

Biological Material Sharing in Research: The Case of Rain Forest Resources

Victor Rodriguez^{a, @}, Alexandre Antonelli^b

^aTNO, Innovation Policy Group, Wassenaarseweg 56, Leiden 2333 AL, The Netherlands

^bUniversity of Zurich, Institute of Systematic Botany, Zollikerstrasse 107, CH 8008 Zurich, Switzerland

[@]Corresponding author e-mail address: victor.rodriguez@tno.nl

Abstract

The outstanding species richness found in the Amazonian rain forest, combined with the gap between taxonomists based in Brazil and abroad, has led many scientists to focus their research interests in Brazilian Amazonia. However, the last years have evidenced a much contrasting development of the federal regulations controlling the access and transfer of biological material from the region. Here we present the preliminary findings of a world-wide survey, reporting for both positive and negative experiences by taxonomists and other researchers when dealing with research permits.

Keywords: science; knowledge diplomacy; biopiracy; plant taxonomy; Amazonia; academic freedom

1. Introduction

The tropical rain forests of Amazonia contain the highest biodiversity found on Earth. Whereas some 110,000 plant species are thought to occur in the entire Neotropical region (i.e. tropical America), Amazonia alone is home to some 45,000 species, most of them occurring nowhere else (Gentry, 1982). This means that the Neotropics contain about 3,5 times more species than tropical Africa, and some 35,000 more species than tropical Australasia – despite the fact that these three areas have about the same land area. Similar biodiversity patterns are found for a large variety of organisms, such as mammals, reptiles, amphibians, fresh water fishes, butterflies etc. This outstanding diversity has since long attracted the attention of the scientific community to study and document Neotropical ecosystems (Antonelli, 2008; Rodriguez and Antonelli, 2009).

Increasing investments in ethanol and meat production at the expense of natural devastation in Brazilian Amazonia, in conjunction with the threats posed by climate change, are expected to lead to the extinction of thousands of animal and plant species in the following decades. The scientific expertise required to document the exceedingly rich Amazonian biota is far greater than what is currently available in the

country, meaning that Brazil will require massive international efforts in order to assess its biodiversity before most of the current rain forest ecosystems collapse.

A biodiversity assessment or taxonomic inventory, resulting in a species checklist, is the first step towards the elaboration of scientific floras and faunas. These references are essential for the correct identification of field-collected specimens, as required by any further research to be conducted on the organism, be it systematic, medicinal, ecological or in almost any other field of science. Biodiversity assessments require the work of especially trained scientists called taxonomists – experts in a particular group of organisms.

Of the 4,626 taxonomists currently registered at the World Biodiversity Database (by June 2009), 987 were located in the United States, 232 in Germany, 214 in the United Kingdom and only 198 in Brazil. If half of these taxonomists worked on plants, this would mean that in Brazil (with an estimated 55,000 plant species, according to <http://earthtrends.wri.org>) each taxonomist would have to be in charge of studying some 560 species. This could be compared to the United Kingdom (~ 1,550 species), where the flora has already been extensively investigated and documented, but still each taxonomist would have to deal with no more than 14 species; a species-per-taxonomist rate some 40 times lower than in Brazil. This discrepancy has contributed to many scientists in developed countries to focus their research interests in tropical regions, a situation commonly regarded as beneficial to both parts.

Despite the clear need of increased international collaboration of foreign taxonomists in Brazil, the last years have evidenced a much contrasting development of the regulations controlling the access and transfer of biological material from the country in general, and Amazonia in special. These regulations have presumably had a large impact in stopping on-going biodiversity assessments led by foreign researchers, as well as hindered the establishment of new projects in the area.

For further assess this problem, this study aims to answer the following question: to which extent have current governmental regulations hindered biological research in Brazilian Amazonia? The remainder of this article is organised as follows. To begin with, the background is framed in Section 2. In addition, data and methodology are detailed in Section 3. After this, findings are provided in Section 4. Then, a discussion is brought in Section 5. Finally, concluding remarks are made in Section 6.

2. Background

In biology, research material used for the study and documentation of diversity are either complete organisms or fragments thereof collected in their natural habitat and preserved for morphological or genetic studies. In most cases, the difficulty in identifying species in the field requires that researchers collect and prepare the specimen for future identification. In particular, identification of problematic groups usually require the examination by an expert in the taxonomic group in question, meaning that specimens (now as pressed plant sheets, nailed insects, alcohol-preserved flies etc.) need to be transferred between the countries where such expertise

exists. Such materials are always sent as either gifts or loans. Every new species described must be referenced to at least one preserved specimen, termed the species *type* (holotypes, isotypes, lectotypes and other definitions can apply depending on the situation and nature of the specimen collected). Specimens used for scientific descriptions must be permanently stored in a biological collection, such as those found in natural history museums and plant herbaria. There is an increased demand that type specimens are eventually transferred and stored in their country of origin.

Recent advances in systematics, which take advantage of molecular methods for the identification and classification of organisms, have led to the practice of collecting additional plant material from each sampled specimen. In the case of plants, leaf material is dried separately from the rest in silica gel, in order to ensure that the genetic components of the cells, such as DNA molecules, do not deteriorate during the drying process. In some countries, special regulations may apply to such silica gel samples as they are obviously used with the intent of conducting molecular analyses.

In the United States, to simplify material transfers between non-profit research institutions, the National Institutes of Health (NIH) published the final version of the Uniform Biological Material Transfer Agreement (UBMTA) and the Simple Letter Agreement of the Transfer of Non-Proprietary Biological Material in 1995. Apart from that solution at national level mirrored in several countries, the international community has developed initiatives to standardise the sharing of materials. As a result of the International Treaty on Plant Genetic Resources for Food and Agriculture in 2001, a Standard Material Transfer Agreement (SMTA) has been available for the Multilateral System under the auspices of the Food and Agriculture Organisation in 2006.

Furthermore, the Parties of the Convention on Biological Diversity (CBD) are engaged in the negotiation of an international regime on access and benefit sharing (ABS) based on a recommendation adopted at the World Summit on Sustainable Development in 2002. The international community has adopted the *Bonn Guidelines* as a voluntary framework of ABS at the national level in 2002. The Parties mandated a *Working Group on ABS* to negotiate the international regime in close co-operation with the *Working Group on Traditional Knowledge* in 2004. The negotiation will be finalised at the tenth meeting of the *Conference of the Parties* in October 2010.

The influence of the CBD on science was predicted to grow. Where none were doing so nine years ago, some 100 countries (largely those that are home to the bulk of the world's biodiversity) have introduced or are considering laws that regulate access by scientists to genetic resources¹, bio-chemicals and associated traditional knowledge. These typically require national and foreign scientists alike to obtain permission for access and to work with partners from the countries providing the genetic resources in the process of sharing benefits, such as royalties, technology, joint research and information (ten Kate, 2002).

¹ As defined in the CBD, genetic resources are any material of plant, animal, microbial or other origin containing functional units of hereditary of actual or potential value.

In particular, the Brazilian authorities currently ask the following requirements to be met in order to allow on-site research for academic purposes (Table 1). Administratively, any foreign researcher aiming at conducting fieldwork in Brazil has to comply with formal requirements and needs to obtain several permits: from *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* (IBAMA) for collection and exportation of non-prospective materials, from *Conselho de Gestão do Patrimônio Genético* (CGEN) for molecular studies and from *Fundação Nacional do Índio* (FUNAI) for field work in Amazonia, and from the mark owner for collection at any site. The considerable amount of bureaucratic paper work required for even simple scientific activities is therefore a presumable reason to the decreasing number of foreigners working in the region. The situation appears to be getting even worse with the announcement made by national justice secretary Romeu Tuma in 2008 that *all* foreign citizens may soon be obliged to obtain a visiting permit prior to their entrance into Amazonia, risking otherwise fines up to US\$ 60,000.

Table 1. Brazil's measures on ABS

Measure	Title	Level	Scope	Coverage
1	Provisional Measure No. 2186-16 of 23 August 2001	National/Federal (Brazil)	Access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources, equitable sharing of benefits from the utilization of traditional knowledge, innovations and practices, customary or traditional use of genetic resources
2	Decree No. 3.945	National/Federal (Brazil)	Access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources, equitable sharing of benefits from the utilization of traditional knowledge, innovations and practices, customary or traditional use of genetic resources
3	Federal Decree No. 4339	National/Federal (Brazil)	Biodiversity, access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources, customary or traditional use of genetic resources, equitable sharing of benefits from the utilization of traditional knowledge, innovations and practices
4	Decree No. 5459	National/Federal (Brazil)	Access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources, equitable sharing of benefits from the utilization of traditional knowledge, innovations and

				practices
5	Resolution No. 09 of 18 December 2003 (of the Genetic Heritage Management Council)	National/Federal (Brazil)	Access to genetic resources and benefit-sharing	Access to genetic resources, customary or traditional use of genetic resources
6	Resolution No. 08 of 24 September 2003 (of the Genetic Heritage Management Council)	National/Federal (Brazil)	Biodiversity, access to genetic resources and benefit-sharing	Access to genetic resources
7	Resolution No. 12 of 25 March 2004 (of the Genetic Heritage Management Council)	National/Federal (Brazil)	Biodiversity, access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources
8	Resolution No. 17 of 30 September 2004 (of the Genetic Heritage Management Council)	National/Federal (Brazil)	Biodiversity, access to genetic resources and benefit-sharing	Access to genetic resources, equitable sharing of benefits arising out of the utilization of genetic resources

Source: Database on ABS Measures <http://www.cbd.int/abs/measures.shtml>

N.B. Documents retrieved by selecting Country: Brazil; Area of activity: Any; Scope of measure: Access to genetic resources and benefit sharing; Title Contains: Any; Select level to which measure applies: Any; Type of measure: Any; Issues covered by the measure: Access to genetic resources; Group by: Country.

4. Data and methodology

In order to assess the problem of access to biological materials for research purposes described by Revkin (2002) and Vale et al. (2008), we have launched a survey among scientists who have conducted or aimed at conducting scientific research in Brazil. The on-line questionnaire www.systbot.uzh.ch/static/brazil/questionnaire_form for scientists is displayed below. The target population was formed by experts listed at <http://www.cbd.int/abs/roster.shtml>, member institutions of the Consortium of Scientific Partners on Biodiversity (The *Muséum National d'Histoire Naturelle de France*, The Smithsonian National Museum of Natural History, The Royal Botanic Gardens Kew, The New York Botanical Garden, Missouri Botanical Garden, The Royal Botanical Garden of Edinburgh, The Royal Botanical Garden in Madrid, The Royal Belgian Institute of Natural Sciences, The German Federal Agency for Nature Conservation, The National Commission for Wildlife Conservation and Development of the Kingdom of Saudi Arabia, The *Comisión Nacional para el Conocimiento y Uso de la Biodiversidad de México*, Museums Nature Montréal and The Higashiyama Botanical Gardens), members of Taxon Editorial Board listed at http://www.botanik.univie.ac.at/iapt/downloads/editorial_board.pdf, among others. The scientific contacts totalise over 150 contacts. Apart from that, invitations to participate in the survey for scientists have been extended to Botanical Gardens

Conservation International and the International Association for Plant Taxonomy.

SURVEY QUESTIONNAIRE for SCIENTISTS

General guidelines:

- 1) If you ever conducted, attempted to conduct, or considered conducting scientific research in Brazil, please proceed with the questionnaire, otherwise there is no need to continue with this questionnaire
- 2) You may select several alternatives for each question, or leave them blank.
- 3) This survey applies for a single project/occasion. If you have had different experiences with different projects, please fill in one survey for each occasion.

Optional information (this will NOT be disclosed by any means)

Name:

E-mail:

Gender:

Type of research and biological material of interest

In which major Brazilian ecosystem were you interested in performing research?

- Amazonian rainforest
- Atlantic rainforest
- Cerrado
- Caatinga
- Pantanal
- Pampas
- Coastal mangroves
- Araucaria forests
- Marine habitats
- Other, please specify:

Have you ever applied for research permits in Brazil?

If YES, then please indicate the year(s) in which you applied:

- If NO, please indicate why not:
- I had heard from other researchers that it was very complicated and time-consuming to apply for permits
 - I had investigated what would be necessary for making a formal application (through direct inquiries, Internet searches etc.) and came to the conclusion it would be too complicated and time-consuming
 - I had already an on-going collaboration with Brazilian researchers and could perform the research using their permits

I had made contact with Brazilian researchers to establish collaboration and perform the research using their permits

I had carried out research without permits because they were not necessary for my research project at that time

I had carried out research without permits because I did not know they were necessary at that time

I had carried out research without permits because even though I knew they were necessary, I considered the risk of being caught and prosecuted negligible.

If other, please specify:

What kind of research permit did you apply for:

collecting permit

export permit

permit for DNA-sequencing

If other, please specify:

Did the permit concern:

one to several taxonomic species

one to several taxonomic genera

one to several taxonomic families

all taxonomic groups

While doing fieldwork, did you collect biological material for other research groups/colleagues?

Yes

No, there was no need

No, I did not come across any other species of interest

No, I came across other species of interest, but my permits did not allow me to collect them

What was the destination of the biological material sampled:

part left in Brazil, and part taken abroad

Brazil only

outside Brazil only

The research project was co-ordinated by:

you

a Brazilian researcher

a Non-Brazilian researcher, if so, please specify nationality:

Did the research involve:

only Brazilians

- only non-Brazilians
- both Brazilians and non-Brazilians

In general, when dealing with the formalities to gain access to the material, was your experience

- positive
- negative

Were the permits:

- granted
- denied
- delayed
- other (please specify):

If granted, did the resource authority:

- ask for co-authorship
- ask to preview the results
- require permission to publish findings
- demand royalties derived from the exploitation of the investigation
- ask for duplicates of collected material
- ask for any other request or demand (please specify):

If denied, did the resource authority:

- cancel your research permission
- refuse to renew the permission
- ask for retrospective charges
- confiscate research material
- ask to vacate the field camp
- prosecute you
- put you in jail
- other (please specify):

Did the setback have:

- financial consequences
- career consequences
- other consequences (please specify):

If the consequences were financial, did it mean

an end of the grant or contract research

having to pay back lump sums to donors

other (please specify):

If the consequences were career-oriented, did it mean any:

delay in obtaining a PhD

delay in gaining tenure

delay in promotion

other (please specify)

If you reported the setback, was it to:

judicial authorities

administrative authorities

your organisation's authorities

other (please specify):

As regards dealing with permits, was your project

a grant

a contract research

other (please specify):

As regards dealing with permits, did the financial support for your research come from:

an international organisation

European Union agency

national body

regional entity

local government

university

private grant

public research institute

botanical garden

foundation/NGO

company

other (please specify):

As regards dealing with permits, did your institutional affiliation come from

university

public research institute

botanical garden

foundation/NGO

company

other (please specify)

As regards dealing with permits, in which country was your institution based?

As regards dealing with permits, were you

undergraduate student

master student

PhD student

post-doctorate fellow

non-tenured researcher

tenured researcher

non-tenured professor

tenured professor

other (please specify):

As regards dealing with permits, were you a citizen of

Brazil

Latin America except Brazil

USA or Canada

Europe

Asia

Africa

Oceania

If possible, please provide here any additional information and/or comments relating to this topic that you wish to REMAIN CONFIDENTIAL

If possible, please provide here any additional information and/or comments relating to this topic that you AGREE TO BE DISCLOSED in scientific papers, conferences etc. If you wish to be cited by name, please state so.

Submit Questionnaire

5. Results

The responses obtained so far in our survey account for both positive and negative experiences by taxonomists. Since this represents an opinion about the entire permit application process, the results are therefore presented separately for each of these two categories. First, about 47% of the entries were focused on obtaining permits for studying the rainforest ecosystems. Second, most applications concerned collecting permits. Third, more permits dealt with larger taxonomic groups (families, genera) than single species as displayed in Table 2.

Table 2. The geography and nature of research permits in Brazil

On which Brazilian ecosystem was the project or research interest focused?	Positive	Negative
Amazonian rainforest	20	23
Atlantic rainforests	22	20
Cerrado	19	14
Caatinga	15	7
Pantanal	9	2
Pampas	4	4
Mangroves	4	1
Araucaria forests	7	7
Marine habitats	1	1
What kind of research permit was applied for?	Positive	Negative
Collecting	32	22
Export	16	12
DNA sequencing	4	2
What did the permit concern?	Positive	Negative
Species	4	4
Genera	8	6
Families	16	11

All groups	9	6
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N.B. 44 positive experiences and 39 negative experiences

Applying for permits seems to be successful despite negative experiences. When permits were granted, the source authority asked for duplicates of the material in most of the cases. If denied, the authority asked for charges, refused to renew the permit or prosecuted the researcher. The setback was reported to other administrative authorities or to the researcher's organisations. The financial consequences of the setback comprised in two cases the end of a research grant. The career consequences included delay in completing doctoral theses or getting tenure (Table 3).

Table 3. Turning permits down

What was the result of the permit application?	Positive	Negative
Granted	29	11
Denied	0	6
Delayed	5	7
When granted, what did the source authority ask?	Positive	Negative
Co-authorship	5	2
Preview results	3	0
Permission to publish	0	0
Demand royalties	2	1
Ask duplicates	17	5
When denied, what did the source authority do?	Positive	Negative
Cancel the permission	0	0
Refuse to renew the permission	0	1
Ask charges	2	0
Confiscate the material	0	0
Vacate the camp	0	0
Prosecute the researcher	0	1
Put the researcher in jail	0	0
To whom was the setback reported?	Positive	Negative
Judicial authorities	0	0
Administrative authorities	2	2
Researcher's organisation	2	4
What were the consequences of the setback?	Positive	Negative
Financial consequences	1	4
End of the grant	0	2
Pay back the lump-sum	0	0
Career consequences	5	4
Delay in PhD	3	2
Delay in tenure	1	0
Delay in promotion	0	0

N.B. 44 positive experiences and 39 negative experiences

The subject of Brazilian federal collecting permits being a hindrance to research is a topic now being fought out between the Brazilian Botanical Society and the Brazilian Environment Ministry since more project coordinators are Brazilian nationals. Because consortia usually involve Brazilians and non-Brazilians, part of the material is deposited in Brazil and part is sent abroad. Apart from that, researchers sometimes

collect materials for colleagues if needed (Table 4).

Table 4. Projects and materials

Who was the project coordinator?	Positive	Negative
A non-Brazilian researcher	16	13
A Brazilian researcher	25	21
Who were the research team members?	Positive	Negative
Only Brazilians	8	2
Both Brazilians and non-Brazilians	36	32
What was the destination of the material?	Positive	Negative
Part left in Brazil and part taken abroad	29	22
Brazil	13	8
Abroad	1	2
In the field, was there collection of material for colleagues?	Positive	Negative
Yes	19	14
No, there was no need	18	10
No, there were no other species of interest	1	1
No, because the permit did not allow so	4	4

N.B. 44 positive experiences and 39 negative experiences

The majority of permits involve research grants, which were obtained by university researchers at national level as shown in Table 5.

Table 5. Profiling the origin of permit applications

What was the nature of the project?	Positive	Negative
Grant	24	16
Contract research	4	0
Who was financially supporting the project?	Positive	Negative
International organisation	4	1
European Union	0	3
National body	18	11
Regional entity	3	1
Local government	4	2
University	14	1
Private grant	3	2
Research institute	4	2
Botanical garden	1	1
Foundation or NGO	3	4
Company	0	0
What was the affiliation for the permit application?	Positive	Negative
University	28	21
Research institute	7	9
Botanical garden	5	3
Foundation	2	1
Company	0	0

N.B. 44 positive experiences and 39 negative experiences

6. Discussion

There is evidence that the anticipated bureaucracy, delay and expense of compliance

with the first wave of access laws have deterred foreign and domestic scientists and thus have unwittingly stifled not only commercial research, but also essential conservation work (ten Kate, 2002).

Revkin (2002) has provided anecdotal evidence to illustrate the problems faced by scientists to gain access to research materials in Brazilian Amazonia. Firstly, Douglas Daly, a curator of Amazonian botany at the New York Botanical Garden, who has worked in Brazil for 20 years in partnerships with Brazilian scientists, had to wait a year and a half for a new research visa.

Secondly, in the Brazilian Amazon in 1998, an American geographer studying the forest for hints of ancient cultivation methods was placed under house arrest by the federal police in Santarem, and his boat, equipment and samples were seized.

Thirdly, scientist Joseph McCann, who had all the appropriate permits and visas, eventually got back his gear and his old riverboat, but lost most of his collection of pressed plants (for a Brazilian herbarium, not a pharmaceutical laboratory) because the police had stored it outdoors, where it rotted.

Fourthly, at the New York Botanical Garden in the Bronx, André Amorim, a visiting botany professor from the State University of Santa Cruz in Bahia, Brazil, had troubles completing his doctoral research because of the ban on shipping even the tiniest leaf fragment. His work focuses on Brazilian lianas and related vines and shrubs, and it requires advanced molecular and genetic analysis using equipment in New York. 'This is a real problem when Brazilian researchers are working in other countries', Mr. Amorim said.

Fifthly, in 1999, Christiane Ehringhaus, a German botanist pursuing a doctorate at Yale, was teaching Brazilian students and studying plants in the state of Acre in the Brazilian Amazon when newspapers implied that she was collecting seeds and insights from indigenous people in pursuit of potential drugs. Although she is still in Acre, Ehringhaus said the resulting difficulties had prompted her to abandon botany altogether and shift to social and economic studies.

7. Concluding remarks

As the results are preliminary, we should be cautious in drawing too many conclusions so far. We expect to obtain further participation in our survey in order to suggest policy recommendations.

Even though we have no other intentions than academic ones, we are dealing with a controversial subject and our study might be viewed through a North-South prism. In this respect, there is a general sentiment that the collecting permit process in Brazil impedes scientific research far more than it protects the Brazilian biota. We acknowledge that the perception of this survey in Brazil might be very different than what we expect. The survey might be viewed as criticism from outside and might evoke a defensive response. However, we believe that field biologists should play a

more active role in science policy, and conservation especially. It is the aim of our survey to provide further evidence on the issue. Sociology of science has provided analytical tools to deal with scientific communities and scientists' practices. Biologists, as any other science practitioners, are not exempted to comply with these rules and norms (Antonelli and Rodriguez, 2009).

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