Chapter II
The Status of Brazilian Biological Diversity

2.1 State-of-the-Art of the Knowledge of Biological Diversity

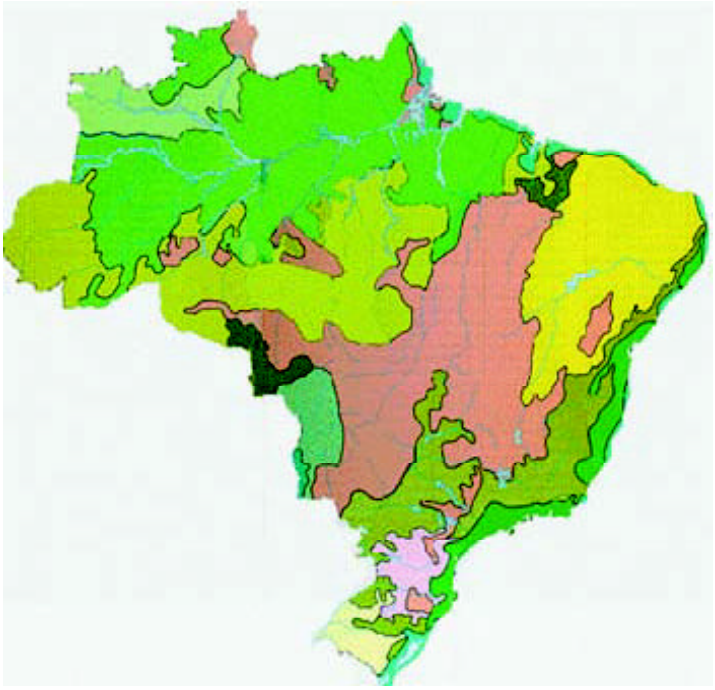
When Brazil signed the Convention on Biological Diversity in 1992, ratified in 1994, it took on a heavy responsibility which must be shared.

Due to the fact that it is largely unknown, the extraordinary richness of Brazil's biodiversity presents currently inconceivable possibilities regarding its use. This richness, however, also results in enormous difficulties in terms of setting up the necessary surveys and inventories for its documentation, as well as the necessary steps for its conservation and preservation, exacerbated by the current socio-economic status of the country, suffering impacts from the internalisation of global economic forces and the immense energy demands and the consumer society current in the industrialised countries.

The magnitude of Brazilian biodiversity can be perceived in the extraordinary wealth of its ecosystems. There are a number of classifications of the terrestrial ecosystems in the country, but one of the most commonly adopted is that of the classic work by Rizzini *et al*. (1988) in which seven principal ecosystems were identified based on phytogeographic criteria (Figure 2.1), corresponding to the 13 phytogeographic units defined by the Brazilian Institute of Geography and Statistics (Fundação Instituto Brasileiro de Geografia e Estatística - IBGE, Brazil, 1993). Numerous biogeographic or physiographic subunits can be identified within each of the Brazilian biomes (Table 2-1).

A report by Conservation International, published in December 1997, places Brazil as the top of 17 megadiversity countries, which combined harbour 70% of the world's animal and plant species (Mittermeier *et al*., 1997). Of these 17 countries, Brazil lies in first place in terms of the numbers of species of plants, freshwater fish, and mammals; in second place for amphibians; in third place for birds; and in fifth place for reptiles (Table 2-2).

In Brazil, there are 55,000 plant species, or 22% of the world total, 524 mammals (of which 131 are endemic), 517



Term used in this report	Term used by IBGE
Amazon forest	Dense ombrophyllous forest / Flor. omb.densa
Amazon forest	Open ombrophyllous forest / Flor. omb. aberta
Amazon forest	Forest on sandy soil /Campinarana
Amazon forest	Seasonal forest /Floresta estacional
Atlantic forest	Dense ombrophyllous forest / Flor. omb. densa
Atlantic forest	Seasonal forest / Floresta estacional
Cerrado	Savannah / Savana
Caatinga	Steppe / Estepe
Pine forest	Mixed ombrophyllous forest (Aráucaria)/Flor. omb.mista
Pantanal	Pantanal complex / Complexo do Pantanal
Pantanal	Chaco (steppe savannah) / Chaco (savana-estepe)
Parkland savanna	Steppe savannah / Savana estépica
Mangroves, restinga, flooded savanna	Pioneer formations / Áreas de form. pioneiras

Figure 2-1. Phytogeographic map of Brazil. Vegetation types.
Source: Rizzini *et al.* (1988).

amphibians (294 endemic), 1,622 birds (191 endemic) and 468 reptiles (172 endemic), besides 3,000 species of freshwater fish and between 10 and 15 million species of insects (Tables 2-3 and 2-4). The numbers for just one biome alone, the Cerrado, are remarkable (Table 2-5). Not only is the number of species high but so also is the level of endemism, combined placing Brazil at the top of the world ranking in biodiversity. Brazil, and the second-ranking country, Colombia, together outdistance by far all of the other 15 megadiversity countries (Table 2-6). Brazil disputes first place with Indonesia for the number of endemic forms (Table 2-7). It is the combination of species diversity and endemism that puts Brazil into first place in the ranking of these countries, all of which have a disproportionately large share of the planet's biological diversity and numerous forms which are endemic (Table 2-8). A large number of centres of endemism have been identified in the principal ecosystems of Brazil: in the Amazon region alone, there are 13 for butterflies (Lepidoptera) and six for terrestrial vertebrates (Table 2-9).

The problems of conserving this biodiversity are as great as its richness. More than 70 Brazilian mammal species and 103 birds are considered endangered. Five hundred years ago, the Atlantic forest, one of the richest in the world in biodiversity, covered more than one million km² along the Brazilian coast extending through 17 Brazilian states. It has now been reduced to less than 9% of its original area, mainly due to the high human population densities along the eastern coast. The Cerrado biome, which has suffered an enormous advance of the agricultural frontier in recent decades, has already lost over 40% of its native vegetation, and economic activities of some sort are present throughout the majority of the remaining area. The huge size of the Brazilian Amazon region, together with economic and social factors and an inadequate administrative structure, make the tasks of preservation, conservation and research extremely complex (the status, problems and progress are described later in this chapter).

Of the megadiversity countries, Brazil, although lacking in many areas, is among the few which have achieved a high level of scientific research, with an established and extensive system of academic and research institutions. This does not mean, however, that Brazil is autonomous in its capacity to acquire a full knowledge of its biodiversity. There are significant limitations, but many can be overcome to enable significant advances in the extent, organization and the use of information available on biological diversity.

One of the limitations concerns the concentration of researchers and their work in certain regions of the country. This has been well documented for certain research fields. For example, botanical collection is unevenly distributed in the Amazon (Figure 2-2), in the north-eastern Atlantic forest (Figure 2-3) and the state of São Paulo (Figure 2-4), as is ornithological research in the Amazon (Figure 2-5) and the Cerrado (Figure 2-6), and the distribution data available for amphibians throughout the country (Figure 2-7).

Workshops have proved to be an important tool for recovering, collating and organising the available information on Brazil's biological diversity and its distribution. A major event of this sort, ´Workshop 90 - Priority Areas for Conservation in the Amazon Region´, held in Manaus in January 1990, was organised by the Brazilian Institute for the Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais

Table 2-1. Indicators of ecological diversity in four Brazilian biomes.

Biome	Physiographic Units[1]	Land Systems[1]	Eco Regions[2]	Phytogeographic Regions[3]	Zoogeographic Regions[4]	River Basins[5]
Amazon	34	181	23	10[e]	3	18[g]
Cerrado	>27[a]	>100[b]	1[c]	3	1[f]	10[g]
Caatinga	n/a	n/a	1[c]	3	1[f]	9[g]
Atlantic Forest	n/a	n/a	10[d]	5	2	15[g]

[a] There are 4 additional units on the borderline between Atlantic Forest and Caatinga shown on five maps (1:1.000.000) not included in the study by the authors mentioned below[1], thus making an estimated total of 31 units.

[b] There are 13 additional systems on the borders of the Atlantic Forest with the Caatinga, estimated on five maps (1:1.000.000) not included in the study by the authors mentioned below[1], thus making an estimated total of 113 land systems.

[c] These large regions were not subdivided for lack of reliable biological data.

[d] 5 additional regions could have been recognised: upland moorlands (*campo rupestre*) and mountain savanna (*campos de altitude*), savanna (*campos gerais*), areas of cerrado and deciduous forests, thus making 15 eco-regions.

[e] Other authors have suggested between eight and 12 phytogeographic divisions for the Brazilian Amazon.

[f] Cerrado and Caatinga are considered to belong to the same zoogeographic region.

[g] First and second order basins and groups of small, isolated basins were recorded, eight of them having a large territorial extension in the Amazon Region, six in the Cerrado, two in the Caatinga and three in the Atlantic Forest.

n/a = data not available.

Sources:

[1]:Cochrane *et al*. (1985). *A Terra na América Tropical, CIAT & EMBRAPA*;

[2]:Dinerstein *et al*. (1995). Conservation Assessment of the Terrestrial Ecoregions of Latin America and the Caribbean. World Bank;

[3]:Hueck (1972). *As Florestas da América do Sul, Polígono & Editora UnB*;

:Stotz *et al*. (1996). Neotripal birds: Ecology and Conservation, University of Chicago Press;

[5]:IBGE (1993). Mapa da Vegetação do Brasil.

Renováveis - IBAMA), Conservation International, Washington, D. C., and its Brazil Programme (Conservation International do Brasil), and the National Institute for Amazon Research (*Instituto Nacional de Pesquisas da Amazônia - INPA). More than 100 scientists and conservationists*, representing all nine Amazon countries, worked for 10 days with the specific purpose of indicating and mapping high priority areas for conservation. Commissioned preparatory documents for this workshop included, country papers (overviews of each country), and information on soils, climate, biogeography and the existing systems of protected areas. The aim of the workshop was to identify key areas in terms of biodiversity through biogeographic analyses of endemism and species richness. Also taken into account was the presence of rare or threatened species, vegetation types, the existence of geological or geochemical phenomena of special interest, and current and future threats to the integrity of the ecosystems. These analyses were carried out by working groups of specialists in different taxonomic areas, as well as one which analysed the status of the protected areas, indicating those of priority in terms of biodiversity, and the threats to their integrity. This group concluded that mechanisms for biodiversity protection in the priority areas should concentrate on creating opportunities for sustainable extractivism and production over large areas, with management protocols to minimise adverse impacts on biodiversity caused by human activities.

Table 2-2. Species richness and endemism of Brazilian vertebrates and higher plants in relation to other megadiversity countries.

Number of species	Freshwater fish	Vertebrates (except Fish)	Birds	Mammals	Reptiles	Amphibians	Flowering plants	Total
Total	>3,000	3,131	1,622	524	468	517	~50,000	
Ranking	1st	2nd	3rd	1st	5th	2nd	1st	1st
Endemic	n/a.	788	>191	131	172	294	~17,500	
Rank		4th	3rd	4th	5th	2nd	1st	2nd

n/a = data not available.

Source: Mittermeier *et al.* (1997)

Also held in 1990 was the ´Workshop on Taxonomic Diversity and Distribution Patterns of Brazilian Angiosperms´. The idea for this workshop arose from the need for a better knowledge of Brazil's flora, focusing on a number of taxonomic groups, and based on morphological variation and their distribution patterns. Families of dicotyledons e monocotyledons were selected according to the availability of Brazilian and North American specialists.

Conservation International, the Biodiversitas Foundation (Fundação Biodiversitas), and the North-eastern Ecology Society (Sociedade Nordestina de Ecologia - SNE) combined forces in organising a Workshop ´Priorities for the Conservation of the Biodiversity of the North-eastern Atlantic Forest´, in 1993, at Itamaracá, state of Pernambuco. The principal objectives were to analyse existing information on the biodiversity of the region, to integrate information on biodiversity with socio-economic and environmental parameters, and to identify the priorities for biodiversity conservation.

Another important workshop, ´Methods for the Assessment of Biodiversity in Plants and Animals´ was held in Campos do Jordão, state of São Paulo, in May 1996 (Bicudo and Menezes, 1996).

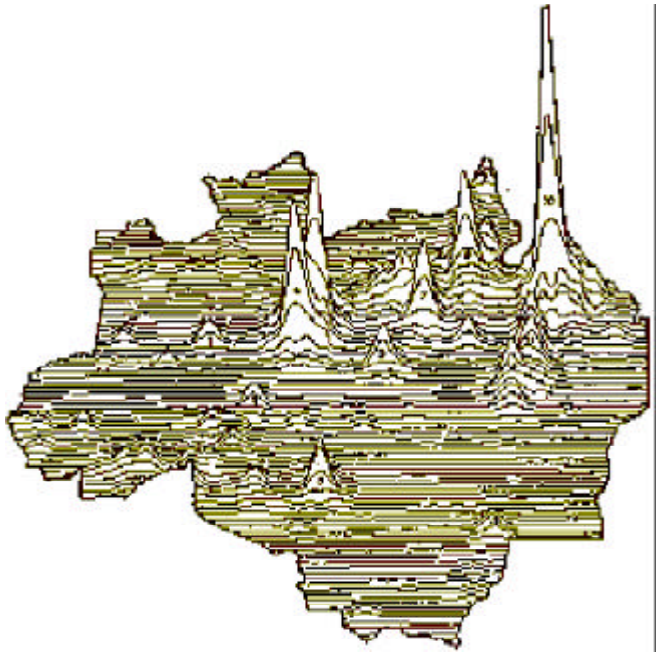


Figure 2-2. Density of scientific collections for arborescent angiosperms in the Brazilian Amazon.

Source: Nelson, B.W., INPA (1991).

Based on a sample of 1% of the Amazonian flora in the herbariums of INPA, MG, R. RB, IAN, SP, UB, NY and US. The relief indicates the number of specimens of the genus Inga in each 10,000 km² (1º latitude x 1º longitude). Collections in duplicate were discounted. Total sample = 2,779 specimens. The peaks on Manaus and Belém result from 160 and 320 specimens respectively. The secondary peaks are: Tefé, Humaitá, Aripuanã, Manaus, Itaituba and the waterfalls of the lower reaches of the Rio Tapajós, Óbidos, Santarém, Jari and Gurupá, Oiapoque, Belém, Tucuruí, Carajás, and Serra Buritirama and the expedition camp of the Royal Geographical Society (RGS) in Mato Grosso.

The Ministry of the Environment - MMA organised a workshop in Rio de Janeiro in June 1996 - ´Assessment, Monitoring and Indicators for Biological Diversity: Methods from a Perspective of Tropical Ecosystems´. More than 60 specialists were involved in evaluating and recommending options for methodologies in assessing and monitoring Brazilian biological diversity.

Marine ecosystems have also been the subject of exercises of this sort. The ´Workshop on Brazilian Coral Reefs: Research, Integrated Management and Conservation´, promoted by the Brazilian Society for the Study of Coral Reefs - Corallus (Sociedade Brasileira para Estudos em Recifes de Coral - Corallus), was held from 9th to 15th March 1997 at the Centre for Fishing Research and Extension of the North-East (Centro de Pesquisa e Extensão Pesqueira do Nordeste - CEPENE) of IBAMA. The results will serve as a basis for formulating policy and establishing priorities in applied research and management and the conservation of Brazilian reefs. The proposal will also be used by Brazilian Government agencies as a basis for a ´Brazilian Initiative on Coral Reefs´, an important step in the process of regulating the sustainable use of Brazilian coral reefs in line with international measures in this area.

A number of Brazilian states have been carrying out their own workshops. São Paulo, for example, held a workshop in October 1995 - ´A Basis for Conservation and Sustainable Use in the Cerrado of the State of São Paulo´. This event brought together some 100 people: from public and private universities; researchers and technicians from research institutes in the state; representatives of Worker's unions and landowners; non governmental organizations; businessmen and representatives of the Secretary for the Environment. This mix guaranteed representation of both socio-economic and conservation interests for the region. The workshop was organised by the Executive Co-ordination of the State Programme for Conservation of Biodiversity - PROBIO-SP, of the Secretariat of the Environment of the State of São Paulo (Secretaria do Meio Ambiente do Estado de São Paulo - SMA/SP), in conjunction with the Botanical Society of São Paulo (*Sociedade Botânica de São Paulo*). The aims for this workshop were to identify critical areas for the conservation of biodiversity and identify viable mechanisms for its conservation.

Another very important workshop held in São Paulo was ´A Basis for Conservation of Biodiversity in the State of Sao

Paulo´ (Bases para a Conservação da Biodiversidade do Estado de São Paulo - BIOTASP). This workshop resulted in a detailed diagnosis of existing knowledge of the biota of the state and of the existing collections and human resources available, and also proposed the establishment of a specific programme to accelerate research efforts on the biological diversity of the state: ´Biodiversity of the State of Sao Paulo - BIOTASP´.

Even though there are still enormous gaps in our knowledge, these various workshops and meetings demonstrate a substantial scientific community and a significant institutional capacity for documenting and researching the country's biological diversity.

A Biodiversity Working Group (Grupo de Trabalho de Biodiversidade - GTB), with funding from UNDP, has been established on the recommendation of the General Co-ordination of Biodiversity - COBIO of the Ministry of the Environment - MMA. Its main task is an analysis of the current state of knowledge of Brazilian biodiversity. The Working Group is comprised of biologists from various universities and research institutions along with representatives of a number of conservation NGOs, and is linked directly to the National Council for Scientific and Technological Development - CNPq. A first report, begun in November 1997, is being compiled in the Nucleus for Environmental Study and Research (Núcleo de Estudos e Pesquisas Ambientais - NEPAM) of the State University of Campinas - UNICAMP and should be concluded by April 1998.

The initial task is to collate information for each taxonomic group on: a) current capacity for research on systematics; b) present state of taxonomy; c) the extent of collections; d) their importance for basic and applied research, their economic use, and their use as indicators of environmental quality, risk or impact; e) genetic research; f) the state of knowledge of the group in Brazil and the world and; g) needs and priorities for further research. Although this initial diagnosis covers only genetic diversity, there is no doubt that a number of conceptual points will be raised which will contribute significantly to our understanding of ecosystem diversity.

2.1.1 Vertebrates

The following vertebrates are currently known to exist in Brazil:

- Class Agnatha, vertebrates with no mandible including lampreys and hagfishes. Of the 65 species known world-wide, one or two species of hagfishes occur in Brazil. Specimens collected off the coast of Rio Grande do Sul are kept in the Zoological Museum of the University of São Paulo (Museu de Zoologia - USP).
- Class Chondrichthyes, cartilaginous fishes, including sharks, stingrays and chimeras. About 850 species world-wide. Approximately 110 marine species and 20 freshwater species (stingrays) occur in Brazil. The main collections are in the Zoological Museum of the University of São Paulo - USP.
- Class Osteichthyes, sea-water and freshwater fish, the largest group of species among the vertebrates. Current estimates for Brazil indicate approximately 750 seawater and 3,000 freshwater species, of a world total of 24,000. It is believed, however, that the real number of freshwater species may be as high as 3,000

Table 2-3. Diversity and endemism of higher plant species[a].

Country	Total diversity	Endemism	Endemism as % of global diversity of higher plants[b]
Brazil	~ 50,000 - 56,000	~16,500 - 18,500	6.6-7.4
Indonesia	~37,000	14,800 - 18,500	5.9-7.4
Colombia	45,000 - 51,000	15,000 - 17,000	6.0-6.8
Mexico	18,000 - 30,000	10,000 - 15,000	4.0-6.0
Australia	15,638	14,458	5.8
Madagascar	11,000 - 12,000	8,800 - 9,600	3.5-3.8
China	27,100 - 30,000	~10,000	~4.0
Philippines	8,000 - 12,000	3,800 - 6,000	1.5-2.4
India	> 17,000	7,025 - 7,875	2.8-3.2
Peru	18,000 - 20,000	5,356	2.1
Papua New Guinea	15,000 - 21,000	10,500 - 16,000	4.2-6.4
Equador	17,600 - 21,100	4,000 - 5,000	1.6-2.0
United States	18,956	4,036	1.6
Venezuela	15,000 - 21,070	5,000 - 8,000	2.0-3.2
Malaysia	15,000	6,500 - 8,000	2.6-3.2
South Africa	23,420	16,500	6.6
Dem.Rep. of Congo	11,000	3,200	1.3

[a] Taking into account a total of 250,000 species in the world.
[b] The 17 megadiversity countries have between 155,475 and 183,025 endemic species, that is, from 62.2% to 73.2% of global higher plant diversity.
Source: Mittermeier *et al.* (1997).

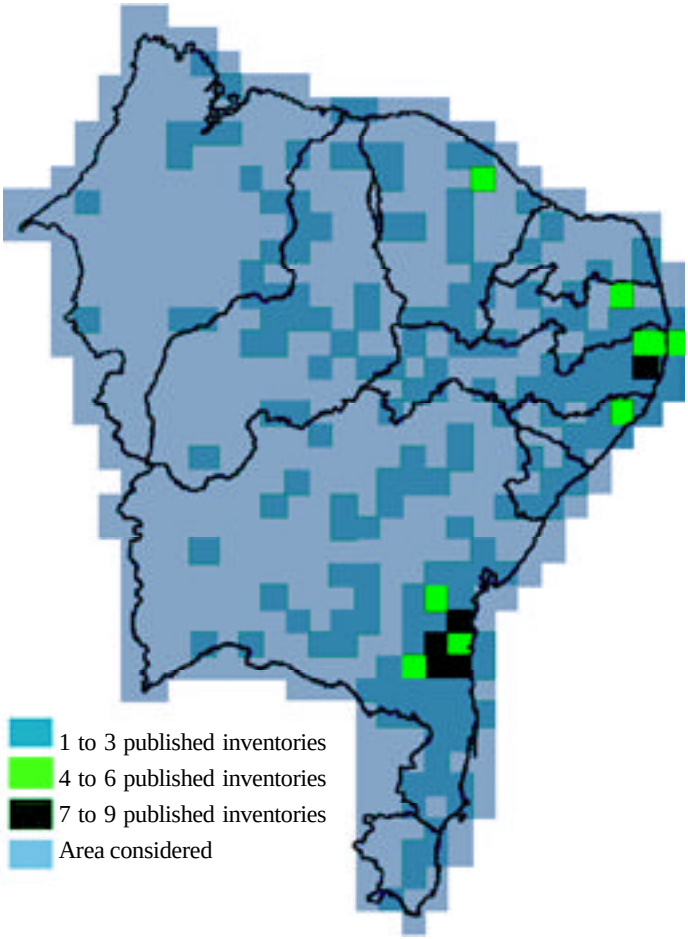


Figure 2-3. Knowledge of the flora of the north-eastern Atlantic forest. Number of published inventories.

Source: Conservation International *et al*., Base de Dados Tropicais (BDT) (1995).

to 5,000, the highest diversity of freshwater fish of any country in the world (compared, for example, to 320 species in European rivers and lakes). Diversity is still poorly documented in the Amazon basin, the centre of origin and dispersal of a large number of freshwater fish, and there are major threats to the existence of many species, mainly from hydroelectric dams. Outside the Amazon, current estimates indicate about 150 species in the São Francisco basin, and 500 species in the basins of Rios Paraná, Paraguai and Uruguai; about, 250 of them located in the Pantanal of Mato Grosso. An evaluation in 1978 argued that 30% to 40% of freshwater species were still unknown to science. There are important collections in various museums, universities and other institutions in the country.

- Class Amphibia, salamanders, anurans and caecilians. Brazil has about 517 species of an estimated 4,500 of the world total. This is the second highest diversity in the world for this Class, and includes mainly frogs, toads and tree frogs, but also some salamanders and blind snakes. This number will increase due to the current interest in collecting frog species in the Amazon region and in the Atlantic Forest. Some species, such as *Phylomedusa bicolor* and *Brachycephalus ephipium*, are being subjected to biochemical and pharmaceutical studies for the isolation of substances of medicinal use. There are numerous scientific collections in the country.

- Class Reptilia, including tortoises, turtles, snakes, lizards, alligators and crocodiles. Of the 6,400 known species, there are an estimated 468 in Brazil, the fifth ranking in the world for reptile diversity. Snakes and lizards are the most speciose group, especially in the Amazon. Important collections are maintained in museums, universities and other institutions throughout the country.

- Class Aves, the birds. There are 1,677 known species in Brazil of a total of 9,050 world-wide. Brazil is third in the world ranking. In Brazil, there are important private collections besides those in a number of museums, universities and other institutions.

- Class Mammalia, the mammals. There are 524 known species in Brazil, of a total of about 4,500 world-wide. The number of Brazilian species is certainly underestimated, especially for groups such as rodents. There are many collections of Brazilian mammals in museums, universities and other institutions, both in Brazil and abroad.

2.1.2 Invertebrates

The invertebrates are distributed through 33 Phyla, and comprise 95% of the known species of animals (the remaining 5% are vertebrates). Arthropods alone account for approximately 1.5 million described species; believed, however, to be just a small fraction of the total existing. Specialists argue that the total number of species is 10 times the current registered total in the case of insects, and 40 times bigger for the nematodes.

The first Brazilian collections begun by naturalists in the past century are kept in museums abroad. The groups best described are those of medical, veterinary or agronomic interest. Today there are numerous important collections in the country.

Of the 33 Phyla of invertebrates, 15 are exclusively, and five predominantly, marine. Nine include marine species, two only a few, and two have no marine species at all.

Research on the marine environment is comparatively recent in Brazil. A list of marine invertebrate Phyla, and the presence or otherwise of specialists for each in Brazil, is shown in Table 2-10. Table 2-11 indicates the diversity estimates for some of the marine invertebrate phyla in Brazil.

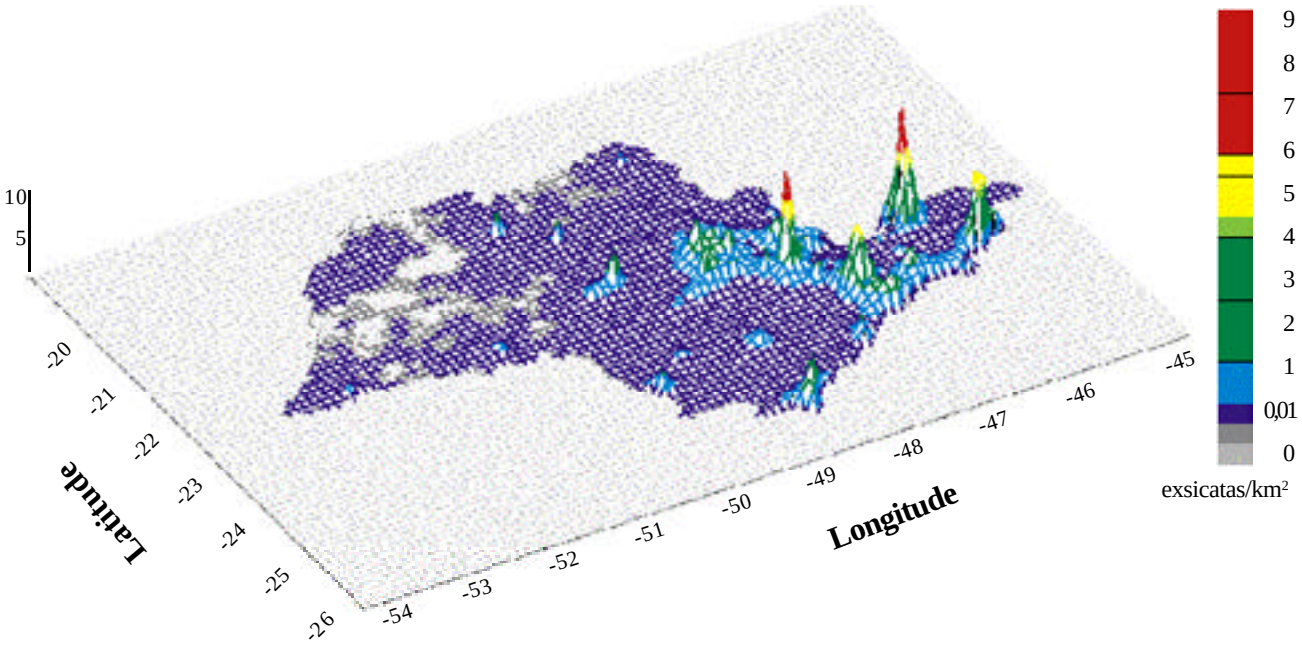


Figure 2-4. Density of scientific collections for the phanerogamic flora of the state of São Paulo.
Source: G.J. Shepherd, Base de Dados Tropicais (BDT) (1997).

Marine Mesozoa, Placozoa, Acanthocephala, Loricifera, Priapulida, Nematomorpha, Entoprocta, Brachiopoda, and Cicliophora are not included for lack of specialists, while for some such as Ctenophora e Ectoprota, tentative estimates are given even though there are no specialists currently working on them in Brazil.

This compilation shows that for most Phyla the number of species described for the Brazilian coastal waters is less than 10% of the number described world-wide. Exceptions are the Phoronida (11%), Hydrozoa (12%), Sipuncula (20%) and Mollusca (30%). It is probable that the number of species will double or triple if priority is given to collecting in areas poorly studied to date. An extreme example is that of the Nematoda. The global estimate is 1 to 1.5 million species, while only 230 to 400 have been described for the Brazilian coast. Geographically, the northern coast is considered the least known in terms of its marine fauna, while the south-eastern coast is the best known. The south and the north-eastern regions are also still poorly researched.

Our knowledge of the freshwater invertebrates is still far from complete. Most of the research has been carried out in the south and south-east of the country and the Amazon, while regions of the central-west and the north-east remain almost entirely unexplored. The maxim that the more people doing research the greater the number of new species described is clearly true for the freshwater invertebrates. Table 2-12 shows current species diversity estimates for freshwater invertebrates in Brazil.

Despite their importance in aquatic ecosystems, the Protozoa are the least-known group of the micro-invertebrates due to problems of sampling and identification. Currently, the global estimate is 30,000 species in the four Classes which comprise the Phylum. Very little is known of this Phylum, the few exceptions being *Trypanosome cruzi* a parasite which causes Chagas' disease, and *Leishmania*, which causes skin degeneration or fatal anaemia, neither of which occur in fresh water, along with some other parasites of medical interest. Species diversity in this case can only be guessed at. Perhaps best known are the amoebae of the Class Sarcodina. Twenty genera and 150 species of capsulated amoebae have been described in Brazilian fresh water ecosystems. The Heliozoaria, frequently found in fresh water, have not been taxonomically studied in Brazil. The ciliates (Ciliophora) make up the greatest part of the freshwater plankton, with 8,000 species described world-wide, and are as such important indicators of water quality. Although still incomplete, the total list for Brazil already includes 147 genera.

Sponges of the Phylum Porifera are largely a salt water group, only a few are found in fresh water. The number of living species in the world is estimated at between 20,000 and 30,000; 33 genera and 149 species are found in fresh water. In Brazil, their occurrence was reported by European naturalists at the end of the last century. Forty-four fresh water species in 21 genera have been recorded for Brazil.

The Phylum Coelenterata is also essentially marine, few species being found in fresh water. Nine thousand living species have been described world-wide, including corals (limnic and marine environments), hydra and jellyfish (limnic environments). Their susceptibility to pollution makes them important ecological indicators. In Brazil, only five freshwater species have been recorded.

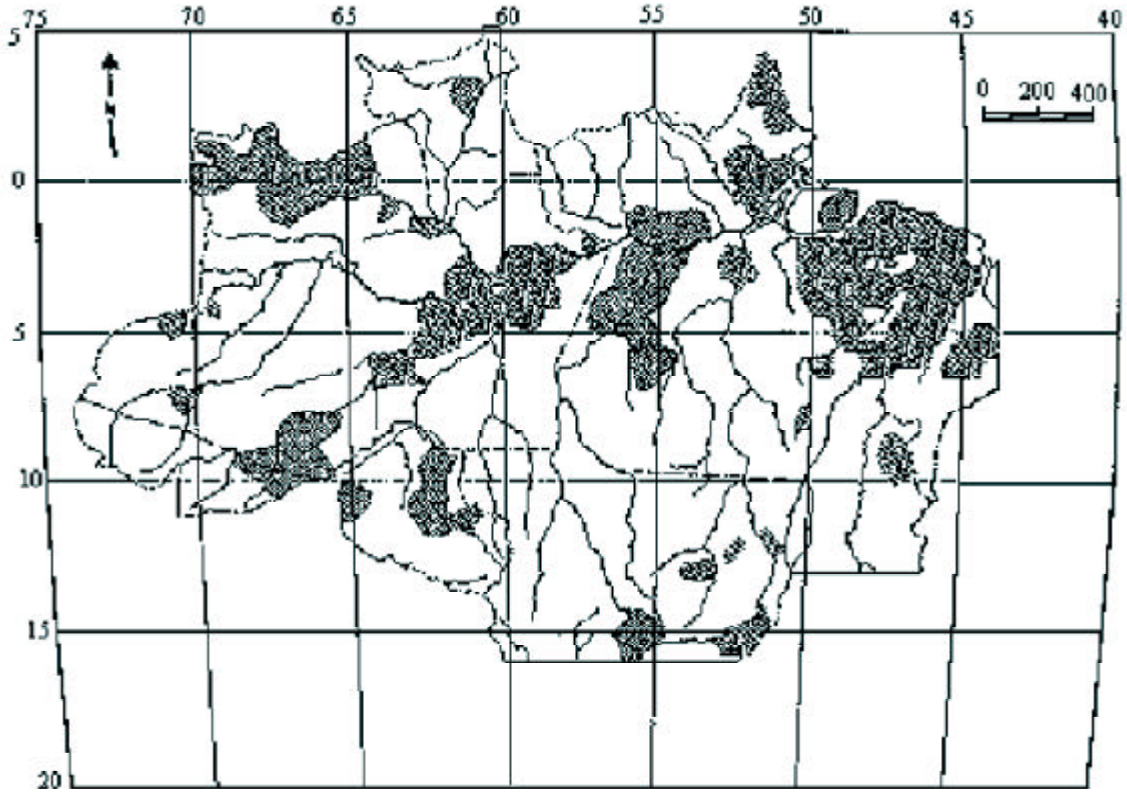


Figure 2-5. Areas which have been subjected to significant ornithological research in Amazonia.
Source: Oren & Albuquerque (1991).

The Phylum Platyhelminthes, the flatworms, is comprised of about 10,000 species in marine and freshwater habitats around the world. There are currently 96 Brazilian species in the Class Turbellaria. Little is known of the remaining Classes in this Phylum in Brazil, although much work has been done on a number of flatworms of medical or veterinary importance, such as Schistosoma mansoni.

The Phylum Nematomorpha (hairworms) includes 100 marine and freshwater species. Only three genera and nine species are known for Brazil.

There are 9,000 marine, freshwater and terrestrial species of annelid worms of the Phylum Annelida world wide. The Oligochaeta (earthworms) have been well-studied in Brazil. Seventy-three species and subspecies are known for Brazilian fresh waters.

The Phylum Rotifera (rotifers) is one of the best-studied groups of planktonic invertebrates in Brazil, with 457 species being found in nearly all freshwater habitats. Of these, 284 are found in the Amazon basin, 138 in the south and south-eastern regions, 89 in the north-east and 176 in the central west. Of these, 66 species have been described only recently and are probably endemic.

Freshwater Arthropoda include acarids and various groups of insects and crustaceans. Of these, the Suborder Cladocera (water fleas), microcrustacean branchiopods, are well-represented in inland Brazilian waters. Eighty-six species have been recorded. Endemism in the Cladocera is high, and will undoubtedly be higher when more taxonomic research is carried out. Another well-represented group of freshwater microcrustaceans are the Subclass Copepoda, with 273 species in four suborders in Brazilian waters: 102 species of the Cyclopoida, 58 of Calanoida, 56 of Harpacticoida and 57 of Poecilostomatoida. In the macrocrustacean Subclass Malacostraca, 12 genera and 76 species have been found in Brazilian fresh waters, including crabs, shrimps, crayfish and small lobsters.

The extent of our knowledge of terrestrial invertebrates is extremely variable, as is the number of researchers active in studying the different groups and the degree to which they are represented in scientific collections and the literature.

Terrestrial molluscs of the Class Gastropoda are relatively little diversified and well-known. Soil annelids of the Class Oligochaeta (earthworms) are likewise few in number, with local communities usually having fewer than 10 species. Even so, they are of considerable functional importance, both in natural and agro-ecosystems, and more research is required. By contrast, another important group, the nematode worms, is extremely diverse, including forms which are free-ranging as well as parasites of animals and plants. Parasitic forms are subject to considerable research efforts in Brazil because of

their economic impact, but the free-ranging species are almost entirely unknown.

The arthropods (Phylum Arthropoda) comprise by far the largest group of terrestrial animals. Included are the Arachnida, principally Acari (mites and ticks) and Araneae (spiders), which, along with the Order Opiliones (harvestmen), have been relatively well-investigated. There are important collections in a number of states, including São Paulo, Rio de Janeiro and Rio Grande do Sul.

The biggest and most diverse group of arthropods is the Insecta. Geographically and taxonomically, our knowledge of their diversity is very patchy. Of the principal Orders (those with more than 40,000 described species in the world and more than 10,000 in Brazil), only the Lepidoptera can be considered reasonably well known, although there are thousands of species of small moths, which make up the majority of this Order, which have yet to be described. In the Hymenoptera, bees, wasps and ants are relatively well-collected and studied, but the small parasitic wasps, for example, are very poorly known, and the number of uncollected and undescribed species could be in the order of tens of thousands.

Our knowledge of the other major Orders is even more irregular. Some families of Coleoptera (the largest) have been well-studied, for example the Cerambycidae (wood-boring beetles), while for others, such as the Curculionidae (weevils) and Scarabaeidae (dung beetles), there are very few specialists working in Brazil. Each of these families contains tens of thousands of species. There are no Brazilian specialists for the other families. This is considered a serious lack, especially for such diverse and important groups as the predacious beetles of the Family Carabidae, much studied in a number of other countries. There is at least one first-class collection, but not a single specialist for this group in Brazil.

The situation is similar for the Diptera, Homoptera and Hemiptera. Families with representatives which are of medical, veterinary and agricultural importance as parasites and pests, or extensively used in genetic research, are relatively well-

Table 2-4. Diversity and endemism of vertebrate species in megadiversity countries.

Country	Mammals	Birds	Reptiles	Amphibians	Vertebrates except fish	Non endemic endemic	Endemism as % of global diversity: all vertebrates excluding fish	Freshwater fish [a]
Brazil	524 (131)[b]	1,622 (>191)	468 (172)	517 (294)	3,131 (788)	3.97:1	~3.3	>3,000
Indonesia	515 (201)	1,531 (397)	511 (150)	270 (100)	2,827 (848)	3.33:1	3.5	1,400
Colombia	456 (28)	1,815 (>142)	520 (97)	583 (367)	3,374 (634)	5.32:1	2.6	>1,500
Mexico	450 (140)	1,050 (125)	717 (368)	284 (169)	2,501 (802)	3.12:1	~3.3	468
Australia	282 (210)	751 (355)	755 (616)	196 (169)	1,984 (1,350)	1.47:1	~5.6	183
Madagascar	105 (77)	253 (103)	300 (274)	178 (176)	836 (630)	1.33:1	2.6	75
China	499 (77)	1,244 (99)	387 (133)	274 (175)	2,404 (484)	4.97:1	2.0	1,010
Philippines	201 (116)	556 (183)	193 (131)	63 (44)	1,013 (474)	2.14:1	1.98	330
India	350 (44)	1,258 (52)	408 (187)	206 (110)	2,222 (393)	5.65:1	1.6	750
Peru	344 (46)	1,703 (109)	298 (98)	241 (>89)	2,586 (342)	7.56:1	1.4	855
Papua & New Guinea	242 (57)	762 (85)	305 (79)	200 (134)	1,509 (355)	4.25:1	1.5	282
Ecuador	271 (21)	1,559 (37)	374 (114)	402 (138)	2,606 (310)	8.41:1	1.3	>44
United States	428 (101)	768 (71)	261 (90)	194 (126)	1,651 (388)	4.34:1	1.6	790
Venezuela	288 (11)	1,360 (45)	293 (57)	204 (76)	2,145 (189)	11.35:1	0.8	1,250
Malaysia	286 (27)	738 (11)	268 (68)	158 (57)	1,450 (163)	8.90:1	0.7	600
South Africa	247 (27)	774 (7)	299 (76)	95 (36)	1,415 (146)	9.69:1	0.6	153
Dem.Rep. of Congo	415 (28)	1,094 (23)	268 (33)	80 (53)	1,857 (137)	13.55:1	0.6	962

[a] Data on endemism in freshwater fish are not available. Freshwater fish are included only in the total species diversity.
[b] Numbers in parentheses refer to endemic species.
The 17 megadiversity countries have 8,443 species of endemic vertebrates excluding fish, or 33.1% of the global diversity of these groups.
Source: Mittermeier *et al*. (1997).

studied. For others, very little or no research has been carried out.

Although an important factor, medical or economic importance, for example, does not necessarily guarantee research on these invertebrate groups. Research on numerous agro-forestry pests, pathogenic vectors and groups which could serve as bioindicators, is still incipient in Brazil, being restricted to very few specialist in the country or none at all. They include Coccidae and Aphidae of the Order Homoptera, Cecidomyiidae (Diptera), carabid and chrysomeline beetles (Coleoptera), and many important families of such as hymenopteran parasites and the Orthoptera.

2.1.3 Plants

Angiosperms (flowering plants) are the principal and economically most important group of terrestrial plants. They include nearly all of the cultivated plants, dominant in nearly all terrestrial environments in Brazil. Globally, there are about of 250,000 angiosperm species, by far the most diverse group.

No precise estimate can be given for the number of species in Brazil, but some inventories provide an idea. In the Atlantic Forest, for example, a team from the New York Botanical Garden working with the Botany Department of the Executive Commission for Cacao Cultivation (*Comissão Executiva do Plano da Lavoura Cacaueira - CEPLAC*) registered 454 tree species in a single hectare in the Serra do Conduru State Park in southern Bahia. An even more impressive figure was obtained during an inventory by researchers from the Mello Leitão Museum of Biology in the Santa Lúcia Biological Station in the state of Espírito Santo: 476 species in one hectare. Estimates range from 40,000 to 70,000 plant species in the country. The best accepted estimates indicate between 55,000 and 60,000, or 22% to 24% of the world's angiosperm species. By way of comparison, the estimate for North America is 17,000 species, that for Europe 12,500, and 40,000 to 45,000 species are believed to occur in Africa.

A significant portion of angiosperm biodiversity, therefore, can be found in Brazil. Regions such as the Atlantic forest, the Amazon basin, the Northeast and the Cerrado are rich in endemic species. Given its enormous economic (food, the pharmaceutical industry, timber) and ecological importance, this group has priority for its preservation, conservation, sustainable use and research.

The only systematic treatise on botany in Brazil is the *Flora Brasiliense* by Martius, compiled over the period 1840-1906. Although still a standard reference, it is of course now out of date, and there is an urgent need for a new synthesis.

The National Botany Plan (Plano Nacional de Botânica) has adopted the strategy of promoting the compilation of flora at the state level, which will hopefully lead eventually

Table 2-5a. Estimated biological diversity (number of species) in the cerrado region of Brazil.

Phylum	Class	Common name	Richnesss
Chordata	Mammalia	Mammals	150
	Aves	Birds	550
	Reptilia	Reptiles	150
	Amphibia	Amphibians	150
	Osteichthyes	Fish	1,000
	Condrichthyes	Rays	10
Uniramia	Hexapoda:		
	Coleoptera	Beetles	35,000
	Hymenoptera	Wasps, etc.	20,000
	Lepidoptera	Moths	15,000
	Diptera	Flies	10,000
	Other Orders	Other insects	10,000
	Myriapoda	Centipedes	500
	Tardigrada		50
	Pentastomida		10
	Onychophora		5
Crustacea	5 classes	Crustaceans	500
Chelicerata	Arachnida	Spiders, Etc.	4,000
Annelida	Oligochaeta	Worms	100
	Hirudinea	Leeches	50
Mollusca	Gastropoda	Snails	500
	Bivalvia	Bivalves	50
Bryozoa	3 classes	Bryozoa	10
Platyhelminthes	5 classes	Flatworms	400
Nematoda	2 classes	Roundworms	500
Nematomorpha	1 class	Hair Worms	10
Acanthocephala	1 class	Worms	50
Gastrotricha	1 class	Worms	10
Nemertini	2 classes	Worms	5
Rotifera	2 classes	Rotifers	100
Coelenterata	Hydrozoa	Hydras	50
Porifera			
Protozoa:	Demospongea	Sponges	10
Mastigophora	2 classes	Flagellates	1,500
Sarcodina	2 classes	Amoeba	400
Sporozoa	2 classes	Sporozoa	1,500
Cnidospora	2 classes	Sporozoa	100

Source: Dias (1996).