending institution. There are further requirements for sound documentation, restrictions relating to DNA/tissue sampling and destructive sampling, and specific statements covering molecular collections such as return of samples, notification of data sent to GenBank, and intellectual property rights related to molecular collections.

Most CETAF institutions hold very large numbers of diverse kinds of specimens, and often manage loans and exchanges on a batch basis – these institutions are generally not yet prepared for detailed monitoring and tracking of individual specimens and their movements using unique identifiers, unless significant new resources are located. In the

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<sup>112</sup> [www.e-taxonomy.eu/](http://www.e-taxonomy.eu/)

<sup>113</sup> EDIT principles: [http://www.e-taxonomy.eu/files/EDIT%20Common%20Loan%20Principles\\_vfinal.pdf](http://www.e-taxonomy.eu/files/EDIT%20Common%20Loan%20Principles_vfinal.pdf)

case of insect samples collected and stored *en masse* in containers, it may take decades before specimens are individually identified to species, although provider details and terms and conditions for the batch can still be passed on via labels and databases<sup>114</sup>.

The Museums Association Ethics Committee guidelines, although not designed specifically to cover the needs of natural history collections, stress the importance of using due diligence to acquire specimens legally, without infringing the national laws in countries of origin or international regulations such as CITES, and with documentation<sup>115</sup>.

### 7.3.3 University research collections and research institutes

There have been no overarching ABS guidelines, codes, or systems designed specifically for the use of university or research institute collections, but there are general guidance tools aimed at academic researchers. The 2005 UK stakeholder survey indicated that awareness of ABS provisions of the CBD (although not the Bonn Guidelines) seemed much higher in research institutions, universities and botanic gardens than in commercial organisations. Universities also appeared to be the only organisations who mainly acquired biological material from *in situ* sources<sup>116</sup>. As universities and research institutes are becoming important players in biodiscovery projects, supplying leads and hits to industry, ABS awareness is vital.

The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG), the self-governing funding organisation for science and research in Germany, actively promotes cooperation in science, as well as the interaction of science with industry and society<sup>117</sup>. The DFG has produced guidelines, including an ABS checklist with indication as to when ABS tools such as MTAs or ABS agreements are necessary to cover the proposed research. Funding applicants are required to 'describe specifically which competent authorities you have contacted or intend to contact, how the access procedure works in the host country, and how you rate the prospects for success. In addition please confirm that you have familiarised yourself with these CBD Guidelines and intend to conduct the project according to the principles described herein'<sup>118</sup>. The guidelines also prompt researchers to

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<sup>114</sup> See case study by L.P. Hirsch & A.C. Villegas: The Smithsonian Institution: the life of natural history museum specimens. In Tobin, B., Cunningham, D. & Watanabe, K. (2004) The feasibility, practicality and cost of a certificate of origin system for genetic resources : preliminary results of comparative analysis of tracking material in biological resource centres and of proposals for a certification scheme. UNEP/CBD/WG-ABS/3/INF/5, [www.cbd.int/doc/meetings/abs/abswg-03/information/abswg-03-inf-05-en.pdf](http://www.cbd.int/doc/meetings/abs/abswg-03/information/abswg-03-inf-05-en.pdf)

<sup>115</sup> [www.museumsassociation.org/ethics/ethical-guidelines](http://www.museumsassociation.org/ethics/ethical-guidelines)

<sup>116</sup> *Ibid.* 44 (Latorre 2005)

<sup>117</sup> [www.dfg.de/en/dfg\\_profile/mission/index.html](http://www.dfg.de/en/dfg_profile/mission/index.html)

<sup>118</sup> [www.dfg.de/download/programme/sonstige/antragstellung/1\\_021\\_e/1\\_021e.pdf](http://www.dfg.de/download/programme/sonstige/antragstellung/1_021_e/1_021e.pdf)

check whether their proposal involves a plant species covered by the ITPGRFA – in which case the guidelines do not apply.

The Swiss Academy of Sciences has produced a good practice manual for non-commercial academic researchers<sup>119</sup> that provides basic information on the CBD (and has been partially updated for the NP), considers case studies across diverse research areas (agriculture, ecology, botanical inventories, medicine and ethnobotany), sets out the basic steps for researchers to take regarding ABS requirements, and provides checklists to aid in the preparation of research projects. Working with models and examples provided by a range of international institutions, the Swiss Academy of Sciences has also developed a model ABS agreement for non-commercial research<sup>120</sup>, which includes options regarding the terms for storage or deposition of material in public collections, and use/transfer from those collections. The model agreement also includes options related to handling traditional knowledge.

Universities and research institutes with commercial interests, as well as private sector organisations and other users who are considering developing more complex projects with commercial potential and/or working with indigenous communities and traditional knowledge, can use the ABS Management Tool<sup>121</sup>. The ABS-MT is a best practice standard and handbook that provides voluntary guidance to help companies, researchers, indigenous and local communities and governments to understand and comply with the ABS requirements of the CBD and the NP. The tool provides elements for an MTA based on the Bonn Guidelines, but its focus is on guiding the overall process of negotiation and decision-making, not addressing practical issues such as specimen exchange. Its post-Nagoya update focuses on national implementation.

Unless institutions have developed their own MTAs and loan agreements, the standard agreement that is most likely to be used for academic transfer of biological material between universities and research institutes is probably the Uniform Biological Materials Transfer Agreement (UBMTA)<sup>122</sup>. The UBMTA was published in 1995 by the US National Institutes of Health for the transfer of biological materials for teaching and academic

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<sup>119</sup> Biber-Klemm, S. & Martinez, S.I. (2012) Access and Benefit Sharing: Good practice for academic research on genetic resources. Swiss Academy of Sciences, Bern, Switzerland. [http://abs.scnat.ch/downloads/documents/ABS\\_GoodPractice\\_2012.pdf](http://abs.scnat.ch/downloads/documents/ABS_GoodPractice_2012.pdf)

<sup>120</sup> Biber-Klemm, S., Martinez, S.I., Jacob, A. & Jevtic, A. (2010) Agreement on Access and Benefit Sharing for Non-Commercial Research: Sector specific approach containing model clauses. Swiss Academy of Sciences, Bern, Switzerland. [http://abs.scnat.ch/downloads/documents/NonCommResearch\\_ABS\\_Agreement.pdf](http://abs.scnat.ch/downloads/documents/NonCommResearch_ABS_Agreement.pdf)

<sup>121</sup> Stratos Inc., Burton, G. & Cabrera, J. (2012) ABS Management Tool: Best Practice Standard and Handbook for Implementing Genetic Resource and Benefit-Sharing Activities. Swiss State Secretariat for Economic Affairs, Switzerland. [www.sib.admin.ch/en/nagoya-protocol/abs-management-tool/index.html](http://www.sib.admin.ch/en/nagoya-protocol/abs-management-tool/index.html)

<sup>122</sup> [www.ott.nih.gov/NewPages/UBMTA.pdf](http://www.ott.nih.gov/NewPages/UBMTA.pdf)

purposes, and contains ABS-relevant terms relating to transfer, ownership and intellectual property, if not to key CBD concepts such as linkage to country of origin and benefit-sharing. Institutions that have signed the UBMTA Master Agreement can transfer materials to each other under the UBMTA once they have signed the Implementing Letter. The Association of University Technology Managers is the repository for the signed agreements and maintains the list of signatories to the Master UBMTA Agreement; there are currently 494, including a range of EU universities and research institutes, though US institutes are in the majority<sup>123</sup>. The AUTM has identified a set of principles to distinguish the legitimate expectations of the primary stakeholders in the technology commercialisation process – but with no ABS-related content. In an effort to make the sometimes overly complex UBMTA terms more user-friendly and applicable to more situations, the Science Commons (now Creative Commons) Biological Materials Transfer Project has been developing alternatives<sup>124</sup>, though it is not clear whether specific ABS concerns are being considered.

### 7.3.3 Culture collections

The culture collections community was also an early adopter of ABS measures. Unlike European botanic gardens, whose collections are predominantly used for non-commercial purposes, culture collections provide services to a diverse range of commercial users, as well as to academic researchers. The Belgian Coordinated Collections of Microorganisms (BCCM) led an EU project to develop the Microorganisms, Sustainable Access and Use, International Code of Conduct (MOSAICC)<sup>125</sup>, involving representatives from commercial and not-for-profit organisations, and like the project that produced the Principles on ABS, representatives from North and South (including collections in Brazil, Costa Rica, Indonesia and South Africa).

MOSAICC provides full guidance on procedures and terms of access to both *in situ* and *ex situ* microbial genetic resources, and model documents – an MTA and different PIC application forms for *in situ* and *ex situ* situations. The *in situ* origin of the material is always mentioned when transfer occurs. Collections' MTAs may differ in detail but should contain at least (1) information about the *in situ* origin or source of material; (2) information about provider and recipient; and (3) mutually agreed terms for the access to and the transfer of resources, access to and transfer of technology, benefit-sharing and technical and scientific cooperation. MOSAICC also recommends that Global Unique Identifiers (GUID) should be issued and attached to samples when they have been

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<sup>123</sup> [www.autm.net](http://www.autm.net)

<sup>124</sup> <http://sciencecommons.org/projects/licensing/details/>

<sup>125</sup> <http://bccm.belspo.be/projects/mosaicc/docs/code2011.pdf>

isolated, to help document their transfer, or (if not already assigned) when they are deposited for long-term storage. The World Data Centre for Micro-organisms (WDCM, the international database developed by the WFCC) has developed a registration system that provides culture collections with a unique acronym and numerical identifier; if collections then catalogue and assign GUIDs to their cultures, then resources, their movements and related publications can be tracked through the collections network.<sup>126</sup> MOSAICC was revised in 2011 and is currently being revisited in the light of the NP via the TRUST project (Transparent User friendly System of Transfer for Science and Technology).

ECCO member collections now employ the ECCO core Material Transfer Agreement (approved in 2009) for the supply of biological material from their public collections, which reflects common positions on traceability, fair and equitable benefit-sharing, intellectual property rights, and quality, safety and security. ECCO collections also agree to continue 'exchange of cultures between culture collections adhering to equivalent and compatible core conditions of supply'<sup>127</sup>. The MTA allows for use 'in any lawful manner for non-commercial purposes', but that if the recipient wishes to use the material commercially, it is required to, 'in advance of such use of such use, to negotiate in good faith the terms of any benefit sharing with the appropriate authority in the country of origin of the material.' Collections may need to use special MTAs for other situations, for example when a depositor wishes to exclude any commercial use, or requires prior informed consent before transfers to third parties<sup>128</sup>.

The MIRRI, EMBaRC and GBRCN networks are all actively engaged in developing sound best practices for the microbial resources sector, aiming for approaches that will meet the concerns of a wide range of international stakeholders and users while also encouraging facilitated access to collections. The new MIRRI partnership is currently developing a policy on Intellectual Property Rights and ABS, analysing the problems and deficiencies in the MTAs in current use, and the minimal requirements for CBD compliance. It welcomes the EU Regulation proposal, which could increase users' trust in culture collections, increase traceability and reduce non-compliant use of resources, and provide an incentive for users to choose resources held by Union Trusted Collections because they will be able to demonstrate due diligence without additional administrative burden. Concerns identified by MIRRI include the need to clarify how material that is post-CBD

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<sup>126</sup> Desmeth, P. & Smith, D. (2011) Tools to implement the NP on Access and Benefit Sharing in microbiology: ABS, an intrinsic preoccupation of the World Federation for Culture Collections. Information document for ICNP1. [www.cbd.int/abs/doc/protocol/icnp-1/wfcc-en.pdf](http://www.cbd.int/abs/doc/protocol/icnp-1/wfcc-en.pdf)

<sup>127</sup> [www.eccosite.org](http://www.eccosite.org)

<sup>128</sup> Verkley, G.J.M. European collections partner to the Microbial Resource Research Infrastructure (MIRRI) develop common approaches to answer the NP. Presentation given at NBRC 10<sup>th</sup> Anniversary Symposium, Tokyo, December 6, 2012.

but pre-Nagoya will be covered (ideally using the ECCO core MTA approach, negotiating benefit-sharing before commercial use), how to handle material that has missing or incomplete documentation, the need to keep type and reference strains unrestricted, and the need for Member States to support collections that meet the trusted collections criteria but lack the resources to fulfil the tasks<sup>129</sup>.

The global culture collections community is moving towards the concept of establishing a Microbial Commons, establishing basic common use principles for access to both material and information, in a way that is complementary to national ABS regulations and IPR laws. In this demarcated open commons space, material and information would be relatively freely accessible provided that outputs are returned to the commons space to be shared again. Benefits would include depositing in collections, publication of associated data, and making material and information easily available to stakeholders including the country of origin. Other benefit-sharing measures would apply in the case of commercial exploitation, such as access, milestone and royalty/license payments. Outside the commons space, ABS would be governed by national and international laws<sup>130</sup>.

### 7.3.5 Zoos and Aquaria

A review of UK stakeholders indicated that the acquisition of animals from wild populations for the zoo sector is generally covered by written agreements following the guidelines of the UK Federation of Zoos and the World Zoo Conservation Strategy, which are not specifically ABS-related, but ban illegal and unethical trade<sup>131</sup>. Draft guidelines on ABS were discussed by WAZA member organisations in 2006<sup>132</sup>. The draft laid out core commitments covering PIC, MAT, benefit-sharing, conservation and sustainable use, traditional knowledge, community participation, and information and transparency, and incorporated the Principles on ABS (see 6.2.1). WAZA members would be expected to record the terms and conditions of acquisition, track and audit the use of those resources and benefits arising from use, record disposal to third parties, including terms, and should develop an institutional policy. However it is not clear whether these guidelines were further developed and released.

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<sup>129</sup> Response of MIRRI to the “Proposal for a Regulation of the European Parliament and of the Council on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union”, prepared by E. Stackebrandt & G. Verkleij, 14 March 2013.

<sup>130</sup> *Ibid.* 126 (Desmeth & Smith); for more discussions on the Microbial Commons concept see National Research Council (US) Board on Research Data and Information, Uhlir P.F. (ed) (2011) *Designing the Microbial Research Commons: Proceedings of an International Symposium*. National Academies Press, Washington DC. [www.ncbi.nlm.nih.gov/books/NBK91499](http://www.ncbi.nlm.nih.gov/books/NBK91499)

<sup>131</sup> *Ibid.* 44 (Latorre 2005)

<sup>132</sup> [www.zoosprint.org/ZooPrintMagazine/2006/June/15-17.pdf](http://www.zoosprint.org/ZooPrintMagazine/2006/June/15-17.pdf)

### 7.3.6 Agricultural genebanks

In both Brazil and the EU, the agricultural collections sectors were deeply engaged in the negotiations leading to the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)<sup>133</sup>, which establishes a specialised instrument for access and benefit-sharing, with a commons space. All EU countries and Brazil are Parties to the ITPGRFA, and so collections of local, national and international gene banks and under the direct control of the Parties share a set of rules for facilitated access, as do the collections in the Consultative Group for International Agriculture Research (CGIAR) research centres. Those that hold Annex I material are required to make that material available to the Multilateral System using the Standard Material Transfer Agreement (SMTA) for transfers, if the intended use is related to food and agriculture, greatly reducing transaction costs.

However not all material is on Annex 1, and not all access is strictly for food and agriculture purposes, so much of the material in gene banks must be transferred outside the commons of the Multilateral System, and a patchwork of ABS rules apply, depending on the countries of origin and the terms of acquisition. Some ITPGRFA Parties have chosen to extend facilitated access and the use of the SMTA to other crops, but institutional ABS awareness is needed to prevent inappropriate use of the SMTA, as it can only be used as a 'default' when there are clearly no CBD-related restrictions on material. Bioversity International and other partners have produced updated technical guidelines<sup>134</sup> and a guide to the use of the SMTA<sup>135</sup> that remind germplasm collectors that they should always ensure that they seek prior informed consent from the country where they are collecting, and adhere to the conditions that are set.

The approach taken by the Centre for Genetic Resources (Netherlands) is to refrain from claiming legal ownership of, or intellectual property rights on, the germplasm (and related information) in its genebank, and to keep it as unrestrictedly available as possible, passing on these same obligations to future recipients. It uses Memoranda of Understanding to cover its collection missions, and the SMTA as a basis for collecting material<sup>136</sup>.

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<sup>133</sup> [www.planttreaty.org](http://www.planttreaty.org)

<sup>134</sup> Moore, G. & Williams, K.A. (2011) Legal issues in plant germplasm collection. Ch. 2 in: Guarino, L., Ramanatha Rao V., Goldberg, E. (eds) Collecting plant genetic diversity: Technical Guidelines – 2011 Update. Bioversity International, Rome, Italy. <http://croptgenebank.sgrp.cgiar.org/images/file/procedures/collecting2011/Chapter2-2011.pdf>.

<sup>135</sup> Guide for the CGIAR Centres' Use of the Standard Material Transfer Agreement [www.bioversityinternational.org/fileadmin/bioversityDocs/Policy\\_module/eng.policy\\_module/Reference\\_Material/Guide\\_SMTA.pdf](http://www.bioversityinternational.org/fileadmin/bioversityDocs/Policy_module/eng.policy_module/Reference_Material/Guide_SMTA.pdf)

<sup>136</sup> *Ibid.* 43 (Defra 2012)

### 7.3.7 DNA and tissue banks

A 2004 global survey of the (agricultural) plant genetic resources community found over 70% of DNA storage in the developed world was performed by private firms, while in the developing world only a few public sector institutions had the research capabilities, and additionally, that almost half of the institutions that supplied DNA to others did not account for legal issues regarding ownership and international transfer, and only one quarter had official policies or MTAs<sup>137</sup> – but it is likely that this situation has much improved, given the international, multi-stakeholder involvement in the negotiations for the NP.

The DNA banks held by botanic gardens and natural history collections (mentioned in 5.1) are governed by those institutions' policies and practices, and are using MTAs that reference the CBD. The Global Genome Biodiversity Network program of work includes the development of a values statement in support of member organisations' work on ABS by (1) being aware of the CBD and the NP and working to respect those agreements, maintaining transparency, and working towards goals of mutual benefit sharing; (2) being aware that biodiversity-rich countries consider their biodiversity as National Assets and working with those countries towards mutual benefit-sharing; and (3) considering a proactive role in the sharing of information and the use of tracking systems<sup>138</sup>.

The International Society for Biological and Environmental Repositories (ISBER) provides updated best practices for repositories<sup>139</sup>. Guidance is provided on the importance of obtaining appropriate collecting and export permits, and repository managers are reminded that the benefits derived from international transfer of biological material extend beyond the physical specimen to include benefits such as training and capacity building. Best practices set out in the document include that use of specimens and associated data should be consistent with informed consent and authorisation; that resources should have a well-documented and clearly defined process for sharing specimens and data; that repository procedures for collection, storage, distribution, use and disposal of specimens should respect the perspectives and traditions of donors from whom the specimens were obtained and minimise risks to communities, populations and groups; that repositories that import specimens and data from other countries should respect the autonomy of the providing country and ensure that fair and equitable benefits are made available to the providing country; and that MTAs (or similar documents)

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<sup>137</sup> *Ibid.* 70 (Anderson et al. 2006)

<sup>138</sup> [http://ggbn.org/taskForce\\_Policies.html](http://ggbn.org/taskForce_Policies.html)

<sup>139</sup> ISBER (2011) Best Practices for Repositories: Collection, storage, retrieval, and distribution of biological materials for research. Biopreservation and Biobanking Vol. 10, no. 2. Mary Ann Liebert, Inc. [www.isber.org/bp/documents/ISBERBestPractices3rdedition.pdf](http://www.isber.org/bp/documents/ISBERBestPractices3rdedition.pdf)

should be used to document the obligations and responsibilities of parties involved in the transfer of materials from a repository prior to shipment.

### 7.3.8 Collections of extracts and compounds

The most stringent ABS measure that has been developed for companies that trade in natural products is the Union for Ethical BioTrade (UEBT)'s internationally-recognised standard, revised in 2012<sup>140</sup>. The standard covers all natural ingredients in the organisation's portfolio, and sets out principles, criteria that must be met, and indicators. The ABS-related measures cover negotiations, equitable prices and recognition of traditional practices, and members are required to gain access subject to PIC and on MAT, and to share benefits, regardless of whether or not there are national ABS laws and regulations. Trading members must demonstrate working knowledge of the principles of the CBD, NP and CITES, and must prepare work-plans and report annually on their implementation.

The International Federation of Pharmaceutical Manufacturers & Associations (IFPMA) has been an active participant in the NP negotiations, and has produced 'guidelines' on ABS that list certain best practices that should be followed by companies<sup>141</sup>, such as the need to obtain PIC (disclosing intended use of the resources) and the use of formal contractual benefit-sharing agreements to set out mutually agreed terms (which may contain conditions on permitted uses and transfers to third parties). They do not provide detailed guidance for collections. INTERFARMA, the Brazilian Research-based Pharmaceutical Manufacturers Association, has produced a new code of conduct (2012)<sup>142</sup> but it does not extend to ABS issues.

EuropaBio has developed Core Ethical Values, which include as a general principle 'we support the principles embodied in the United Nations Convention on Biological Diversity (CBD) to protect biological diversity including adherence to the principles of access and benefit-sharing'<sup>143</sup>.

### 7.3.9 Genetic sequence databases

The International Nucleotide Sequence Databases do not currently require information depositors to supply ABS information such as country of origin, or evidence that prior

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<sup>140</sup> [http://ethicalbiotrade.org/news/wp-content/uploads/STD01-Ethical-BioTrade-Standard-2012-04-11\\_.pdf](http://ethicalbiotrade.org/news/wp-content/uploads/STD01-Ethical-BioTrade-Standard-2012-04-11_.pdf)

<sup>141</sup> [www.ifpma.org/innovation/biodiversity.html](http://www.ifpma.org/innovation/biodiversity.html)

<sup>142</sup> [http://www.ifpma.org/fileadmin/content/About%20us/2%20Members/Associations/Code-Brazil/Brazil\\_-\\_Interfarma\\_Code\\_of\\_Conduct\\_2012\\_-\\_English\\_version.pdf](http://www.ifpma.org/fileadmin/content/About%20us/2%20Members/Associations/Code-Brazil/Brazil_-_Interfarma_Code_of_Conduct_2012_-_English_version.pdf)

<sup>143</sup> Available at [www.basf.com/group/corporate/en/products-and-industries/biotechnology/europabio](http://www.basf.com/group/corporate/en/products-and-industries/biotechnology/europabio)

informed consent was obtained and mutually agreed terms were established<sup>144</sup>. In GenBank, 'source' field refers to the biological source of the sequence (the organism's name, and the type of molecule), not to geographic source, and the 'origin' field, not required, refers to the sequence start in older records<sup>145</sup>. Some qualifiers are available, for example an optional institution code and collection code for where the material is currently stored.

To gain a 'BARCODE' flag in one of the INSDs, barcode sequence records from IBOL-related projects require much more stringent and unambiguous information, such as a country code and a unique identifier for a voucher specimen in a biorepository<sup>146</sup>, and the barcoding community is currently in the process of developing model ABS agreements for the acquisition, use and transfer of DNA and voucher specimens (particularly important for those institutions that do not yet have other ABS measures in place that would cover barcoding activities).

## 8. Information-sharing and cooperation between *ex situ* collections

Although there are clearly many legal and practical impediments to exchanging physical specimens between *ex situ* collections, there has been an astounding increase in global access to the biodiversity information that they hold, thanks to the growth of the Internet and the decreasing costs of digitisation and information storage. Collections worldwide are joining forces and building networks to make available resources such as catalogues of holdings, taxonomic bibliographic databases and species-focused resources such as floras and monographs. In particular, the last decade has seen the development of initiatives to share high-quality digital specimen images, which greatly help to address the uneven physical distribution of specimens in international collections. There has been a parallel development of aggregators that can draw together data on many taxa from many separate sources<sup>147</sup>. The numbers of species that are not yet known and specimens that are not yet digitised or even catalogued are still very great (and projects involving flat herbarium specimens far outnumber those attempting to capture images of zoological specimens), and institutional resources are limited, but huge advances have been made on a project-by-project basis on many different levels. European and Brazilian institutions have been centrally involved in many of these developments.

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<sup>144</sup> The DDBJ/EMBL/GenBank Feature Table: Definition. Version 10.2 November 2012. [ftp://ftp.ebi.ac.uk/pub/databases/embl/doc/FT\\_current.html#7.1.1](ftp://ftp.ebi.ac.uk/pub/databases/embl/doc/FT_current.html#7.1.1)

<sup>145</sup> Sample GenBank Record. [www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html](http://www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html)

<sup>146</sup> Hanner, R. (2009). Data Standards for BARCODE Records in INSDC (BRIs). [http://barcoding.si.edu/pdf/dwg\\_data\\_standards-final.pdf](http://barcoding.si.edu/pdf/dwg_data_standards-final.pdf)

<sup>147</sup> Lughadha, E.N. & Miller, C. (2009) Accelerating global access to plant diversity information. *Trends in Plant Science*, 14(11): 622-628.

## 8.1. Database networks and data aggregators

Aggregators include the intergovernmental Global Biodiversity Information Facility, a mega-science project that encourages free and open access to biodiversity data through the creation of a global decentralised network of interoperable databases that contain primary biodiversity data held by biodiversity information facilities around the world<sup>148</sup>. The data include information associated with specimens documented in *ex situ* collections, as well as records from *in situ* studies. The Catalogue of Life is another important aggregator, a quality-assured checklist of more than 1.3 million species of plants, animals, fungi and micro-organisms<sup>149</sup>. Complete databases across all groups of organisms are being created in some regions, including Europe and Brazil (the Catalogo da Vida Brasil), in part with EU funding for the 4D4Life (Dynamic Distributed Databases for Life) project<sup>150</sup> and EU-Brazil OpenBio, a project to deploy an open-access platform from the federation and integration of existing European and Brazilian infrastructures and resources (2011-2013)<sup>151</sup>.

In Europe, the BioCASE (the Biological Collection Access Service for Europe) network<sup>152</sup> has helped to increase access to heterogeneous European collection and observational databases of unit-based data, as well as metadata on non-databased collections<sup>153</sup>.

The microbial collections community has developed strong networks for data-sharing. The WFCC-MIRCEN World Data Centre for Microorganisms (WDCM) links microbial resource centres, as well as their customers. Its databases include Culture Collections Information Worldwide (CCINFO), a database management system for all registered culture collections, which currently covers 643 collections from 73 countries and regions, including 64 collections in Brazil and 167 in EU countries<sup>154</sup>.

The Global Catalogue of Microorganisms (GCM), another WFCC initiative, is a new system to help culture collections to manage, disseminate and share the information related to their holdings<sup>155</sup>. As is the case for other types of *ex situ* collections, many collections have not yet put their data online – currently around one-sixth of registered in

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<sup>148</sup> [www.gbif.org](http://www.gbif.org)

<sup>149</sup> [www.catalogueoflife.org](http://www.catalogueoflife.org)

<sup>150</sup> [www.4d4life.eu](http://www.4d4life.eu)

<sup>151</sup> [www.eubrazilopenbio.eu](http://www.eubrazilopenbio.eu)

<sup>152</sup> [www.biocase.org/index.shtml](http://www.biocase.org/index.shtml)

<sup>153</sup> The BioCASE metadata network was replaced by the more global Biodiversity Collections Index, which in turn has been merged with Index Herbariorum and Biorepositories.org (which links DNA barcode voucher specimens to barcode data records in GenBank) [www.biorepositories.org/merger\\_announcement](http://www.biorepositories.org/merger_announcement)

<sup>154</sup> [www.wfcc.info/ccinfo/statistics/](http://www.wfcc.info/ccinfo/statistics/)

<sup>155</sup> <http://gcm.wfcc.info/mission/>

CCINFO have an online catalogue. GCM currently contains data from 25 countries and regions, 50 collections (1 in Brazil, 22 in the EU), 37,382 species and 253,981 strains.

## 8.2. Specimen images and data

Earlier specimen data repatriation projects involved exchange of catalogue data and cibachrome prints, such as the first phase of the Northeastern Brazilian Repatriation Project (a partnership between RBG, Kew and three local Brazilian herbaria, IPA, CEPEC and HUEFS, and part of the Biodiversity Subprogramme of the Plantas do Nordeste Project, between RBG Kew and the Associação Plantas do Nordeste<sup>156</sup>), but the availability of lower-cost digital scanners and digital photography revolutionised the possibilities for sharing specimen images and data.

The Global Plants Initiative (GPI) is a major international collaboration to digitise and make available plant type specimen images, funded by the Andrew W. Mellon Foundation and hosted via JSTOR Plant Science<sup>157</sup>. The project involves more than 166 herbaria in 57 countries (including 56 in 13 EU countries, and 6 herbaria in Brazil). The Latin American Plants Initiative is the second stage of the global project (after the first, the African Plants Initiative), involving partners already active from the African initiative and new ones with Latin American interests<sup>158</sup>.

Project Re flora is a large-scale research and data-sharing collaboration initiated by CNPq, involving data capture in Brazilian and European herbaria, software development, infrastructure enhancement, and research support for Brazilian botanists and capacity-building. The scope extends beyond the digitisation of types and historic specimens (the focus of the GPI), aiming to capture data from some one million Brazilian plant specimens held in foreign collections in Europe and the US. The major collaborating collections in Europe are MNHN and Kew, which together house an estimated 600,000 Brazilian specimens<sup>159 160</sup>.

Other smaller, but highly significant projects have focused on capturing images and data from the specimens gathered by particular European collectors, as well as other objects, such as their field notes, maps, illustrations and bibliographic data. In connection with Project Re flora and with support from CNPq, the A. de Saint-Hilaire Virtual Herbarium is aiming to make available images of Auguste Saint-Hilaire's 30,000 specimens as well as

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<sup>156</sup> [www.kew.org/science/tropamerica/repatriation.htm](http://www.kew.org/science/tropamerica/repatriation.htm)

<sup>157</sup> <http://gpi.myspecies.info/content/all-vascular-types-line-global-plants-initiative>

<sup>158</sup> <http://plants.jstor.org/action/community>

<sup>159</sup> [www.kew.org/science-research-data/directory/projects/Re flora.htm](http://www.kew.org/science-research-data/directory/projects/Re flora.htm)

<sup>160</sup> [www.scidev.net/en/news/brazil-to-repatriate-its-botanical-data.html](http://www.scidev.net/en/news/brazil-to-repatriate-its-botanical-data.html)

his field notes from his travels in south and central Brazil between 1816 and 1822. At the time of this paper's preparation, 6197 specimens had been captured from the MNHN collections and 636 from the Institut des Herbiers Universitaires, CLF, Clermont-Ferrand<sup>161</sup>.

The Martius Project, a prototype for larger networking efforts, made available a selection of digital images of type specimens from the Martius collection types that were cited in the *Flora Brasiliensis*, held in the National Botanic Garden of Belgium, the National Herbarium of the Netherlands and Herbarium Botanische Staatssammlung Muenchen, Germany. The project fits into larger networking efforts between Brazilian, North American and European herbaria to expand the digitisation of the Martius collections to cover all relevant collections and link to key illustrated works including the *Flora Brasiliensis*<sup>162</sup>.

The Richard Spruce project was a joint initiative between Kew and the NHM (London) that resulted in the digitisation of over 6000 specimens and notebooks from Spruce's 15 years of travels from Amazon to Andes<sup>163</sup>.

### 8.3 Cooperation and capacity-building

Although the organisation of field collecting trips and the acquisition and exchange practices have become much more complex since 1992, and national and international laws and regulations are continuing to develop post-Nagoya, *ex situ* collections continue to provide a vital base for conservation, research and development. European collection and research in biodiverse countries has not stopped: instead, institutions and companies (at least those that are aware of ABS developments) have needed to consider their options, resources and strengths, and focus their activities in fewer countries and deeper partnerships, working with knowledge of the relevant ABS legislative framework.

Among CETAF institutions, MNHN and Kew are prominent examples of large institutions that have put significant effort into deepening their research and conservation partnerships in Brazil. They have built collaborations with a range of Brazilian institutions and have developed imaginative initiatives to share information that was previously in effect locked away<sup>164 165</sup>.

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<sup>161</sup> <http://hvsh.cria.org.br/project>

<sup>162</sup> In total 1089 types were found and digitised, from eight target plant groups. <http://projects.bebif.be/enbi/martius/>

<sup>163</sup> [www.kew.org/science-research-data/directory/projects/RichardSpruceCollectn.htm](http://www.kew.org/science-research-data/directory/projects/RichardSpruceCollectn.htm)

<sup>164</sup> See projects illustrated in 'The Muséum National d'Histoire Naturelle (France) in Brazil' (brochure), and presentations from meeting 'La Biodiversité en question: Coopération entre le Muséum National d'histoire Naturelle et le Brésil', 2009. [www.mnhn-brasil.info/program\\_fr](http://www.mnhn-brasil.info/program_fr)

Kew, MNHN and other European institutions are also actively involved in more general capacity-building initiatives for professionals and students from many different developed and developing countries including Brazil. At the higher education level, MNHN (among other institutions) offers Masters and Doctoral programmes, while Kew runs a suite of professional development courses for botanists, horticulturalists and plant conservation specialists<sup>166</sup> (including two in association with BGCI). The Distributed European School of Taxonomy (DEST), established during the EDIT project and managed by the Royal Belgian Institute of Natural Sciences, continues to organise training sessions in European institutions for international students<sup>167</sup>.

## 9. Conclusions and questions

The history of exchange, and non-exchange, between Brazil and Europe shows the clear need for enlightened balance and cooperation on all sides to further the three objectives of the Convention on Biological Diversity. The knowledge necessary for conservation and sustainable use comes from research and development, but the research-enabling collections and tools have been heavily concentrated in some places while the research subject, the diversity of life, is often concentrated in others. Stringent rules to stem the flow of valuable genetic resources at risk of use without benefit-sharing can also stem the flow of cooperation that generates most of the benefits, while ignorance of the concerns and lack of will or actions to address them provides justification for tough measures. This workshop will try to bridge the science-policy gap and identify and overcome barriers to research and cooperation.

This paper highlights action at the network level, because capacity to track ABS developments and develop new measures is spread very unevenly at the institution level in both regions, and because network- and community-level approaches are more likely to facilitate ABS-aware exchange and research. Individual institutions still need to take responsibility for their own actions and practices (such as sound agreements with providers), but networks can help to share knowledge, ideas and tools to fill the gaps in capacity. The draft EU Regulation on ABS would allow for user associations (such as these networks) to propose a specific combination of procedures, tools or mechanisms overseen by the association as 'best practice', but designation as a Union Trusted Collection would apply at the level of individual collections.

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<sup>165</sup> [www.kew.org/news/kew-projects-brazil.htm](http://www.kew.org/news/kew-projects-brazil.htm)

<sup>166</sup> [www.kew.org/learn/specialist-training/continuing-professional-development/index.htm](http://www.kew.org/learn/specialist-training/continuing-professional-development/index.htm)

<sup>167</sup> [www.taxonomytraining.eu/](http://www.taxonomytraining.eu/)

The workshop group might wish to consider whether the already existing codes of conduct, guidelines and model documents could be adopted more widely to harmonise and facilitate exchanges and increase scientific collaboration between Brazil and Europe – and if, and how, such measures need to be adjusted to meet the requirements of post-Nagoya legislation/regulation. Clearly there is a need for ABS capacity-building for collections personnel in both regions in order to ensure that facilitating exchange systems are used appropriately and that cooperation is truly enhanced.

Tracking is an important practical issue for collections in both regions. The NP will require all institutions to consider how they monitor their use of genetic resources. The draft EU Regulation requires the use of unique identifiers for transfers to third parties; the proposal for a new Brazilian regulation would also involve registration in a national online system, and the use of unique identifiers to monitor transfer to third parties. At the moment, only a few collections sectors in Europe and Brazil are tracking individual specimen/sample use. Until very significant resources can be directed towards new systems and more staff, and a greater proportion of holdings are registered in databases, some natural history collections will likely fail to meet those requirements. IPEN (a network that includes small gardens with few staff) shows how a unique identifier system can actually help to reduce documentation costs for exchanges of living plants. It would be useful to explore whether that type of documentation could realistically be applied at a large scale for preserved herbarium and natural history specimens (bearing in mind the need to honour more restrictive terms for some specimens).

Change of intent of use, from non-commercial research to commercial development, is another key issue for collections in Brazil and Europe, especially for those with links to universities and industry. This multi-sectoral group can consider whether this issue can be tackled in a consistent, harmonised manner that will build trust and cooperation – and ideally develop a best practice that can be taken into account by regulators. Although the microbial collections community welcomes the concept of ‘Union Trusted Collections’, other EU institutions that, post-CBD, generally acquire and supply material on strictly non-commercial terms may not be comfortable with a system that positions them as sources of material for small- and medium-sized commercial enterprises, and some may choose not to become ‘Union Trusted Collections’. A Brazil- and EU-developed common approach to change of intent issues that could still allow collections to use simpler access procedures for non-commercial use might possibly motivate more collections to seek EU ‘trusted’ status. Brazilian authorities and collections may wish to consider how significant they would find ‘trusted’ designation when choosing whether to exchange material with European collections.

Regardless of the ‘trusted collections’ discussions, and collections’ readiness to apply unique identifiers to individual specimens, it is clear that almost all of the collections communities surveyed are gaining experience in using agreements such as MTAs, and that they would be capable of curating certificates of compliance. As long as provider PIC and MAT continue to travel with specimens (and specimen information, e.g. for IBOL projects) and benefit-sharing expectations are met, participants might wish to consider the extent to which specimen-level tracking or tracing is necessary for Nagoya implementation. Could standard terms and agreements be used as a basis for facilitated exchange, even if those standard terms do not guarantee tracking?

This workshop also provides a space for participants from both regions to consider creatively what other roles, beyond monitoring and control, collections play in NP: for example what are the opportunities for innovative cooperation and technology transfer, and what responsibilities do collections have related to traditional knowledge?

The challenge for workshop participants is to find insightful and practical ways to balance the diverse needs and recognise the common interests of European and Brazilian collections communities and European and Brazilian regulators in a way that biodiversity research and sustainable use can be enabled in an equitable and collaborative manner.

## Abbreviations and acronyms

ABS	Access to genetic resources and benefit-sharing
ABS-MT	ABS Management Tool
AUTM	Association of University Technology Managers
BCCM	Belgian Coordinated Collections of Microorganisms
BCI	Biodiversity Collections Index
BGBM	Botanic Garden and Botanical Museum Berlin-Dahlem
BGCI	Botanic Gardens Conservation International
BioCASE	Biological Collection Access Service for Europe
BOLD	Barcode of Life Database
CBD	Convention on Biological Diversity
CBOL	Consortium for the Barcode of Life
CCINFO	Culture Collections Information Worldwide
CENARGEN	National Research Center for Genetic Resources and Biotechnology
CETAF	Consortium for European Taxonomic Facilities
CEPEC	Herbário Centro de Pesquisas do Cacau
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
CGEN	Genetic Heritage Management Council
CGIAR	Consultative Group for International Agriculture Research
CNPq	National Council for Scientific and Technological Development
CONABIO	National Biodiversity Commission
CRIA	Reference Center on Environmental Information
CTCB	Technical Chamber of Biological Collections
DDBJ	DNA DataBank of Japan
DFG	German Research Foundation
EAZA	European Association of Zoos and Aquariums
EBI	European Bioinformatics Institute
ECCO	European Culture Collections' Organisation
ECPGR	European Cooperative Programme for Plant Genetic Resources
EDIT	European Distributed Institute of Technology
EFPIA	European Federation of Pharmaceutical Industries and Associations
ELF	European Lead Factory
EMbaRC	European Consortium of Microbial Resources Centres
EMBL	European Molecular Biology Laboratory
Embrapa	Brazilian Agricultural Research Corporation
ESBB	European, Middle Eastern & African Society for Biopreservation and Biobanking
EU	European Union
EUFORGEN	European Forest Genetic Resources Programme
EURISCO	European Search Catalogue
EuropaBio	European Association for Bioindustries

GBIF	Global Biodiversity Information Facility
GBRCN	Global Biological Resource Centre Network
GGBN	Global Genome Biodiversity Network
GPI	Global Plants Initiative
GUID	Global Unique Identifier
HUEFS	Universidade Estadual de Feira de Santana
IABG	International Association of Botanic Gardens
IBAMA	Brazilian Institute for the Environment and Natural Resources
IBOL	International Barcode of Life
INSD	International Nucleotide Sequence Database
INSDC	International Nucleotide Sequence Database Collaboration
IPA	Empresa Pernambucana de Pesquisa Agropecuária
IPEN	International Plant Exchange Network
IPR	Intellectual Property Rights
ISBER	International Society for Biological and Environmental Repositories
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MAT	Mutually Agreed Terms
MCTI	Ministry of Science, Technology and Innovation
MIRRI	Microbial Resources Research Infrastructure
MNHN	Muséum National d’Histoire Naturelle, Paris
MOSAICC	Microorganisms, Sustainable Access and Use, International Code of Conduct
MTA	Material Transfer Agreement
NHM	Natural History Museum, London
NordGen	Nordic Genetic Resource Centre
NP	Nagoya Protocol
OECD	Organisation for Economic Co-operation and Development
PIC	Prior Informed Consent
PPBio	Research Program in Biodiversity
PROTAX	Project for Capacity Building in Taxonomy
RBH	Brazilian Network of Herbaria
RENARGEN	National Network of Genetic Resources
SCICOLL	Scientific Collections International
SIBBR	Information System on Brazilian Biodiversity
SMTA	Standard Material Transfer Agreement
TK	Traditional Knowledge
TRUST	Transparent User friendly System of Transfer for Science and Technology
UBMTA	Uniform Biological Materials Transfer Agreement
UEBT	Union for Ethical BioTrade
WAZA	World Association of Zoos and Aquaria
WDCM	World Data Centre for Micro-organisms
WFCC	World Federation for Culture Collections

**Table 1: Numbers of EU botanic gardens and other botanical institutions with living collections, and affiliations**

Country	Number of gardens	With seed bank	With tissue facilities	BGCI members	IPEN members	Endorsed Principles on ABS
Austria	22	1	0	4	8	0
Belgium	28	4	0	7	3	0
Bulgaria	10	0	0	1	0	0
Cyprus	0	0	0	0	0	0
Czech Republic	27	2	3	4	1	0
Denmark	10	2	1	3	0	0
Estonia	10	0	0	2	0	0
Finland	8	0	2	4	3	0
France	95	18	6	23	6	0
Germany	103	9	4	16	48	1
Greece	11	2	1	6	3	0
Hungary	14	3	1	6	2	0
Ireland	16	1	2	6	0	0
Italy	107	8	1	21	10	0
Latvia	2	0	1	1	0	0
Lithuania	9	3	3	4	0	0
Luxembourg	1	1	0	1	1	0
Malta	1	0	0	1	0	0
Netherlands	44	6	0	6	20	0
Poland	32	2	0	6	0	0
Portugal	13	7	1	8	7	0
Romania	15	2	0	3	2	0
Slovakia	10	0	1	2	0	0

<b>Slovenia</b>	5	1	0	2	0	0
<b>Spain</b>	29	14	3	12	9	0
<b>Sweden</b>	9	1	0	4	3	0
<b>United Kingdom</b>	182	11	3	50	6	3
<b>EU total</b>	813	98	33	203	132	4

Sources: BGCI GardenSearch database [http://www.bgci.org/garden\\_search.php](http://www.bgci.org/garden_search.php); IPEN [www.bgci.org/resources/ipen/](http://www.bgci.org/resources/ipen/); Principles on ABS [www.kew.org/conservation/endorsements.html](http://www.kew.org/conservation/endorsements.html))

**Table 2: Major EU taxonomic institutions (members of CETAF/SCICOLL/GGBN) and contributors of Brazil specimen data to the Global Plants Initiative**

Country	Institution	CETAF	SCICOLL/ GGBN	Brazil specimens digitised for GPI
<b>Austria</b>	Biologiezentrum der Oberösterreichischen Landesmuseen, Linz	C		
<b>Austria</b>	Naturhistorisches Museum, Vienna	C		
<b>Austria</b>	Karl-Franzens-Universität, Graz			587
<b>Belgium</b>	Royal Belgian Institute of Natural Sciences	C	S	
<b>Belgium</b>	National Botanic Garden, Meise	C		9990
<b>Belgium</b>	Royal Museum of Central Africa, Tervuren	C		
<b>Belgium</b>	Herbarium, Laboratory of Botany, Gent University			5
<b>Czech Republic</b>	National Museum (Natural History), Prague	C		
<b>Denmark</b>	Natural History Museum of Denmark, Copenhagen	C	G	1040
<b>Estonia</b>	Estonian Academy of Sciences, Tartu	C		
<b>Finland</b>	Finnish Museum of Natural History, Helsinki	C		233
<b>France</b>	Muséum National d'Histoire Naturelle	C	S	16412

<b>France</b>	Herbier de l'Université Montpellier			1307
<b>Germany</b>	Botanischer Garten und Botanisches Museum, Berlin-Dahlem	C		2832
<b>Germany</b>	Senckenberg, Forschungsinstitute & Naturmuseum, Frankfurt	C		18
<b>Germany</b>	Museum für Naturkunde	C	S	
<b>Germany</b>	Staatliches Museum für Naturkunde, Stuttgart	C		
<b>Germany</b>	Staatliches Naturwissenschaftliche Sammlungen Bayerns	C		5818
<b>Germany</b>	Zoologisches Forschungsinstitut und Museum Alexander König, Bonn	C		
<b>Germany</b>	Universität Göttingen			522
<b>Germany</b>	Martin-Luther-Universität			969
<b>Germany</b>	Biozentrum Klein Flottbeck und Botanischer Garten der Universität Hamburg			423
<b>Germany</b>	Friedrich-Schiller-Universität Jena			556
<b>Hungary</b>	Hungarian Natural History Museum, Budapest	C		
<b>Ireland</b>	Herbarium, Trinity College, Dublin			2161
<b>Italy</b>	Museo Civico di Storia Naturale di Milano	C		

<b>Italy</b>	Museo di Storia Naturale dell'Università degli Studi di Firenze	C		394
<b>Italy</b>	Museo civico di Storia Naturali di Genoa	C		
<b>Netherlands</b>	Centraalbureau voor Schimmelcultures, Utrecht	C		
<b>Netherlands</b>	Nederlands Centrum voor Biodiversiteit NCB Naturalis, Leiden	C	S	(number not obtainable from GPI)
<b>Poland</b>	Museum and Institute for Zoology PAN, Warsaw	C		
<b>Slovakia</b>	National Taxonomic Facility of Slovakia	C		
<b>Spain</b>	Consejo Superior de Investigaciones Científicas, Museo Nacional de Ciencias Naturales, Madrid (MNCN/CSIC)	C	S	
<b>Spain</b>	Real Jardín Botánico, Madrid	C		62
<b>Sweden</b>	Naturhistoriska Riksmuseet, Stockholm	C		3724
<b>United Kingdom</b>	Royal Botanic Gardens, Edinburgh	C		1750
<b>United Kingdom</b>	Royal Botanic Gardens, Kew	C		21622
<b>United Kingdom</b>	Natural History Museum London	C	S,G	6777
<b>United Kingdom</b>	Linnean Society of London			90

Sources: Consortium for European Taxonomic Facilities (CETAF) institutions [www.cetaf.org/](http://www.cetaf.org/); Scientific Collections International (SCICOLL) founders [www.scicoll.org/](http://www.scicoll.org/); Global Genome Biodiversity Network (GGBN) collaborators [www.ggbn.org/](http://www.ggbn.org/); data on Brazil specimens digitised for the Global Plants Initiative <http://plants.jstor.org> (accessed 23/4/13)

**Table 3: EU microbial collection networks: European Culture Collections' Organisation (ECCO), Microbial Resources Research Infrastructure (MIRRI), European Consortium of Microbial Resources Centres (EMbaRC) and Global Biological Resource Centre Network (GBRCN)**

Country	ECCO members	MIRRI participants (P) & collaborating parties (C)	EMbaRC	GBRCN
<b>Austria</b>	<a href="#">ACBR</a> VIENNA, Austrian Center of Biological Resources and Applied Mycology. Hyphomycetes & yeast strains			
<b>Belgium</b>	<a href="#">BCCM</a> Belgian Co-Ordinated Collections of Microorganisms, Belgium: consortium of 7 Biological Research Centres coordinated by central team at Belgian Science Policy. Includes: <a href="#">BCCM/IHEM</a> Scientific Institute for Public Health - biomedical fungi & yeasts <a href="#">BCCM/LMBP</a> Ghent University - plasmids & DNA libraries <a href="#">BCCM/LMG</a> Ghent University - bacteria <a href="#">BCCM/MUCL</a> Catholic University of Louvain - (agro)industrial fungi & yeasts <a href="#">BCCM/DCG</a> Ghent University - diatoms <a href="#">BCCM/ITM</a> Institute of Tropical Medicine - mycobacteria <a href="#">BCCM/UCL</a> University of Liège - polar cyanobacteria	P  C  C (& P as UGENT) C	E  E E	G
<b>Bulgaria</b>	<a href="#">NBIMCC</a> SOFIA, National Bank for Industrial Microorganisms and Cell Cultures. <b>Bacteria, actinomycetes, plasmid bearing microorganisms, yeasts, fungi, animal and plant viruses, and animal cell cultures</b>			
<b>Czech Republic</b>	<a href="#">FCCM</a> Federation of Czechoslovak Collections of Microorganisms. 17 collections <a href="http://web.natur.cuni.cz/fccm/collecze.htm">http://web.natur.cuni.cz/fccm/collecze.htm</a> . In ECCO: <a href="#">CAPM</a> Collection of Animal Pathogenic Microorganisms <a href="#">CCF</a> Culture Collection of Fungi, Charles University. <a href="#">CCM</a> Czech collection of Microorganisms, Masaryk University. Bacteria and fungi. <a href="#">CNCTC</a> Czechoslovak National Collection of Type Cultures, National Institute of Public Health. Deposited strains.	C		
<b>Denmark</b>	<a href="#">SCCAP</a> The Scandinavian Culture Collection of Algae and Protozoa. Representatives from most algal divisions. <a href="#">IBT</a> (no data)			
<b>Estonia</b>	<a href="#">CELMS</a> Collection of Environmental and Laboratory Strains, Institute of Molecular and Cell Biology, University of Tartu. Non-medical environmental and laboratory microbial strains. <a href="#">HUMB</a> Human Microbiota Biobank, Institute of Microbiology, University of Tartu			

<b>Finland</b>	<p><a href="#">HAMBI</a> University of Helsinki, Faculty of Agriculture &amp; Forestry, Division of Microbiology; non-profit. Total no. cultures ~5500. Includes: HAMBI / BAC for bacteria HAMBI / FBCC for fungi HAMBI / UHCC for cyanobacteria</p> <p><a href="#">VTI</a> VTT Culture Collection, under VTT Technical Research Centre. Yeasts, filamentous fungi and bacteria</p>	C		G
<b>France</b>	<p><a href="#">CCRB</a> French Comité Consultatif des Ressources Biologiques :</p> <p><a href="#">CRBIP</a> Centre de Ressources Biologiques de l'Institut Pasteur. Bacteria, fungi, cyanobacteria, viruses, plasmids, probes &amp; transposons, culture media.</p> <p><a href="#">CIRM</a> International Centre of Microbial Resources, Institut Micalis, INRA/AgroParis Tech; 5 sites. Food bacteria, pathogenic bacteria, lignocellulolytic filamentous fungi, phytopathogenic bacteria, hemiascomycetous yeasts.</p> <p><a href="#">CIRM-CFBP</a> French Collection for Plant-Associated Bacteria, Institut for Horticulture and Seeds. Bacteria.</p> <p><a href="#">BRC-oenology</a></p> <p><a href="#">CRB-Leish</a></p> <p><a href="#">LCP</a></p>	P	E	G
<b>Germany</b>	<p><a href="#">DSMZ</a> Leibniz-Institut DSMZ - Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Braunschweig. Microorganisms, plant cell cultures, plant viruses, human and animal cell lines.</p> <p><a href="#">CCAC</a> Culture Collection of Algae at the University of Cologne. 85% from freshwater/terrestrial habitats. Also has strains from ASW (Algenkultur-Sammlung Wien).</p> <p><a href="#">SAG</a> : Culture Collection of Algae at Göttingen University. Microscopic algae</p>	P	E	G
<b>Greece</b>	<p><a href="#">ACA-DC</a> Laboratory of Dairy Research at the Agricultural University of Athens. Lactic acid bacteria, propionibacteria and yeast strains.</p> <p><a href="#">ATHUM</a> National and Kapodistrian University of Athens Faculty of Biology</p>	C		
<b>Hungary</b>	<p><a href="#">NCAIM</a> The National Collection of Agricultural and Industrial Micro-organisms, Corvinus University of Budapest. Bacteria, yeasts and fungi.</p>	C		
<b>Italy</b>	<p><a href="#">DBVPG</a> Industrial Yeasts Collection. Yeast and yeast-like cultures</p> <p><a href="#">MUT</a> Mycotheca Universitatis Taurinensis. Filamentous fungi and yeasts.</p> <p><a href="#">JCLC</a> Banca Biologica e Cell Factory, IST Istituto Nazionale per la Ricerca sul Cancro</p> <p><a href="#">ITEM</a> Culture Collection of Toxigenic Fungi and their Secondary Metabolites</p>	C P		G
<b>Latvia</b>	<p><a href="#">MSCL</a> Microbial Strain Collection of Latvia, University of Latvia. Bacteria, filamentous fungi, yeasts</p>	C		
<b>Netherlands</b>	<p><a href="#">CBS</a> Fungal Biodiversity Centre, Royal Netherlands Academy of Arts and Sciences. Fungi, bacterial mutants, hosts suitable for DNA research, genetically engineered plasmids, broad-host-range plasmids and phages.</p>	P	E	G

<b>Poland</b>	<a href="#">PCM</a> Polish Collection of Microorganisms, Institute of Immunology and Experimental Therapy, Wroclaw. Bacteria and bacteriophages. <a href="#">IBA</a> Collection of Microorganisms Producing Antibiotics (IBA), Bioengineering Department, Institute of Biotechnology and Antibiotics. Filamentous fungi, yeasts and bacteria	C			
	<a href="#">KOS</a> GDANSK The KOS Collection of <i>Salmonella</i> Microorganisms. Bacteria.	P			
	<a href="#">IAFB</a> Institute of Agricultural and Food Biotechnology.				
<b>Portugal</b>	<a href="#">PYCC</a> Portuguese Yeast Culture Collection. Ascomycetous and basidiomycetous yeasts.	C			
	<a href="#">MUM</a> Micoteca da Universidade do Minho, Biological Engineering Centre of University of Minho. Filamentous fungi culture collection. <a href="#">MEAN</a> Mycotheque, Estação Agronómica Nacional/L-INIA/INRB. Filamentous fungi.	P		E	G
<b>Slovakia</b>	<a href="#">CCY</a> Culture Collection of Yeasts, Institute of Chemistry, Slovak Academy of Sciences. Yeasts and yeast-like organisms	C			
<b>Slovenia</b>	<a href="#">EX</a> Microbiological culture collection, Biotechnical Faculty, University of Ljubljana				
<b>Spain</b>	<a href="#">BEA</a> Banco Español de Algas (Spanish Bank of Algae), Marine Biotechnology Center, University of Las Palmas de Gran Canaria. Microalgae and cyanobacteria.				
	<a href="#">CECT</a> Spanish Type Culture Collection, University of Valencia. Broad scope collection of microbial strains: prokaryotes (bacteria and archaea), yeasts and filamentous fungi	P		E	G
<b>Sweden</b>	<a href="#">CCUG</a> Culture Collection, University of Gothenburg. Broad range of bacteria, filamentous fungi and yeasts.	P (as UGOT)			
<b>United Kingdom</b>	<a href="#">UKNCC</a> UK National Culture Collection co-ordinates the activities of the UK national service collections of microbial organisms.	P		E	G
	<a href="#">CABI</a> CABI, Egham. Fungi and bacteria from over 145 countries. Incorporates UK Collection of Fungus Cultures, UK National Collection of Wood Rotting Fungi, British Antarctic Survey Culture Collection	C			
	<a href="#">NCPPB</a> National Collection of Plant Pathogenic Bacteria.				
	<a href="#">NCIMB</a> National Collection of Industrial, Food and Marine Bacteria. Bacteria, bacteriophages and plasmids in bacterial hosts.				
	<a href="#">CCAP</a> Culture Collection of Algae and Protozoa				
	<a href="#">NCYC</a> National collection of Yeast Cultures				
	<a href="#">HPACC</a> UK Health Protection Agency Culture Collections. Cell lines, bacteria, viruses, fungi. HPACC collections include both:				
	<a href="#">ECACC</a> European Collection of Cell Cultures. Cell lines.				
	<a href="#">NCTC</a> National Collection of Type Cultures. Bacteria pathogenic to animals and humans.				

Sources: ECCO ([www.eccosite.org](http://www.eccosite.org)), MIRRI ([www.mirri.org](http://www.mirri.org)), EMbarC ([www.embarc.eu](http://www.embarc.eu)) and <http://www.gbrcn.org> websites.