Technical Report on the Workshop

'The role to be played by biological collections under the Nagoya Protocol as part of the Project under the 6th EU/Brazil Sectorial Dialogue Support Facility'

Brasilia
June 18-20th 2013

SUMMARY

IDENTIFICATION

Report of the workshop 'The role to be played by biological collections under the Nagoya Protocol' as part of the Project under the 6th EU/Brazil Sectorial Dialogue Support Facility

Project: Implementation of the Nagoya Protocol about the Access and Benefit Sharing - MMAA0002

Dialogue: Environmental Dimension of Sustainable Development
Brazilian Institution responsible for the project: Ministry of Environment - MMA

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OBJECTIVES

- **Main objective of the workshop**
  - Promote dialogue and create opportunities for cooperation over the medium and long term to facilitate the exchange of biological material between scientific collections and access to genetic resources (GR) from *ex situ* collections, in the context of the Nagoya Protocol and national and regional ABS legislation, as well as stimulate capacity building and awareness of ABS rules and practices.

- **Specific Objectives**
  - Enable communication between Brazilian and European holders of biological collections regarding the Nagoya Protocol and national and regional ABS legislation;
  - Discuss simplified procedures for the exchange of biological material between collections (both in Europe and Brazil) for research purposes under the Nagoya Protocol;
  - Share information on access to genetic resources from *ex situ* collections, in the context of the Nagoya Protocol.

ACTIVITIES

Pre-workshop

The list of participants and institutions is provided in Annex 2. Brazilian participants for the international workshop also participated in the first project (Brazilian) workshop (see report in Annex 3); European participants were chosen to represent sectorial associations, collections with major Brazilian specimen holdings and institutions with experience of ABS best practices.

Before the workshop, the document *'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 practice'* was written to provide participants with information on context and current practices. The complete document is presented in the Annex 4. The document '*Brazil's Legislation on Access and Benefit Sharing*' provided information on current Brazilian ABS legislation (see Annex 5).

The provisional agenda, setting out general goals and suggested issues for discussion, is presented in Annex 6.

Workshop structure

Day 1 - 18 June 2013

Presentations (as listed below) were delivered on Brazilian and European legislation/regulation on access to genetic resources and the Nagoya Protocol, to provide participants with information on the current and developing regulatory environments in both regions, and on the results and recommendations of the Brazilian workshop, to enrich the international discussion.

- ***Ex situ* conservation under the Nagoya Protocol and under the Brazilian ABS legislation -** Larissa Costa, Brazilian Ministry of Foreign Affairs

- **Brazilian trusted depository institutions -** Ana Yamaguishi, Ministry of the Environment

- **The E.U. Commission's legislative proposal on implementing the Nagoya Protocol -** Kate Davis, Senior Project Consultant (delivered on behalf of the E.U. Commission)

- **Report on the Brazilian workshop "O papel das coleções biológicas no cenário do Protocolo de Nagoia" -** Luciane Marinoni, Senior Project Consultant

After the presentations, a roundtable was established to discuss the subjects

related to *Research Needs and Barriers Related to ABS Legislation Suggested issues*.

Dr. Bert Visser and Dr. Arthur Mariante were invited by the organizers of the workshop to be the mediators.

Before the discussions began, Kate Davis introduced the background paper, emphasizing the history of flux in levels of control over resources and research freedom, the diversity of collections communities, the importance of networks for developing and disseminating ABS practices, the need to evaluate such practices post-Nagoya, and new key issues to address, including tracking and change of intent.

Afterwards the following topics were presented for roundtable discussion.

• Needs and barriers for research, including exchange and transfer of biological material, in the face of current national/regional legislation, guidelines, and rules of procedure; what will change under the new scenario of the Nagoya Protocol;

• Challenges and opportunities for facilitation of research collaboration, traceability of genetic resources, monitoring of utilization, changes of intent (where access for non-commercial purposes leads to interest in use for commercial purposes);

• Issues raised by the proposed European and Brazilian ABS regulations/legislation on the role played by *ex situ* collections on access to genetic resources;

• Innovative roles that biological collections can play in the implementation of the Nagoya Protocol to promote access to genetic resources and the conservation and sustainable use of biological diversity.

Day 2 - 19 June 2013

The second day's presentations (as listed below) provided further background for the discussions, focusing on practical initiatives:

- **Collecting, use and supply of plants at Kew -** Natasha Ali – Royal Botanic Gardens, Kew

- **Activities of science, technology and innovation for the systematization of knowledge and information on biodiversity -** David Oren – Ministry of Science and Technology

- **Exchange of genetic resources under the ITPGRFA -** Filipe Teixeira, Brazilian Agricultural Research Corporation – Embrapa Cenargen

Following the presentations, four small break-out groups were established, each containing EU and Brazilian representatives from different collections sectors, to discuss issues and to identify commonalities and key differences between different sectors/institutions, briefly explain these, and develop recommendations. Each group received a topic and questions intended to give direction to the discussion; a rapporteur was identified for each group to record the group's considerations.

Following the discussions in small groups, the roundtable re-assembled and the rapporteurs presented their results. All the participants were invited to contribute and to give suggestions.

The following topics and guiding questions were provided to the small groups:

Group A: Tracking/tracing + open access

What level of tracking/tracing is desired by Brazilian/EU authorities, what level is necessary for NP implementation, and what level is actually possible for collections? What do collections need (infrastructure, staff) to be able to track, or trace, material and information? What are the commonalities across collections sectors? What are some best practices? What are the vital differences that may require different approaches? Is it possible to enable open access AND to track specimens/data and their use?

Group B: Transfer to third parties + charge of intent + open access

What are the different practices currently? What are the commonalities between sectors, what are the alternatives? Do we need to transfer to 3rd parties? Would 'commons' approaches be acceptable to authorities and providers? What is the cost/benefit balance of restricting information/material flow for provider countries? How can we address possible changes in intent? What are the minimum requirements for a functional system?

Group C: Brazilian Model MTAs + alternatives

How is the Brazilian MTA system working for international exchanges, and how could it be improved? What are the 'sticking points' for international exchange? Are there differences between sectors in the MTA system's effectiveness? What are the alternatives? Is it possible to develop a standard MTA that could be used by ALL collections, or do we need different standards for different sectors? Would a model MTA – with different options for different sectors/situations – be more appropriate? Could such a standard/model be developed by an extension of this project?

Group D: Cooperation

How is the cooperation between Brazilian and European collections currently working? What are the current barriers and impediments to better cooperation? How can collections help to create new opportunities and models for cooperation?

Day 3 - 20 June 2013

On the final day the small group discussions resumed but with an exchange of topics. The rapporteurs for the previous day's topics remained with their topics while the other group members changed (although staying together); the previous day's report for each topic was circulated to the new group and introduced by the rapporteur, and participants were able to provide fresh suggestions for a second topic. Again the rapporteur was invited to present the results.

Following the reports of the rapporteurs, participants were invited to contribute any more general recommendations or observations from the meeting, and then the meeting was closed.

RESULTS

Day 1 - 18 June 2013: Presentations and roundtable discussion

The following issues and ideas emerged from the general roundtable discussion on the subjects suggested in the workshop agenda.

It was noted that, among the participants of the meeting, there is a difference in the understanding of the same terms used in the Brazilian legislation, the draft European Regulation and the Nagoya Protocol (NP). This partly stems from the use of the terms in the above-mentioned texts. For example, 'access' is not defined in the NP. The Brazilian and European definitions of 'access' are fundamentally different, while the Brazilian term 'access', the NP term 'utilization' and the draft EU Regulation the term 'use' cover very similar concepts. In addition the Brazilian concept of **Trusted Depository Collections** differs in meaning and intention from the EU concept of **Union Trusted collections** (under the proposed draft EU Regulation on ABS); the former focuses on a facility for users to deposit their germplasm as reference material in a safe way, the latter would guarantee to users that genetic resources (GR) have been acquired in harmony with the legal requirements.

Trackability and traceability were also mentioned as two different approaches to monitoring the use of GR. Tracking starts from the user end: when users receive material, they also receive documentation that allows them to track back to the source of the material/data. Tracing starts at the provider end, and necessitates a system that allows information to flow back to providers over use and user chains.

It was noted that the draft EU Regulation builds on three major pillars, i.e. due diligence, best practices and Union Trusted Collections. Due diligence means to show that the user took certain actions to ensure that "genetic resources and traditional knowledge associated with genetic resources used were accessed in accordance with applicable legal requirements and that, where relevant, benefits are fairly and equitably shared upon mutually agreed terms"). Best practices and Union Trusted Collections might take away some of the administrative burden stemming from the due diligence obligation.

The results stemming from the previous Brazilian meeting were recognized as addressing major issues to be resolved in international and national contexts and include:

- Facilitating the exchange of biological material between collections for the purpose of scientific non-commercial research;

- Addressing access to genetic resources in ex situ collections for commercial purposes;
- Facilitating cooperation and the sharing of benefits between Brazilian and European collection holders;
- Monitoring the utilization of genetic resources;
- Promoting the recognition of ex situ collections for their role to provide access under the Nagoya Protocol;
- Accrediting (national) trustee institutions.

Given the large number and variety of collection holders, the limited capacity amongst collection holders and some common types of use, developing standards and models is highly recommended, recognizing that different user sectors might need different models and standards. Jointly developing standards and models would also contribute to building trust between Contracting Parties and institutions.

Collection holders and prospective users would benefit greatly from the development of a process chart to 'translate' any legal procedure or set of procedures to comply with ABS regulations, and to identify the correct regulatory actions and forms to accompany the processes. Such a chart was for example provided in the MOSAICC project developed for microorganisms (BCCM, Belgium).

Fundamental, non-commercial research might be facilitated by transfer of GR under an MTA that provides free access to the GR involved for the purpose of that research, but that obliges the user who signs the MTA to negotiate PIC and MAT with the initial provider/country of origin, if commercial utilization is intended at a later stage. Such a provision would avoid overcautious interpretations of 'fundamental research' in an MTA that does not include such obligation for renewed negotiations at a change of intended use. The ECCO "Core MTA" was mentioned as an example of such an MTA.

Barriers to international collaboration could be removed if participation was on an equal footing, including capacity building and performing research at both ends. It would change the discourse from exportation of plant material into exchange of plant material. International collaboration for mutual gain can be regarded as an effective example of non-monetary benefit-sharing.

It was noted that GR and traditional knowledge associated with GRs within the scope of the Convention are protected under the NP. However, there are no provisions to cover the use of specific data associated with GR, e.g. phenotypic data or genomic information. Reference was made to the option of data protection by a data use agreement. Some participants mentioned that this might be in contradiction to current

open-access to e.g., sequence or genomic data emanating from research results from GR, whereas others were of the opinion that public availability would not have to be identical to unconditional use, claiming that data use agreements should not be considered as limiting public availability of the GR concerned.

On the question as to what we expect from the implementation of the NP, some participants stressed the relevance of legal certainty for users but also for collection holders. Others stressed the need and opportunities to promote increasing knowledge about the collections.

Days 2 and 3: Recommendations

The results of the small group discussions are reported. Small groups were asked to make recommendations for the wider group, with supporting arguments and further details. The recommendations below were mainly formulated by the rapporteurs and were therefore not finally agreed upon at the meeting by all participants, but reflect the results of the discussions in the small break-out groups and the round-table. The sequence of the following recommendations does not imply any weighting.

A: Tracking and tracing

Recommendation 1: Consider developing a structured unique identifier (UID) standard as an efficient way to encode minimum set of standard data fields into a single UID that can travel with a sample and derived data, and reduce the need for other forms of documentation.

> Examples of a 'lightweight' structured UID include the IPEN number: a multi-part ID separated by hyphens, containing coded information on the country of origin, restrictions (sharing rules), institute first acquiring the material, and that institution's accession number. It is thus far used for tracking but can equally facilitate tracing. The World Data Centre for Micro-organisms' (WFCC WDCM) databases system is based on assignment of Globally Unique Identifiers (GUIDs) specific to microbial items (using unique acronyms for each collection), and the Global Catalogue of Micro-organisms (GCM) provides information on the holdings of contributing collections. The ITPGRFA will implement a UID system for agricultural collections.
>
> UIDs can also be used at the transaction level (for loans/transfers), and can also be linked to the UIDs for internationally-recognised certificates of compliance of the Nagoya Protocol (which will contain information on PIC and MAT).

A standard would ideally be developed by a consensus body. Conflicting standards (e.g. from scientific community versus policymakers) should be avoided.

Recommendation 2: Consider developing standard lists of the codes for such structured UIDs and make these accessible to all from a single place on the internet.

Recommendation 3: The creation of new UID systems in fields with already working systems should be avoided, but current UID systems should be examined, considering possible synergies.

A large number of UID systems are in use, and the systems used by GBIF and SiBBr should be considered.

Recommendation 4: Any UID should preferably travel with derived data (e.g. sequence data), and this requirement should be written into MTAs.

Use of the UID in global databases would enable global searches to find where the UID is in scientific literature.

Enforcement of this requirement could be difficult; engagement from professional standards bodies, journals and societies will be required.

Recommendation 5: Consider developing a core standard, with flexibility for different sectors.

The role of the collection should meet minimum data standards (e.g. country of origin, PIC, country institute) but should not necessarily provide a service. Depending on the sector, some information may need to be kept confidential (e.g. for commercial use of agricultural germplasm and microbial collections, or to protect highly threatened species), with information provided to regulatory bodies but not made publicly available.

Recommendation 6: Unfunded mandates should be avoided. Requirements should be paired with implementation: the government that requires traceability should provide the required infrastructure (clearing house, regulating body) and funding for collections and information flow.

Recommendation 7: The degree of effort and resource expended on tracing should be proportional to the risk of mis-use.

Policy standards should be flexible to recognise differences in risk, and should be arrived at by consensus between national regulatory bodies and academics. However, some standards must be set, even if there is a range of different sectorial standards.

Recommendation 8: A tracking system must be practical, cost-effective and scalable to work for different collection holders, large and small, with different staff and infrastructure capacity.

Recommendation 9: There should be no requirement to assign UIDs retroactively to whole collections: any UIDs should be used for new acquisitions and/or transactions.

Recommendation 10: MTAs should follow samples in a chain of distribution and should require reporting back to a clearing house.

> This process could be made more efficient within 'trusted networks' such as IPEN that are treated as a **single entity for tracking/tracing of each transfer within the network** so long as the original intent (academic or commercial) is maintained. Such networks must have strong internal guidelines for membership and binding rules for use to make this a secure option.

Group B: Transfer to third parties and change of intent

Recommendation 11: Consider developing a glossary of terms, to harmonise understanding and usage of terms and concepts such as 'access', 'use' and 'utilisation', 'trusted collections', 'third party transfer' and 'MTA'.

> For example, the Brazilian legislation definition of 'access', the Nagoya Protocol definition of 'utilisation' and the current draft European ABS regulation of 'use' are very similar, while the Brazilian definition of access differs markedly from the European understanding of that term. A glossary of what is meant exactly by which term in which context is key to building understanding and reducing individual and legal confusion.

Recommendation 12: Consider the inclusion of a glossary of terms in each MTA, including a clear definition of 'third party' appropriate to the situation and sector.

> There is considerable difference of opinion between and within sectors as to what constitutes a 'third party.' For example in the case of Brazilian microbial collections, anyone outside the collection is considered a third party, even within the same institution. This is also the case for IPEN gardens attached to universities (researchers are third parties), but within IPEN itself, other gardens are not considered third parties and transfer does not require an MTA. At the Royal Botanic Gardens - Kew and at Embrapa, a third party is an entity outside the institution, but not other collections within the institution.

Recommendation 13: At the point of material exchange, information should be disseminated on the range of different practices for transfers, depending on the type of material.

The development of standards and models can facilitate compliance with Brazilian legislation and build trust between contracting parties and institutions, e.g. for sending seed to institutes outside Brazil. For European collections, standards and models can legitimise exchange between collections and sharing of material of regular users with collaborating scientists.

There is general consensus that it is beneficial to send material to other institutions, particularly when there is not sufficient in-house expertise. Duplicate herbarium specimens are commonly exchanged.

Recommendation 14: The modalities should be considered for a system that could remove, but with safeguards, the requirement to gain Brazilian approval for third party transfer.

If material was to be deposited externally, the requirement to gain Brazilian approval for third party transfer was believed (by at least some) to be unworkable and a barrier to research and cooperation, and should be removed, with safeguards – there must be a mechanism to ensure that permission is sought/obtained for any subsequent move to commercial benefit (see, e.g., recommendation 4 and 10).

Recommendation 15: Agreements (such as MTAs) should be made at the institutional level rather than at the individual level.

This recommendation may pose problems for associates. Institutional procedures and policies may provide solutions.

Recommendation 16: The Brazilian model procedure for benefit-sharing, which contains a useful approach for identifying change of intent, should be translated and the translations should be made publicly available.

There is debate as to when change of intent from non-commercial to commercial research begins. The Brazilian approach is that the provider must be informed if there is a commercial research venture. The MTA is the preferred method for formalizing a change of intent.

Brazilian legislation defines “non-commercial” research in Resolution 21 (Annex 7). Research that is not covered in the definition is considered to have commercial potential. In the MTA used when shipping genetic heritage samples for non-commercial research purposes, change of intent is considered thus: *“In cases of any subsequent wish to make use of the samples of the genetic*

heritage components transferred under this MTA for the purposes of bioprospection, technological development, or the request of a patent, the Receiving Institution shall undertake to so inform the Sending Institution, which shall in turn inform the Genetic Heritage Management Council or an institution accredited under the terms of Article 11(IV)(e) of Provisional Act No. 2,186, dated August 23, 2001."

Recommendation 17: The minimum requirements for a functional system to enable transfer to third parties that could be considered are *inter alia*:

- A series of standard functional MTAs for different circumstances containing appropriate information about terms of use;
- Benefit-sharing models in a range of languages;
- Legal and policy support and advice;
- Databases to record/provide information for purposes of tracking and tracing, taking into account confidentiality of certain data if appropriate;
- Sufficient budget and staff resources: more standardisation lowers the costs.

Group C: The Brazilian MTA and alternatives

Recommendation 18: Consider developing a single MTA with the possibility of invoking different additional clauses, linked to a decision tree, to provide operational clarity and to ensure that appropriate legislation is followed. If it is not possible to have a single MTA, there should be a clear decision tree to determine which MTA is appropriate to use for particular situations.

Four types of MTA are being used in Brazil for biological material, derived from different instructions/ resolutions, and with officially approved text. The first three are ranked by degree of likely commercial activity, and have increasingly detailed requirements to match this; the first three cover both loans and permanent deposit in a collection (including outside the country); the fourth is exclusively for loans (and was not used by any of the group participants).There was clarity that loans should be fully returned, including any aliquots or parts if sequencing or other destructive sampling had been undertaken.

The development of a single MTA could also support user compliance, because users would become familiar with the MTA format and requirements.

Recommendation 19: There should be a means to clearly indicate relevant regulatory requirements, ideally in both Portuguese and major user languages.

There is currently no clarity in MTAs as to which Brazilian Resolutions are relevant (e.g. Resolution 21 is implicit in reference to non-commercial research

and explains what activities are possible, but is not referenced in the MTAs). Links to the relevant texts would be very helpful for foreign institutions seeking legal surety.

Recommendation 20: A web portal could be developed (on CGEN) as a tool to help institutions to develop the appropriate MTA, using such a single MTA model with options.

This tool could be comparable to those available on the SISBIO and CNPq that provide structured information on how to obtain authorisation for collecting, for Brazilians and for foreigners.

Recommendation 21: Prepare and make available a list or register of Brazilian institutions that are empowered to sign MTAs.

The current lack of such a list presents a risk to non-Brazilian collections.

Recommendation 22: Consider the practicalities and requirements of a system to track delivery of non-commercial benefits (such as publications, as set out in MTA conditions).

Such a system would assist institutions in Brazil to demonstrate their international profile and for all to manage and demonstrate the delivery of non-commercial benefits. There is also a need to 'mainstream' agreed benefits across institutions so that institutional level agreements are known and understood.

Recommendation 23: Consider a data use agreement for publication of sequence data within the International Nucleotide Sequence Database Collaboration (INSD; involving GenBank, EMBL and DDBJ), and this recommendation should be considered across the EU countries.

There is potentially a system already in place at INSD record level to assert rights and restrictions on the data but more information from these databases is needed to find out to what extent that can be implemented.

Group D: Cooperation

General observations:

Cooperation between Brazilian and European collections works quite well on an individual basis or for specific research projects, including e.g. the exchange of PhD

students. There are some minor problems and delays related to transferring material within research projects.

Recommendation 24: Disseminate information (in Portuguese and English) about relevant legislation and procedures in Brazil and EU countries that is relevant to scientific collaboration and the exchange of material covered under the NP for non-commercial research. Institutional collaboration decreased over the last decade chiefly due to European concerns related to Brazil's ABS legislation, including some rare but worrying cases in which specimens were not returned to European collections. In general European institutions are not aware that the legislation has changed recently and that it is easier to collaborate now.

Recommendation 25: Import and export requirements for the exchange of material should be streamlined and simplified so as not to unnecessarily hamper exchange.

> A significant impediment to collaboration is that it is sometimes problematic to exchange material due to quarantine restrictions, based on a lack of trust between authorities at both ends.

Recommendation 25: National authorities in Brazil should develop standardized forms and procedures to facilitate exchange of material.

Recommendation 26: Consider developing a permanent online platform to provide and explain information on specimen exchange (ABS legislation and processes related to shipment and quarantine), using user-friendly, easy-to-understand simple schema and decision trees.

> This platform could initially focus on Brazilian and European rules, but link to other initiatives as results emerge from similar discussions being conducted at other levels.

Recommendation 27: The needs of collections institutions in Brazil and in Europe that bear the costs of maintaining collections and providing services for basic research, conservation and commercial use should be recognised and supported.

> Possible options for cost recovery include receiving a percentage of monetary benefits in case of commercialization of a product derived from GR, or charging a general handling fee. This discussion is underway in Brazil, and the results could potentially serve as a model for Europe and beyond.

Recommendation 28: The establishment of national nodes to deal with benefit-sharing should be considered.

The Brazilian National authority for Genetic Resources (CGEN) is mentioned as an example of good practice in this respect.

Recommendation 29: Institutions should be encouraged to document and make their collections information available online to stimulate new collaborations and enable meta-analyses.

The current REFLORA digitisation project is seen as exemplary.

Recommendation 30: Collections should be encouraged to share information on ABS best practices with each other, between as well as within sectors.

ANNEX 1. Abbreviations and acronyms

ABS	Access to genetic resources and benefit-sharing
CENARGEN	National Research Center for Genetic Resources and Biotechnology
CGEN	Genetic Heritage Management Council
CNPq	National Council for Scientific and Technological Development
DDBJ	DNA DataBank of Japan
ECCO	European Culture Collections' Organisation
EMBL	European Molecular Biology Laboratory
Embrapa	Brazilian Agricultural Research Corporation
EU	European Union
GBIF	Global Biodiversity Information Facility
GCM	Catalogue of Micro-organisms
GUID	Global Unique Identifier
GR	Genetic Resources
INSD	International Nucleotide Sequence Database Collaboration
IPEN	International Plant Exchange Network
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MAT	Mutually Agreed Terms
MTA	Material Transfer Agreement
MOSAICC	Micro-organisms Sustainable Use and Access Regulations International Code of Conduct
NP	Nagoya Protocol
PIC	Prior Informed Consent
SIBBR	Information System on Brazilian Biodiversity
UID	Unique Identifier
WDCM	World Data Centre for Microorganisms
WFCC	World Federation for Culture Collections

Annex 2. Participants and institutions

Name	Institution
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Christopher Lyal	Natural History Museum
Francisco Pando	Real Jardín Botánico de Madrid
Justin Paschall	European Bioinformatics Institute
Ole Seeberg	Copenhagen Botanic Garden
Erik Smets	Naturalis Biodiversity Center
Bert van den Wollenberg	International Plant Exchange Network/ Botanic Garden, Technical University of Delft
Gerard Verkley	Microbial Resource Research Infrastructure/WFCC/ CBS-KNAW Fungal Biodiversity Centre
Bert Visser	Netherlands Centre for Genetic Resources

Annex 3. Report on the First Brazilian Workshop 'The role to be played by biological collections under the Nagoya Protocol" – Brasilia, May 9 - 10th 2013

RESULTS

Following are the results of the workshop in priority order as established by the participants within the six topics proposed for discussion. Some suggestions are repeated in different themes, where they were responses to more than one question.

1. **Make the exchange of biological material between collections easier for scientific research, where there is no economic interest.**

a. CGEN Resolution No. 21 of August 31st, 2006 is useful and functional and should be used as a permanent instrument. This resolution provides for research and scientific activities that do not fall under the concept of access to genetic resources for purposes of Provisional Measure No. 2,186-16 of August 23rd, 2001. The Resolution 21 is attached to this report (Annex VI).

b. Loan forms of the collections belonging to various institutions should be similar between them with clear aims and with the same items. A model to be used by the collections could be presented by the Genetic Heritage Management Council (CGEN) or by the Technical Chamber of Biological Collections (CTCB) of the National Biodiversity Commission (Conabio).

c. To improve organization and transparency, the Biological Collections should be responsible for deploying in their institutions: a) a policy for scientific collections, b) a policy of availability of and access to scientific data and information and c) a manual of standards and collections procedures. Of course, the success of these best practices depends on the qualification and training of personnel and dissemination via the institutional web sites of its rules and the forms required for loan and material transfer.

d. The Material Transfer Agreement (MTA) - has been used by all Biological Collections and has been shown effective for our purposes. In the case of formalized cooperation with overseas institutions and development projects, there should be no need to sign the MTA. Registration for transportation must be done in the case of research with economic purpose.

e. Although the MTA, as mentioned above, meets the needs of the Biological Collections in general, there is uncertainty about the transfer of samples of seeds germplasm and, similarly, the sending of material abroad, for required services, for example for sequencing and flow cytometry. Thus there is a need to include these practices in the current model of MTA or develop a new

document that addresses them.

f. In the case of microorganisms, when a new species is described, a series of type specimens must be deposited in an international collection. This material has to be considered available as a reference. Currently the rules are not explained in relation to the rights of the institutions regarding the deposited material. Thus, the rules should be clarified and a new agreement / contract should be prepared in order to guarantee the sharing of benefits with the depositor. This applies to the ex-situ material.

g. The participation of local communities providing information to inventories of organisms should not be treated the same as those cases in which there are benefit sharing requirements arising from the use of Associated Traditional Knowledge (CTA). This type of survey does not generate any kind of information of commercial nature. In this case, procedures that involve filling out questionnaires with members of the community should be very clear.

h. Ethnobotanical Collections are a form of testimony of local knowledge of plant species and should follow the standards laid down in the Convention on Biological Diversity (CBD) and MP 2.186-16/01, as well as codes of ethics of the scientific society (Declaration of Belém 1988; De Bot Soc. Economica, 1999; Internat Soc. Ethnobiology De, 1988). The collection should be digitised and follow the Policy of Data Access and Scientific Information and may not be exchanged or transferred.

i. It is necessary and urgent to unify a system that facilitates the process of license and transport involving all agencies and institutions (ANVISA, FEDERAL POLICE, IBAMA, MAPA and POST). For this purpose it is proposed that a single portal should be created for registration of biological collections for exchange of scientific material, which can be accessed by the agencies listed above at the time of the transit.

j. To support the previous proposal, a physical barcode system should be installed to identify to the above authorities material that is not intended for commercial use or for access (in the sense of the Brazilian legislation - under current law defined as "*activity performed on the genetic heritage with the aim of isolating, identifying or using information from genetic or molecules and substances in the metabolism of living beings and extracts of these organisms, for purposes of scientific research, technological development and bioprospecting, aiming their industrial application or otherwise".*) Such a code would be recognized by the system and the registration of the collections in this system would be the

responsibility of the institutions that exchange material but do not access it, for example, the license for collection issued by SISBIO (http://www.icmbio.gov.br / SISBIO /).

k. Besides the unification of the process of material control by the agencies mentioned above, the training of inspectors and inspection agents is essential, regardless of the control system.

2. Discuss and address the access to genetic resources in *ex situ* collections for trade procedures.

a. The collections should standardize the procedures and documents required for the shipment of material - as described in items 1b and 1c.

b. The collections should be considered as sources of material for commercial purposes: they hold the information about the origin of the material, its geographic distribution, its taxonomic classification, and are the only bodies with the capacity to ensure reliability and to give such information. As the collection is responsible for the conservation of this material and bears the great costs of keeping it, it is essential that the collection be considered as a provider, as well as the depositor of the material. We suggest that 10% of the amount of the transaction should go to the provider collection.

c. Add to MTA an item obliging the recipient to sign a Prior Informed Consent Form (PIC) and to establish Mutually Agreed Terms (MAT) if there is a change of intent for bioprospecting, technological development and an application for a patent.

d. Adopt a standard model agreement for various types of material giving legal certainty to these exchanges, similar to the multilateral system of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

e. Develop a national platform for data banks of genomics and proteomics, among others, of the Brazilian biological material that has clear rules for free access, use and benefit sharing.

f. Develop a plan for dissemination and training on Nagoya Protocol for all those sectors involved in the conservation of collections of genetic resources.

g. Facilitating cooperation and the sharing of benefits between Brazilian and European collections.

h. Consider what is described in item 1 d (MTAs) and 1f (deposit requirements) – focusing on cooperation with the countries of the European Community (EC).
i. Consider what is described in item 1 f - mainly because the deposit of the type material of microorganisms is done in European collections.
j. Elaborate calls for joint projects with the European Community (EC) involving Brazilian biological collections.
k. Periodically review the cooperation agreement with the EC, within the scope of Nagoya Protocol.
l. Develop a plan for ongoing training of Brazilian and European technicians who work in the collections, to ensure their knowledge of the Nagoya Protocol and associated regulations.

3. Monitor the utilization of genetic resources.

a. Establish a database of national collections that provides for tracking of the material from its origin. Such a database would provide transparency on the use of material, and also information on the status of the research. The database could be integrated into the Information System on Biodiversity (Brazilian SiBBr), converging to single platform that generates a Biological Registration Code.

b. Increase the term of maintenance of genetic heritage in the collection, beyond the end of scientific research project. The term should be defined, as well as the indication of the trustee collection at the end of scientific research.

c. Consider what is described in the item 2 g.

4. Promote recognition of *ex-situ* collections taking into account the role they play for access to genetic resources, primarily under the Nagoya Protocol.

a. Consider what is described in paragraphs 1 b and 1c.

b. Promote recognition of the collections within the institutions that maintain them, considering the three levels: local, state and federal.

c. Ensure that collections are maintained in functional units, formally recognized within their institutions, with rules and policies , staff and own budget.

d. Ensure that the collection that provides access to materials is included in contracts for benefit sharing, even if it is not a trustee collection, regardless of the original provider and the date of obtaining the material for the collection.

e. Ensure that the government assists with financial resources those collections considered trustee collections of CGEN, as well as those who can afford to be

Biological Resource Centers (CRBs).

f. National calls for project submissions by CNPq and other agencies should allocate a percentage of the financial resources to the maintenance of the collections for projects that involve access to biological resources.

g. Review the representation of the institutions in CGEN, including a chair for representatives of ex situ collections.

h. The recognition of the collection institution could be made based on certain minimum criteria such as: having a curator and deputy curator; being computerized at least in part, to ensure the traceability of biological material; possessing infrastructure and human resources to ensure the maintenance of the collection, including the activities of deposit, loan, donation, sale and exchange; capacity for quality identification of material by trained personnel.

i. The collections that meet the requirements listed above should be recognized institutionally by an ordinance that should include the names of the curator, deputy and contact.

j. Among the criteria for the recognition of the institution and its collection(s), compliance with legal requirements regarding Access and Benefit Sharing must be considered. The collection shall use the MTA (Res. 15, 20, 25 and IN 160) for the transportation of the biological material and ensure the traceability relating to the deposit of the biological material.

k. Develop workshops about the collections and the Nagoya Protocol in collaboration with other institutions.

l. Include in the institutional project a plan for application of resources.

m. Train personnel linked to the biological collections and to legal advice about the regulations and legislations of genetic heritage (MP 2.186-16/01).

n. Include in the curriculum of universities (undergraduate and graduate) subject on Access Legislation for courses related to the theme.

5. Accreditation of the trustee institutions

a. Considering item 5 h. CGEN must have a list of minimum attributes for a collection that can be accredited. In this case, the issues of computerization and traceability must have greater weight.

b. Define a flow for this institutional accreditation, using the existing Center for Technological Innovation (NIT), or similar. The responsible body would have to evaluate the function of accreditation applications, check the documentation and

forward for accreditation.

c. The group agrees that this accreditation should be unlimited but restricted to public institutions.

Annex 1. Name of participants and institutions

Name	Institution
Alberto Cardoso Arruda	Universidade Federal do Pará, Centro de Ciências Exatas e Naturais
Aldo Trindade	Empresa Brasileira de Pesquisa Agropecuária, Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical.
Alexandre L. P. Aleixo	Museu Paraense Emílio Goeldi, Coordenação de Zoologia
Carla Simone Pavanelli	Universidade Estadual de Maringá - Nupélia, Coleção Ictiológica
Carlos Augusto Rosa	Universidade Federal de Minas Gerais, Instituto de Ciências Biológicas - Depto. Microbiologia.
Darci Moraes de Barros Battesti	Instituto Butantan, Secretaria da Saúde, Laboratório de Parasitologia
Glyn Mara Figueira	Universidade Estadual de Campinas, Reitoria, Centro Pluridisciplinar de Pesquisas Químicas e Biológicas
Gonçalo A. Guimarães Pereira	Universidade Estadual de Campinas, Instituto de Biologia, Departamento de Genética e Evolução
Itamar Soares de Mello	Empresa Brasileira de Pesquisa Agropecuária, Meio Ambiente
Lara Durães Sette	Universidade Estadual Paulista Júlio de Mesquita Filho, Instituto de Biociências de Rio Claro, Departamento de Bioquímica e Microbiologia.
Lúcia Helena Rapp PyDaniel	Instituto Nacional de Pesquisas da Amazônia, Coordenação de Biodiversidade
Luis Fabio Silveira	Universidade de São Paulo, Museu de Zoologia, Seção de Ave
Manuela da Silva	Fundação Oswaldo Cruz, Vice-Presidência de Pesquisa e Laboratórios de Referência.
Maria Fulgência C. L. Bandeira	Universidade Federal do Amazonas, Faculdade de Odontologia-UFAM
Maria Nelman Antunes de Souza	Fundação Ezequiel Dias – Minas Gerais
Maria Regina de V. Barbosa	Universidade Federal da Paraíba, Centro de Ciências Exatas e da Natureza - Campus I, Departamento de Sistemática e Ecologia.
Mariane Silveira de Sousa-Baena	Centro de Referência em Informação Ambiental.
Marilia Lobo Burle	Empresa Brasileira de Pesquisa Agropecuária, Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia
Osmar Alves Lameira	Empresa Brasileira de Pesquisa Agropecuária, Centro de Pesquisa Agroflorestal da Amazônia Oriental
Rogério Biaggioni Lopes	Empresa Brasileira de Pesquisa Agropecuária, Cenargen.

Sérgio Ricardo Sodré Cardoso	Instituto de Pesquisa Jardim Botânico do Rio de Janeiro, Diretoria de Pesquisas, Programa Diversidade Taxonômica
Suzete A. Lanza Destéfano	Instituto Biológico, Secretaria de Agricultura e Abastecimento, Centro Experimental do Instituto Biológico Laborató de Bacteriologia Vegetal.

ANNEX 4. Document *"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"*. Authors: Kate Davis and Luciane Marinoni

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 16th 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[1].

[1] Baratay, E. & Hardouin-Fugier, E. (2002) Zoo: a History of Zoological Gardens in the West. Reaktion Books, London, UK

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 conducted 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[2].

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 17th century and early 18th 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 16th and 17th centuries[3]. 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[4]. 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)[5]. 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 Banks and fellow expedition members made illicit forays to the shore to collect specimens[6]. In 1803-04, when the expedition led by Adam Johann von

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[2] 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.

[3] *Ibid.*

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

[5] 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.

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

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[7].

In the late 18th 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[8].

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[9].

A few key 19th 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[10].

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, 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.

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7 *Ibid.* 2 (Barman 1971)

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

9 *Ibid.*

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

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[11]; 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[12]; 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)[13] [14].

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 1836-1841 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)[15]; similarly, British naturalists Alfred Russel Wallace and Henry Walter Bates sold insect and bird specimens to support their 1848

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11 *Ibid.* 2 (Barman 1971)

12 Steindachner went on the coordinate the Austrian Expedition of 1903; www.nhm-wien.ac.at/en/research/_zoology_vertebrates/fish_collection_/history

13 *Ibid*. 8 (Bastos & Sá 2011)

14 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

15 www.kew.org/science/tropamerica/gardner/index.html

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[16] [17].

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.[18].

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 zoologist Emil Goeldi and German zoologist Hermann von Ihering[19]. Ihring 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.

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16 www.nhm.ac.uk/research-curation/research/projects/spruce/INTRODUCTION/introduction_spruce.dsml

17 Gribbin, M. & Gribbin, J. (2008) The Flower Hunters. Oxford University Press, Oxford, UK.

18 *Ibid*.

19 www.bbk.ac.uk/ibamuseum/texts/Andermann01.htm

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[20].

2.4 20th century exchange

Due to many factors, the mode of exploration and collection by large European expeditions declined after the 19th century. Most 20th 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 20th 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 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.

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[20] Jackson, J. (2008) The Thief at the End of the World: Rubber, Power, and the Seeds of Empire. Penguin Books.

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[21].

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

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

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)[22] and the Biota Fapesp[23]. Other initiatives have concentrated their effort towards gathering the collections into networks and releasing the biological information via the internet, such as SpeciesLink[24] and Taxonline - Network of Biological Collections in Paraná State[25].

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 Information (CRIA). 29 documents and technical notes were produced and presented in two workshops with more than 80 participants, including international specialists[26]. 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[27].

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

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22 http://ppbio.inpa.gov.br/colecoes

23 www.biota.org.br/

24 http://splink.cria.org.br

25 www.taxonline.ufpr.br

26 See www.cria.org.br/cgee/col/

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

Brazilian Biological Collections and Consolidation of Integrated Biodiversity Information Systems' for approval and it was published as Deliberation number 53[28].

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[29]. 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 Environment[30]. 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.

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

29 www.botanica.org.br/rede_herbarios.php

30 www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes_fieis_depositarias_04-2013.pdf

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[31]. 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[32] (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[33].

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[34]. 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

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

32 The BCI was accessed via 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).

33 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.

34 BGCI GardenSearch database, www.bgci.org/garden_search.php

indicate that, in EU countries, 98 botanical institutions hold seed banks[35] 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)[36], and Botanic Gardens Conservation International (BGCI)[37]. 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[38].
Most EU countries have established garden networks. Convened by BGCI, the European Botanic Gardens Consortium[39] 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 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) [40] 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

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35 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/

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

37 www.bgci.org

38 Although 17 Brazilian institutions are International Agenda registrants

39 www.botanicgardens.eu

40 www.cetaf.org

collections and include almost all of the major repositories for historic Brazilian material[41], 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[42]. 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 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[43] [44]. 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[45].

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

42 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 and http://scicoll.org/sites/default/files/Sci_Coll_Brochure.pdf.

43 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

44 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.

45 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

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 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[46].

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[47].

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[48]. The WFCC World Data Centre for Microorganisms (WDCM)

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general interest. Federal Public Service of Public Health, the Safety of the Food Chain and the Environment – Directorate General of the Environment, Belgium.

[46] 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

[47] 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/

[48] www.wfcc.info/about

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[49].

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)[50]. 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[51], 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, 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.[52]

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[53].

The Global Biological Resource Centre Network (GBRCN)[54] 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.

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49 www.wfcc.info/ccinfo

50 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.

51 www.mirri.org

52 www.embarc.eu

53 www.gbrcn.org

54 *Ibid.* and www.gbrcn.org/fileadmin/gbrcn/media/downloads/GBRCN_Final_Report/GBRCN-FinalReport2012.pdf. Partners include Centro de Referência em Informação Ambiental (CRIA), Campinas.

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[55]. 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 Association of Zoos and Aquariums (EAZA, a WAZA member) represents 345 institutions (including national associations) in 41 countries, including 299 institutions in EU countries[56] (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[57].

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

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55 *Ibid* 44 (Latorre 2005)

56 www.eaza.net

57 www.alpza.com/index.php

genebanks[58]. The Nordic countries (Denmark, Finland, Iceland, Sweden and Norway) coordinate their efforts via NordGen, the Nordic Genetic Resource Centre[59].

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[60]. The EURISCO web catalogue receives data from the national inventories[61] 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[62] 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[63]. 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[64]. 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

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58 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

59 www.nordgen.org

60 including those maintained at the National Botanic Garden of Belgium and the Millennium Seed Bank at Kew; www.ecpgr.cgiar.org

61 http://eurisco.ecpgr.org/about/the_network/online_national_inventories.html

62 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

63 www.euforgen.org

64 www.rfp-europe.org

'South' between regions of the North, and South to South is currently much more significant than transfer from South to North[65].

In Brazil, the national organisation for pure and applied agricultural research is Embrapa[66], 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 Information System called Sibrargen (Brazilian Information System for Genetic Resources)[67].

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.

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65 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

66 www.embrapa.br

67 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

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 7th 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 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.

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

5.1. 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[68]. However their numbers are growing worldwide, especially with the development of the International Barcode of Life (IBOL) project[69], which necessitates the extraction and isolation of DNA. A 2004 global survey of the Plant Genetic Resources

[68] 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

[69] 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.

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%)[70].

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)[71] 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[72]. ESBB members are chiefly health-care related institutions, although the intended scope of ISBER and ESBB includes 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[73]. Five Polish institutions have established the National Plant, Fungi and Animal DNA Bank[74]. 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[75].

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)[76]. In the field of food and agriculture, Embrapa's Laboratory of Animal Genetics (LGA) maintains a

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70 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

71 www.isber.org

72 www.esbb.org/biobanks.html

73 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

74 www.bankdna.pl

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

76 http://www.jbrj.gov.br/pesquisa/div_molecular/bancodna/sobre_ing.htm

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[77]. Several Brazilian universities also hold important and diverse DNA and tissue collections[78], 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[79].

5.2. Extracts and compounds

A wide range of organisations use and store extracts and isolated compounds derived from genetic resources, though these 'collections' are predominantly are 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[80]. 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[81].

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77 http://plataformarg.cenargen.embrapa.br

78 See CGEN list of Instituições Fiéis Depositárias (Trustee institutions): www.mma.gov.br/images/arquivo/80043/fiel%20depositario/instituicoes_fieis_depositarias_04-2013.pdf

79 http://ggbn.org/

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

81 *Ibid*.

The Union for Ethical BioTrade (UEBT)[82] 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 discovery of hits and leads to universities, public institutes, and smaller discovery companies[83].

Many compound libraries are held by European pharmaceutical companies represented by the European Federation of Pharmaceutical Industries and Associations (EFPIA)[84], 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)[85].

At the global network level, the International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)[86] 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)[87] currently has 47 member companies, many of which are Brazilian subsidiaries of Europe-based multinationals.

5.3. Genetic sequence databases

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82 www.ethicalbiotrade.org

83 Secretariat of the Convention on Biological Diversity (2008)

84 www.efpia.eu

85 www.europabio.org/members

86 www.ifpma.org

87 www.interfarma.br

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)[88]. 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[89].

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)[90] 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[91].

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[92].

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

88 www.boldsystems.org

89 www.barcoding.si.edu/CBOLDatabasesBOLD.htm

90 www.insdc.org

91 www.barcoding.si.edu/PDF/DWG_data_standards-Final.pdf

92 www.ebi.ac.uk

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 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[93], 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

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[93] 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.

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 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[94], 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

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

decide to involve *ex situ* collections as checkpoints, which in most 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'[95] .

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 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

[95] http://ec.europa.eu/environment/biodiversity/international/abs/index_en.htm

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[96] [97]. 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 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[98].

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

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96 www.bgci.org/resources/abs_principles/; www.kew.org/conservation/principles.html

97 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.

98 www.kew.org/conservation/endorsements.html

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[99]. 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 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[100].

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 carried out within IPEN's

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99 www.bgci.org/resources/ipen/

100 www.bgci.org/resources/Description_of_IPEN/

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[101]).

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

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 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[106], 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

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101 A. Wyatt, pers. comm. (2012)

102 www.kew.org/conservation/docs/ABSPolicy.pdf

103 www.botanicgardens.ie/educ/accnosho.pdf

104 www.rbge.org.uk/assets/files/science/Herbarium/Destructive_sampling_policy.pdf; www.rbge.org.uk/assets/files/databases/RBGEcond.pdf

105 www.bgbm.org/BGBM/research/colls/garden/CBD.HTM

106 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

and training tool (with a focus on ABS) for people working with botanical collections[107], and the CBD Manual for Botanic Gardens[108], 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[109]. Currently there are 110 International Agenda registrants in EU countries[110], 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[111].

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[112] 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'[113]. The principles aim to facilitate access to collection material through loans while maximising their long-term preservation. The general policy statements include the provision

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107 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

108 Davis, K. (2008) A CBD Manual for Botanic Gardens. Botanic Gardens Conservation International, Richmond, UK. www.bgci.org/resources/cbdmanual

109 BGCI (2012) International Agenda for Botanic Gardens in Conservation: 2nd edition. Botanic Gardens Conservation International, Richmond, UK. www.bgci.org/files/Worldwide/News/SeptDec12/international_agenda_web.pdf

110 BGCI GardenSearch database

111 www.bgci.org/resources/abs

112 www.e-taxonomy.eu/

113 EDIT principles: http://www.e-taxonomy.eu/files/EDIT%20Common%20Loan%20Principles_vfinal.pdf

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 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[114].

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[115].

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

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[114] 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

[115] www.museumsassociation.org/ethics/ethical-guidelines

also appeared to be the only organisations who mainly acquired biological material from *in situ* sources[116]. 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[117]. 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'[118]. The guidelines also prompt researchers to 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[119] 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[120], 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,

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116 *Ibid*. 44 (Latorre 2005)

117 www.dfg.de/en/dfg_profile/mission/index.html

118 www.dfg.de/download/programme/sonstige/antragstellung/1_021_e/1_021e.pdf

119 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

120 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

can use the ABS Management Tool[121]. 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)[122]. The UBMTA was published in 1995 by the US National Institutes of Health for the transfer of biological materials for teaching and academic 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[123]. 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[124], 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

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121 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

122 www.ott.nih.gov/NewPages/UBMTA.pdf

123 www.autm.net

124 http://sciencecommons.org/projects/licensing/details/

Code of Conduct (MOSAICC)[125], 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 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.[126] 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'[127]. 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[128].

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

126 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

127 www.eccosite.org

128 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 10th Anniversary Symposium, Tokyo, December 6, 2012.

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 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[129].

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[130].

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[131]. Draft guidelines on ABS were discussed by WAZA

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129 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.

130 *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

131 *Ibid*. 44 (Latorre 2005)

member organisations in 2006[132]. 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.

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)[133], 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[134] and a guide to the use of the SMTA[135]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.

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132 www.zoosprint.org/ZooPrintMagazine/2006/June/15-17.pdf

133 www.planttreaty.org

134 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://cropgenebank.sgrp.cgiar.org/images/file/procedures/collecting2011/Chapter2-2011.pdf.

135 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

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[136].

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[137] – 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[138] .

The International Society for Biological and Environmental Repositories (ISBER) provides updated best practices for repositories[139]. 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

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136 *Ibid.* 43 (Defra 2012)

137 *Ibid*. 70 (Anderson et al. 2006)

138 http://ggbn.org/taskForce_Policies.html

139 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

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) 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[140]. 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[141], 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)[142] 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'[143] .

7.3.9 Genetic sequence databases

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140 http://ethicalbiotrade.org/news/wp-content/uploads/STD01-Ethical-BioTrade-Standard-2012-04-11_.pdf

141 www.ifpma.org/innovation/biodiversity.html

142 http://www.ifpma.org/fileadmin/content/About%20us/2%20Members/Associations/Code-Brazil/Brazil_-_Interfarma_Code_of_Conduct_2012_-_English_version.pdf

143 Available at www.basf.com/group/corporate/en/products-and-industries/biotechnology/europabio

The International Nucleotide Sequence Databases do not currently require information depositors to supply ABS information such as country of origin, or evidence that prior informed consent was obtained and mutually agreed terms were established[144]. 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[145]. 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[146], 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[147]. 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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144 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

145 Sample GenBank Record. www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html

146 Hanner, R. (2009). Data Standards for BARCODE Records in INSDC (BRIs). http://barcoding.si.edu/pdf/dwg_data_standards-final.pdf

147 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[148]. 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[149]. 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[150] 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)[151].

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

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[154].

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

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148 www.gbif.org

149 www.catalogueoflife.org

150 www.4d4life.eu

151 www.eubrazilopenbio.eu

152 www.biocase.org/index.shtml

153 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

154 www.wfcc.info/ccinfo/statistics/

holdings[155]. 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 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[156]), 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[157]. 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[158].

Project Reflora 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[159] [160].

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 Reflora and with support from CNPq, the A. de Saint-Hilaire Virtual Herbarium is aiming to make

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155 http://gcm.wfcc.info/mission/

156 www.kew.org/science/tropamerica/repatriation.htm

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

158 http://plants.jstor.org/action/community

159 www.kew.org/science-research-data/directory/projects/Reflora.htm

160 www.scidev.net/en/news/brazil-to-repatriate-its-botanical-data.html

available images of Auguste Saint-Hilaire's 30,000 specimens as well as 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[161].

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 Staatssamlung 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*[162].

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[163].

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[164] [165].

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161 http://hvsh.cria.org.br/project

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

163 www.kew.org/science-research-data/directory/projects/RichardSpruceCollectn.htm

164 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 Museum National d'histoire Naturelle et le Brésil', 2009. www.mnhn-brasil.info/program_fr

165 www.kew.org/news/kew-projects-brazil.htm

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[166] (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[167].

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.

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

166 www.kew.org/learn/specialist-training/continuing-professional-development/index.htm

167 www.taxonomytraining.eu/

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

Sources: BGCI GardenSearch database http://www.bgci.org/garden_search.php; IPEN www.bgci.org/resources/ipen/; Principles on ABS 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
Austria	Biologiezentrum der Oberösterreichischen Landesmuseen, Linz	C		
Austria	Naturhistorisches Museum, Vienna	C		
Austria	Karl-Franzens-Universität, Graz			587
Belgium	Royal Belgian Institute of Natural Sciences	C	S	
Belgium	National Botanic Garden, Meise	C		9990
Belgium	Royal Museum of Central Africa, Tervuren	C		
Belgium	Herbarium, Laboratory of Botany, Gent University			5
Czech Republic	National Museum (Natural History), Prague	C		
Denmark	Natural History Museum of Denmark, Copenhagen	C	G	1040
Estonia	Estonian Academy of Sciences, Tartu	C		
Finland	Finnish Museum of Natural History, Helsinki	C		233
France	Muséum National d'Histoire Naturelle	C	S	16412
France	Herbier de l'Université Montpellier			1307
Germany	Botanischer Garten und Botanisches Museum, Berlin-Dahlem	C		2832
Germany	Senkenberg, Forschunsinstitute & Naturmuseum, Frankfurt	C		18
Germany	Museum für Naturkunde	C	S	
Germany	Staatliches Museum für Naturkunde, Stuttgart	C		
Germany	Staatliches Naturwissenschaftliche Sammlungen Bayerns	C		5818
Germany	Zoologisches Forschunsinstitut und Museum Alexander König, Bonn	C		
Germany	Universität Göttingen			522
Germany	Martin-Luther-Universität			969

Germany	Biozentrum Klein Flottbeck und Botanischer Garten der Universität Hamburg			423
Germany	Friedrich-Schiller-Universität Jena			556
Hungary	Hungarian Natural History Museum, Budapest	C		
Ireland	Herbarium, Trinity College, Dublin			2161
Italy	Museo Civico di Storia Naturaledi Milano	C		
Italy	Museo di Storia Naturale dell'Università degli Studi di Firenze	C		394
Italy	Museo civico di Storia Naturali di Genoa	C		
Netherlands	Centraalbureau voor Schimmelcultures, Utrecht	C		
Netherlands	Nederlands Centrum voor Biodiversiteit NCB Naturalis, Leiden	C	S	(number not obtainable from GPI)
Poland	Museum and Institute for Zoology PAN, Warsaw	C		
Slovakia	National Taxonomic Facility of Slovakia	C		
Spain	Consejo Superior de Investigaciones Científicas, Museo National de Ciencias Naturales, Madrid (MNCN/CSIC)	C	S	
Spain	Real Jardin Botánico, Madrid	C		62
Sweden	Naturhistoriska Riksmuseet, Stockholm	C		3724
United Kingdom	Royal Botanic Gardens, Edinburgh	C		1750
United Kingdom	Royal Botanic Gardens, Kew	C		21622
United Kingdom	Natural History Museum London	C	S,G	6777
United Kingdom	Linnean Society of London			90

Sources: Consortium for European Taxonomic Facilities (CETAF) institutions www.cetaf.org/; Scientific Collections International (SCICOLL) founders www.scicoll.org/; Global Genome Biodiversity Network (GGBN) collaborators 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
Austria	ACBR VIENNA, Austrian Center of Biological Resources and Applied Mycology. Hyphomycetes & yeast strains			
Belgium	BCCM Belgian Co-Ordinated Collections of Microorganisms, Belgium: consortium of 7 Biological Research Centres coordinated by central team at Belgian Science Policy. Includes: BCCM/IHEM Scientific Institute for Public Health - biomedical fungi & yeasts BCCM/LMBP Ghent University - plasmids & DNA libraries BCCM/LMG Ghent University - bacteria BCCM/MUCL Catholic University of Louvain - (agro)industrial fungi & yeasts BCCM/DCG Ghent University - diatoms BCCM/ITM Institute of Tropical Medicine - mycobacteria BCCM/ULC University of Liège - polar cyanobacteria	P C C (& P as UGENT) C	E E E E	G
Bulgaria	NBIMCC SOFIA, National Bank for Industrial Microorganisms and Cell Cultures. **Bacteria**, **actinomycetes, plasmid bearing microorganisms, yeasts, fungi, animal and plant viruses,** and **animal cell cultures**			
Czech Republic	FCCM Federation of Czechoslovak Collections of Microorganisms. 17 collections http://web.natur.cuni.cz/fccm/collecze.htm . In ECCO: CAPM Collection of Animal Pathogenic Microorganisms CCF Culture Collection of Fungi, Charles University. CCM Czech collection of Microorganisms, Masaryk University. Bacteria and fungi. CNCTC Czechoslovak National Collection of Type Cultures, National Institute of Public Health. Deposited strains.	C		
Denmark	SCCAP The Scandinavian Culture Collection of Algae and Protozoa. Representatives from most algal divisions. IBT (no data)			
Estonia	CELMS Collection of Environmental and Laboratory Strains, Institute of Molecular and Cell Biology, University of Tartu. Non-medical environmental and laboratory microbial strains. HUMB Human Microbiota Biobank, Institute of Microbiology, University of Tartu			
Finland	HAMBI University of Helsinki, Faculty of Agriculture & Forestry, Division of Microbiology; non-profit. Total no. cultures ~5500. Includes: HAMBI / BAC for bacteria HAMBI / FBCC for fungi HAMBI / UHCC for cyanobacteria VTT VTT Culture Collection, under VTT Technical Research Centre. Yeasts, filamentous fungi and bacteria	C		G
France	CCRB French Comité Consultatif des Ressources Biologiques : CRBIP Centre de Ressources Biologiques de l'Institut Pasteur. Bacteria, fungi, cyanobacteria, viruses, plasmids, probes & transposons, culture media. CIRM International Centre of Microbial Resources, Institut Micalis, INRA/AgroParis Tech; 5 sites. Food bacteria, pathogenic bacteria, lignocellulotytic filamentous fungi, phytopathogenic bacteria, hemiascomycetous yeasts. CIRM-CFBP French Collection for Plant-Associated Bacteria, Institut for Horticulture and Seeds. Bacteria. BRC-oenology CRB-Leish LCP	P P	E E	G
Germany	DSMZ Leibniz-Institut DSMZ - Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Braunschweig. Microorganisms, plant cell cultures, plant viruses, human and animal cell lines. CCAC Culture Collection of Algae at the University of Cologne. 85% from freshwater/terrestrial habitats. Also has strains from ASW (Algenkultur-Sammlung Wien). SAG : Culture Collection of Algae at Göttingen University. Microscopic algae	P C	E	G
Greece	ACA-DC Laboratory of Dairy Research at the Agricultural University of	C		

Sources: ECCO (www.eccosite.org), MIRRI (www.mirri.org), EMbaRC (www.embarc.eu) and http://www.gbrcn.org websites.

ANNEX 5. Brazil's Legislation on Access and Benefit Sharing. Author: Eliana Fontes

Brazil's Legislation on Access and Benefit Sharing

Brazil was one of the first countries to put in place – over ten years ago – domestic legislative, administrative and policy measures designed to implement this objective at national level.

However, there was a common understanding from the beginning that the international regime depended on the third objective of the Convention to be met. Provider countries should enact legislation that would enable benefit sharing from users of genetic resources.

Brazil is a biologically megadiverse country, with a rich population of indigenous and local communities holding valuable traditional knowledge about their genetic resources. The country also possesses significant scientific and technological capacity. A functioning and fair ABS system is crucial to develop new biodiversity-based activities that will generate benefits for the nation, including for further conservation and sustainable use of our biological resources.

Brazil's interest in developing a functioning and fair ABS system derives from its position as a megadiverse country of continental proportions – a terrestrial area of 8.5 million km^2 and a marine area of 4.5 million km^2. Two-thirds of the country are still covered by native vegetation. It is home to six continental biomes (Amazon, Caatinga, Cerrado, Pantanal, Atlantic Forest, Pampas) and 15 per cent of known species (and possibly 25 per cent of all species).

Brazil is a culturally megadiverse country too. It has a population of 190 million, multi-ethnic par excellence, including 220 indigenous peoples speaking 180 different languages, as well as numerous categories of non-indigenous traditional communities whose livelihoods depend upon the sustainable use of biodiversity. Overall the national population is made up of Brazilians with ethnic backgrounds originating from all continents.

Brazil produces 6 per cent of the science on biodiversity and has significant genomics and biotechnology programmes. It is the world's second largest exporter of agricultural commodities and producer of biofuels.

As a provider of genetic resources, Brazil seeks to use this potential wealth to foster research and development that will build scientific and technological capacity, create wealth and promote sustainable human development. This will contribute to the conservation and sustainable use of its natural capital.

Provisional Measure 2.186-16 establishes the ABS legal framework in Brazil. Its main provisions require:

- Previous authorization by CGEN (Council for Genetic Heritage Management) in order to access genetic resources and associated traditional knowledge for research, bioprospecting and technological development.
- Prior Informed Consent from indigenous and local communities as a necessary condition for accessing their genetic resources and/or traditional knowledge associated to genetic resources.
- Benefit sharing with the providers when any product or process that results from the access to genetic resources or associated traditional knowledge arrives at the market.
- The signing of benefit sharing contracts and their submission for approval by CGEN.

Simultaneously, Decree 3.945/2001 provided overall complementary regulation. It designated the Council for Genetic Heritage Management (CGEN) as the ABS national competent authority and the Department of Genetic Heritage (DPG) to operate as Secretariat for CGEN. DPG functions within the Ministry of the Environment.

Subsequent Decrees have amended the requirements for obtaining authorization for access, regulated the application of administrative penalties and regulated the use of public funds for benefit sharing.

Since its establishment in April 2002 CGEN has approved a number of norms to clarify and promote the implementation of the legislation, including 40 Resolutions and 7 Technical Orientations. The Council has also certified over 300 public *ex situ* collections.

To increase CGEN's capacity to manage the ABS system, the council may accredit other institutions to concede access authorizations. The Federal Environment Agency -IBAMA, the National Science Research Council - CNPq, and the National Institute of Historic and Artistic Heritage - IPHAN have been accredited by CGEN.

The Brazilian National Patent Office (INPI) has begun refusing patent requests which do not fulfill the requirements of Provisional Measure 2.186-16. This is an important step towards meeting the requirements of Article 17 of the Nagoya Protocol which requires Parties to designate one or more checkpoints to ensure compliance by monitoring and enhancing transparency about the utilization of genetic resources.

The regulatory system as established in 2001 has proved to be very difficult to implement, notwithstanding the clarifications and adjustments made by CGEN over the succeeding eleven years. This is not surprising given that Brazil was a pioneer in the attempt to incorporate the provisions of Article 15 of the CBD into a national legislative, administrative and policy framework. There were no existing models to be followed.

The rationale of the system put in place twelve years ago revolved largely around command and control principles. This is understandable in light of Brazil's longstanding concern to forestall biopiracy in the absence of any international benefit sharing framework. However one of the consequences of this focus is that the required procedures may have resulted as a disincentive to applied research and development for both academic researchers and industry.

Despite the difficulties, there has been significant progress. By 2012, CGEN and accredited institutions had registered more than 600 access authorizations. Institutions and companies, mainly cosmetic and pharmaceutical, are sharing benefits, sometimes through capacity building and training, but mostly in monetary form. Over 70 contracts have been registered by CGEN, generating benefits for local communities and landowners. However, that is still well short of the existing potential.

Nevertheless the experience accumulated over the past twelve years is very valuable. The imminent adoption of a legally-binding global regime on ABS in the form of the Nagoya Protocol provides a unique window of opportunity. Brazil is now able to refocus its domestic ABS regime from command and control to encouraging cooperation in scientific research, within Brazil and with international partners, thereby generating more benefits and reinforcing conservation and sustainable use of biodiversity. Indeed, the government is working on a new bill to be sent to the Congress. The elaboration of this bill is well in advance, after thorough consultation to the many stakeholders involved.

Brazilian regulation on ex situ conservation and on transfer of biological samples for ABS

The legislation regulates activities of *ex situ* collections. Foreign institutions or companies that wish to access genetic resources must be associated with a Brazilian institution. For identification purposes 'sub-samples' of material sent abroad must be lodged with an accredited Brazilian *ex situ* collection. Furthermore, authorization from CGEN or accredited institutions (CNPq, IBAMA, and IPHAN) is required for the shipment abroad.

Notably for *ex situ* collections, the technical guidelines clarified that the term 'collection' refers to removal of an organism (or parts of it) from *in situ* conditions, whilst the term 'access to the component of genetic resource' refers to access at molecular level – isolating, identifying or utilising information stemming from genetic origin – or of substances stemming from living organisms' metabolism and extracts obtained from organisms.

CGEN's Resolution 32 sets guidelines for Prior Informed Consent and benefit-sharing requirements to access material in most *ex situ* collections that was collected *in situ* before, and since the Provisional Measure was enacted: for material collected after 2001, PIC should be sought from the original provider, as identified by the collection (CGEN will evaluate cases where the provider cannot be found), while the *ex situ* collection holding the material should handle PIC for pre-2001 specimens[168].

Regarding transfers and shipment of genetic resources, the minimum requirements are:

- information on intended use
- collecting data
- deposit of a "sub-sample" on a trusted depository collection;
- PIC and Material Transfer Agreement in the form of a benefit sharing contract (BSC).

BSCs are not required for access to genetic resources for research purposes, but are required for bioprospecting and technological development.

CGEN keeps working towards improving guidelines and norms to promote a better regulatory environment for researchers, industry, indigenous peoples and local communities. Many challenges still lie ahead. Transparency and wide interlocution with all stakeholders involved are paramount to promote the necessary conditions for innovation to thrive, benefits to be fairly shared and sustainable development to take place.

[168] https://www.cbd.int/abs/measures/measure.shtml?id=68321

ANNEX 6. Provisional Agenda

WORKSHOP AGENDA

The Role Played by Scientific Biological Collections under the Nagoya Protocol

18 to 20 June 2013,
Álvaro Barcellos Room, Brazilian Agricultural Research Corporation,
Brasília, Brazil

Context

In 2008, the EU-Brazil Sector Dialogues Support Facility was created as part of a bilateral cooperation programme spanning 2007-2013, signed between the Brazilian government and the European Community.

The present meeting is part of the EU-Brazil Sector Dialogues Support Facility. It seeks to explore and build upon the history of interactions between Brazilian and European *ex situ* collections, and the current practices that were developed in response to the Convention on Biological Diversity, and how such practices are suitable or adaptable to the new realities brought by the Nagoya Protocol.

Moreover, the main goals of this meeting are to discuss possible roles that collections could play in the implementation of the Nagoya Protocol, and explore common interests and mechanisms to promote more effective cooperation towards facilitation of research, traceability of genetic resources, and mechanisms to deal with the change of purpose in the use of genetic resources.

It is well known how diverse are the *ex situ* collections: plant, animal and microbial resources; maintained in preserved or living form; utilized for non-commercial or commercial purposes by public or private bodies. Nevertheless, this dialogue will focus predominantly on publicly-held collections and non-agricultural collections and their relation to the Protocol.

Furthermore, one of the outcomes of the present high level meeting is to assist in the implementation of Articles 8a, 9, 19, 20, 22 and 23 of the Nagoya Protocol. In that sense, this opportunity aims to bridge the science – policy gap by gathering researchers and curators of biological collections to engage in an insightful exchange of ideas.

Working Time:

- 09:00 – 12:00 and 13:00-17:30.

1. Opening of the Meeting

2. Research Needs and Barriers Related to ABS Legislation

Introductory presentations:

***Ex situ* conservation under the Nagoya Protocol and under the Brazilian ABS legislation**

- Larissa Costa – Brazilian *Ministry of Foreign Affairs*

Brazilian trusted depository institutions

- Ana Yamaguishi – *Ministry of the Environment*

The E.U. Commission's legislative proposal on implementing the Nagoya Protocol

- Kathryn K. Davis, Project's Senior Consultant

Report of the Brazilian workshop "O papel das coleções biológicas no cenário do Protocolo de Nagoia"

- Luciane Marinoni, Project's Senior Consultant

Suggested issues for discussion:

- Needs and barriers for research, including exchange and transfer of biological material, in the face of current national/regional legislation, guidelines, and rules of procedure; what will change under the new scenario of the Nagoya Protocol;
- Challenges and opportunities for facilitation of research collaboration, traceability of genetic resources, monitoring of utilization, changes of intent (where access for non-commercial purposes leads to interest in use for commercial purposes);
- Issues raised by the proposed European and Brazilian ABS regulations/legislation on the role played by *ex situ* collections on access

to genetic resources;

- Innovative roles that biological collections can play in the implementation of the Nagoya Protocol to promote access to genetic resources and the conservation and sustainable use of biological diversity.

3. Good ABS Practices for Research Facilitation and Cooperation

Introductory presentations:

Activities of science, technology and innovation for the systematization of knowledge and information on biodiversity

- David Oren – Ministry of Science and Technology

Collecting, use and supply of plants at Kew

- Natasha Ali – Royal Botanic Gardens, Kew

Exchange of genetic resources under the ITPGRFA

- Filipe Teixeira, Brazilian Agricultural Research Corporation

Suggested issues for discussion:

- Identification of best practices for the exchange of biological material between collections for non-commercial scientific research purposes, and the monitoring of utilization;
- Practical measures to facilitate the cooperation and sharing of benefits between Brazilian and European collections;
- Practical measures to address access to genetic resources in *ex situ* collections for commercial purposes;
- Considerations and possible measures for appropriate collection, use and transfer of traditional knowledge associated with genetic resources;
- Future developments: how *ex situ* collections can adapt to cutting-edge and future scientific developments, including the transfer and use of genomic and epigenomic information, and associated capacity-building, aiming at better knowledge of biodiversity.

4. Recommendations

5. Closure of the Meeting

6. Guided visit to a Brazilian collection

- Thursday 20 June 2013. From 14:00 to 18:00. Visit to EMBRAPA/CENARGEN *ex situ* collections

ANNEX 7.
RESOLUÇÃO CGEN Nº 21, DE 31 DE AGOSTO DE 2006

Dispõe sobre as pesquisas e atividades científicas que não se enquadram sob o conceito de acesso ao patrimônio genético para as finalidades da Medida Provisória no 2.186-16, de 23 de agosto de 2001.

Provides for the research and scientific activities that are not under the concept of access to genetic resources for purposes of the Provisional Measure 2,186-16 of August 23, 2001.

O CONSELHO DE GESTÃO DO PATRIMÔNIO GENÉTICO, tendo em vista as competências que lhe foram conferidas pela Medida Provisória nº 2.186-16, de 23 de agosto de 2001, e pelo Decreto nº 3.945, de 28 de setembro de 2001, e o disposto no art. 13, inciso I, do seu Regimento Interno;

THE BOARD OF MANAGEMENT OF GENETIC HERITAGE, considering the powers conferred by Provisional Measure No. 2,186-16 of August 23, 2001, and Decree No. 3,945, of September 28, 2001, and the provisions of art. 13, paragraph I, of its Rules of Procedure;

Considerando que diversos tipos de pesquisas e atividades científicas poderiam enquadrar-se sob o conceito de acesso ao patrimônio genético para fins de pesquisa científica simplesmente pelo fato de utilizarem ferramentas metodológicas moleculares para a sua execução de modo circunstancial e não propriamente porque seus objetivos ou perspectivas estejam relacionados com o acesso ao patrimônio genético;

Considering that various types of research and scientific activities could be under the concept of access to genetic resources for scientific research purposes simply because they use methodological molecular tools for their implementation in a circumstantial manner and not because your objectives or intentions are related to access to genetic resources per se;

Considerando que a finalidade dessas pesquisas e atividades, assim como seus resultados e aplicações, não interferem no principal objetivo da Medida Provisória no 2.186-16, de 2001, que é a garantia da repartição justa e equitativa dos benefícios resultantes da exploração econômica de produto ou processo desenvolvido a partir de amostras de componentes do patrimônio genético, resolve:

Considering that the aims of such research and activities, as well as their results and applications, do not interfere with the main objective of Provisional Measure 2.186-16, 2001, which is the guarantee of fair and equitable sharing of benefits arising from economic exploitation or product process developed from samples of genetic heritage components, determines:

Art. 1º As seguintes pesquisas e atividades científicas não se enquadram sob o conceito de acesso ao patrimônio genético para as finalidades da Medida Provisória no 2.186-16, de 23 de agosto de 2001:

Article 1. The following research and scientific activities are not under the concept of access to genetic resources for the purposes of Provisional Measure No. 2.186-16 of August 23, 2001:

I - as pesquisas que visem elucidar a história evolutiva de uma espécie ou de grupo taxonômico a partir da identificação de espécie ou espécimes, da avaliação de relações de parentesco, da avaliação da diversidade genética da população ou das relações dos seres vivos entre si ou com o meio ambiente;

I - research that aims to elucidate the evolutionary history of a species or taxonomic group from the identification of species or specimens; the evaluation of phylogenetic relationships; the assessment of the genetic diversity of the population or the relationship of living beings with each other or with the environment;

II - os testes de filiação, técnicas de sexagem e análises de cariótipo que visem a identificação de uma espécie ou espécime;

II – paternity tests, sexing techniques and karyotype analyses intended to identify a species or specimen;

III - as pesquisas epidemiológicas ou aquelas que visem a identificação de agentes etiológicos de doenças, assim como a medição da concentração de substâncias conhecidas cujas quantidades, no organismo, indiquem doença ou estado fisiológico;

III - epidemiological research or research that aims to identify the etiologic agents of diseases, as well as measurement of the concentration of known substances whose relative quantities in the body indicate disease or physiological state;

IV - as pesquisas que visem a formação de coleções de ADN, tecidos, germoplasma, sangue ou soro.

IV - research intended to build DNA, tissues, germplasm, blood or serum collections.

§ 1º As pesquisas e atividades científicas mencionadas neste artigo estão dispensadas da obtenção de autorização de acesso a componente do patrimônio genético.

§ 1 The research and scientific activities mentioned in this article are exempted from obtaining authorization for access to genetic heritage components.

§ 2º O critério estabelecido nesta Resolução tem a finalidade exclusiva de orientar o enquadramento destas atividades sob a Medida Provisória no 2.186-16, de 2001, sem

prejuízo do atendimento das exigências estabelecidas em outros instrumentos legais, bem como em tratados internacionais dos quais o Brasil seja Parte.

§ 2 The criteria established in this Resolution have the sole purpose of guiding the framework of these activities under the Provisional Measure 2186-16, 2001, subject to compliance with the requirements established in other legal instruments, as well as in international treaties to which Brazil is a party.

Art. 2 º Esta Resolução entra em vigor na data de sua publicação.

Article 2 This Resolution shall come into force on the date of its publication.