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BDGEOPRIM – Database of Geo-Referenced Localities of Neotropical Primates

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Introduction

One of the main problems for the conservation of the Neotropical primates is that our understanding of their geographical distributions is still poor. This is underlined by the fact that many new forms are still being discovered: 31 species and subspecies since 1960 (three from the Atlantic forest and the remainder from Amazonia), 13 of them since 1990 (Rylands *et al.*, 2001). Many of the Neotropical primates are now threatened (Rylands *et al.*, 1995, 1997), and a database documenting their past and present distri-

butions is a vital tool for an understanding of their conservation status (degree of reduction in their range), for priority-setting, and for planning conservation strategies, allowing for information to be made available in a timely fashion to field researchers, conservation organizations and government institutions. In more dire situations, it is essential to have access to the maximum information on the past and present ranges of critically endangered species for their management and the translocation of populations from areas suffering strong human impacts to locations where they can be guaranteed greater protection (see for example, Garcia-Orduña *et al.*, 1987; Kierulff and Procópio de Oliveira, 1994). Only recently was it possible to identify the extent of the historic occurrence of the red-handed howling monkey (*Alouatta belzebul*) in the north-east of Brazil through some very few and obscure locality records; a species now largely extinct in the region (Bonvicino *et al.*, 1984; Coimbra-Filho *et al.*, 1995). The need for an understanding of historic and recent distributions for the conservation of primates in regions where forests have been largely destroyed also became evident during surveys in the Rio Doce basin in the state of Minas Gerais (the "Steel Valley"), as well as when drawing up conservation priorities and strategies for the Atlantic forest in the south of the state of Bahia, Brazil (CI and IESB, 1997; Hirsch, in prep.).

The goal of the BDGEOPRIM, the Database of Georeferenced Localities for Neotropical Primates, is to organize the scattered information available in gazetteers, in the scientific literature (much of it grey), and from field studies, of the locality records of all Neotropical primate species, and to make it available for use in libraries and museums, and by professionals in primatology, conservation, biogeography, and taxonomy.

Although we have checked the entire database three times, the users will undoubtedly find errors, and we would be very grateful for comments and suggestions, as well as leads regarding sources of information that we have missed. In some parts of the Database and in the maps, the foreign users will find some terms in Portuguese because we began tabulation of the information in Brazil's native language. As a next step, we will make the BDGEOPRIM available in Portuguese, Spanish and English.

This database has not yet been published, but we decided to put it on an Internet homepage (see <http://www.icb.ufmg.br/~primatas/home_bdgeoprim.htm>), because there have been so many enquiries and requests for information and analyses from numerous people and institutions from Brazil (Rio Grande do Sul, Minas Gerais, Paraiba, Conservation International, the Brazilian Institute for the Environment - IBAMA) and other countries such as Argentina, Paraguay.

Our initial objectives were to a) tabulate all the localities for Neotropical primates listed in the current literature; b) arrange the information in a database format; c) georeference all the tabulated localities; d) check the veracity of the information by crossing all the data with maps of primate geographical distributions, hydrography, topography, vegetation (biomes and ecosystems), conservation units, and political divisions, and e) plot the records by taxa on maps generated through a Geographic Information System (GIS).

Methods

The taxonomy of Neotropical primates is still far from definitive. Most especially the application of molecular genetics and cytotaxonomy, along with the findings of new species and subspecies, over the last two decades, has resulted in numerous revisions and a far better understanding of the true diversity of the Platyrrhini, based increasingly on the Phylogenetic Species Concept (see Groves, 2001). A number of genera (for example the woolly monkeys, *Lagothrix*) and groups of species (for example, the red howling monkeys, *Alouatta seniculus*) are in need of a modern revision of their component taxa, while some particularly tricky genera are still subject to dispute (for example, the capuchin monkeys, *Cebus*, the night monkeys, *Aotus*, and the squirrel monkeys, *Saimiri*). For BDGEOPRIM, we adopted the taxonomic arrangement proposed by Rylands *et al.* (2000).

To start, we made an extensive bibliographical review to check the information already available. We first tabulated all the records listed in the published gazetteers of such as Hershkovitz (1977), Kinzey (1982), Torres de Assumpção (1983) and Oliver and Santos (1991). We then searched for more recent scientific papers, including all those published in *Primate Conservation* and *Neotropical Primates*. We also checked some classic works from the 18th century, such as Wied-Neuwied (1821) and von Spix and von Martius (1981). To this, we added unpublished records of primate localities from museum collections and from the field, obtained by the authors of BDGEOPRIM and by a number of researchers who spontaneously contributed information from surveys.

The information associated with each record (locality) was standardized, even if it was a type locality. This was necessary for two reasons: 1) to sort and classify all the records in alphabetical order, and 2) to avoid duplicating records from the same place and/or the same taxon. When we confirmed that information was erroneous, we assigned the correct data and stored the original information in the "Observations" field. When the information for a specific field was lacking (a "missing value"), we completed it, when possible, with the correct information. To give an example of the standardization of references for the same "locality", "right bank of Amazon River, Santarém, PA, Brazil", "Amazon River, right bank, Santarém, Brazil", and "Santarem, right bank, Amazon River" were all recorded as:

Locality	Municipality	State	Country
Amazon River, right bank	Santarém	PA	Brazil

Many abbreviations were used - geographic names, Brazilian states, categories of protected areas, IUCN categories of threatened status, museum acronyms, and so on. For easy identification, we drew up specific tables for each set.

All the information associated with each record (locality) was tabulated in a Database with 58 fields (see Table 1). In this way, it is possible to consult the Database using different combinations of information fields, and the output report can be viewed either as a simple table (list) or as a more complex matrix, crossing the fields one by one, or one for several fields.

Almost all the geopolitical data which was not available in the original scientific papers consulted, we obtained from official publications, multimedia products and online services released by government agencies, non-governmental organizations and other institutions, including:

IBGE (<www.ibge.net/home/default.php>),
SURAPA CD-Rom (<http://csf.colorado.edu/mail/elan/may99/msg00799.html>),
ESRI ArcData Online (<www.esri.com/company/free.html>),
Expedia.com Maps Online (<http://www.expedia.com/pub/>),
USGS (<http://edc.usgs.gov/geodata/>),
UNEP/GRID (<http://grid2.cr.usgs.gov/>),
Garmin MapSource World Atlas (<www.garmin.com/cartography/>),
GEOMinas (<www.geominas.mg.gov.br/>), and other printed world atlases.

After tabulating all the records, we linked the Database with a Geographic Information System, using three information fields: the record identification number (N_ID) and the geographic coordinates (longitude and latitude). Georeferenced, it is possible to plot any field of information

Table 1. Database information fields and abbreviations associated with the locality records. Y = yes, N= no.

Field	Abbreviation
1. Record Identification No. (# primary key)	N_ID
2. Date	DATE
3. Operator	OPERATOR
4. Family	FAMILY
5. Genus	GENUS
6. Species	SPECIES
7. Subspecies	SUBSPECIES
8. Description (Author)	DESCRIPTIO
9. Description (Year)	YEAR
10. Common Name	COMMON_NAM
11. Type Locality (Y or N)	TYPE_LOCAL
12. Survey Area of Hirsch Ph.D. Thesis (Y or N)	THESIS_FRA
13. IUCN (1996) Category	IUCN_1996
14. Present Population Status and Risk of Threat	POPUL_STAT
15. Biome	BIOME
16. Ecosystem or Habitat Type	ECOSYSTEM
17. Conservation Unit Category	CU
18. Locality	LOCALITY
19. Municipality or "City"	MUNICIPAL
20. State, "Departamento" or "Província"	STATE
21. Country	COUNTRY
22. Geog. Coord. (Latitude, dd)	LAT_DD
23. Geog. Coord. (Latitude, mm)	LAT_MM
24. Geog. Coord. (Latitude, ss)	LAT_SS
25. Geog. Coord. (Longitude, ddd)	LONG_DDD
26. Geog. Coord. (Longitude, mm)	LONG_MM
27. Geog. Coord. (Longitude, ss)	LONG_SS
28. Geog. Coord. (Longitude, decimal format)	LONGITUDE
29. Geog. Coord. (Latitude, decimal format)	LATITUDE
30. Altitude Minimum (m)	ALT_MIN
31. Altitude Maximum (m)	ALT_MAX
32. Altitude Average (m)	ALT_AVG
33. Area (ha)	AREA
34. Year of Creation (ha), if it was a CU	YEAR_CREAT
35. Administration	ADMINISTRA
36. Reference	REFERENCE
37. Type of Record	TYPE_REC
38. Collector	COLLECTOR
39. Year of Collection	COL_YEAR
40. Museum	MUSEUM
41. Number of Museum Collection	COL_NUM
42. Original Record Number from Gazetteer	N_ORIG
43. Change or Attributed of Genus (Y or N)	ATB_GENUS
44. Change or Attributed of Species (Y or N))	ATB_SP
45. Change or Attributed of Subspecies (Y or N)	ATB_SSP
46. Change or Attributed of Cons. Unit (Y or N)	ATB_UC
47. Change or Attributed of Locality (Y or N)	ATB_LOCAL
48. Change or Attributed of Municipality (Y or N)	ATB_MUNIC
49. Change or Attributed of State (Y or N)	ATB_STATE
50. Change or Attributed of Country (Y or N)	ATB_COUNTR
51. Change or Attributed of Altitude (Y or N)	ATB_ALT
52. Change or Attributed of Area (Y or N)	ATB_AREA
53. Change or Attributed of GCs (Y or N)	ATB_CGS
54. Change or Attributed of GCs with ArcGIS (Y or N)	ATB_ARCGIS
55. Change or Attributed of GCs with Garmin (Y or N)	ATB_GARMIN
56. Change or Attributed of GCs with Expedia (Y or N)	ATB_EXPED
57. Change or Attributed of GCs with SURAPA (Y or N)	ATB_SURAPA
58. Observations	OBS

on a projected map, showing the records in their actual geographic position. Unfortunately, it was not possible to locate 39 records that had no geographic coordinates, so that we were unable to find their exact location. These records were stored in the Database but are not visible on the maps.

Because the distributions of the Neotropical primates embrace South America (southern hemisphere) and Central America (northern hemisphere), we used a World Geographic Coordinate System and WGS84 Datum (World Geographic System 1984). As such, we avoided some problems with displacement and data matching, and facilitated the combination of "overlays" from different sets of data.

All the maps were generated using ArcGIS v. 8.1 (ESRI, 2001). Initially, we produced maps for all 18 genera, showing the records (points) only for the species. The next step will involve the production of species maps which show the records for each subspecies.

At this stage, we decided not to trace lines delimiting the distributions of the different species in each genus. This is because for some the limits remain unclear, this kind of delimitation is laborious and is, besides, often guesswork, using inferences from natural boundaries, such as rivers, mountain ridges, and vegetation types and, an often inadequate, knowledge of historic changes in vegetation.

Summary Results

At the present stage, the BDGEOPRIM consists of 5,631 locality records, embracing all of the 18 Neotropical primate genera, 110 species and 205 subspecies in 21 countries from Central and South America (see Fig. 1).

- A total of 487 bibliographical references were reviewed, naturally including the classic works (gazetteer) of Hershkovitz (1977) with 807 records, Kinzey (1982) with 679 records, and Oliver and Santos (1991) with 516 records. A further 45 references provided more than 50 records. Besides Hershkovitz' (1977) gazetteer for callitrichids, a further 655 records were cited for the first time and 472 records are exclusive citations.
- The map of localities, recorded in a 25 x 25 km grid, shows that they are not uniformly distributed. The highest density is concentrated in one continuous area in the southeast region of Brazil, in the Atlantic forest. In Amazonia, locality records are highly clumped, distributed along the major rivers. The Cerrado has a uniformly low density of records, while in Mesoamerica the records show a patchy distribution as in Amazonia (see Fig. 1).
- The genera with the highest numbers of records are: 1,166 for the howling monkeys (*Alouatta*); 894 for the capuchin monkeys (*Cebus*); 665 for the marmosets (*Mico* and *Callithrix*); 616 for tamarins (*Saguinus*); and 545 for the titi monkeys (*Callicebus*).

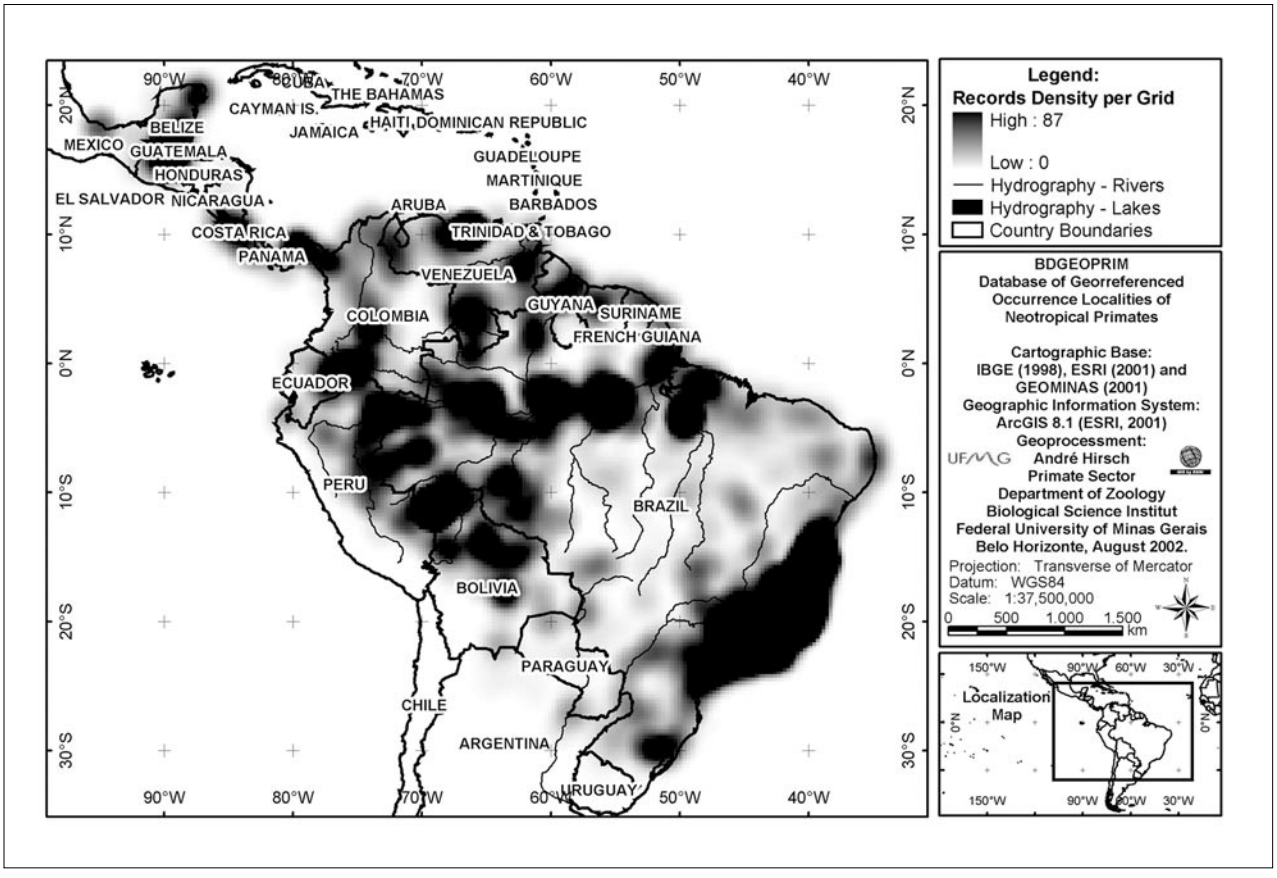

Figure 1. Distribution of Neotropical primate locality records. Density per 25 x 25 km grid.

• All the Central and Mesoamerican countries with primates are included. Those with the highest numbers of records are: Brazil with 3,680; Bolivia with 431; Venezuela with 379; Peru with 299; and Colombia with 227.
• Regarding threatened species, 304 records are of Critically Endangered (CR) primates, 632 records of Endangered (EN), 1,078 of Vulnerable (VU), 2,922 records are of the Low Risk (LR) category, and 20 records are from those classified as Data Deficient (DD).
• Considering only the Brazilian biomes, 2,429 records are from the Amazon, 1,843 from the Atlantic forest, 367 from the Cerrado, 84 from the Caatinga and 23 from the Pantanal Matogrossense.
• A total of 1,746 records (31%) are from protected areas, the majority National Parks, according to the base maps provided by SURAPA (1999).
• Records from museum collections are not well-represented in the database. A more comprehensive survey of the key museums has still to be done. At this time, 1,003 records are from museum specimens, representing 17.8% of the total records.

Future Products

We hope that the BDGEOPRIM will be released in three different languages (Portuguese, Spanish and English) over the next year, as a CD-ROM, and/or in a form which will allow for on-line interactive access, structured in such a way that information stored in the Database will be easily and quickly available. The BDGEOPRIM will eventually include biological and ecological data on the Neotropical primate species, with a picture of each.

A Dedication

The database is dedicated to Philip Hershkovitz 1909–1997 (*in memoriam*), Emeritus Curator of Mammals at the Field Museum of Natural History, Chicago, and one of the world's most distinguished mammalogists and prominent primatologists of the Neotropical region. Over 50 years, he described 75 new species and subspecies, and published more than 160 scientific papers and 100 non-technical publications. His book, *Living New World Monkeys* (1977), along with numerous accompanying papers, put our knowledge of platyrrhine systematics and distributions years ahead of other primate groups.

Correct Reference Citation

Hirsch, A., Dias, L. G., Martins, L. de O., Campos, R. F., Landau, E. C. and Resende, N. A. T. In prep. BDGEOPRIM - Database of Geo-referenced Localities for Neotropical Primates. Departamento de Zoologia, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte. Web site: <http://www.icb.ufmg.br/~primatas/home_bdgeoprim.htm>.

Acknowledgments

We are very grateful to the Margot Marsh Biodiversity Foundation (Grant CP FY02/007) for financial support; to Luiz Paulo de S. Pinto and Carlos A. Bouchardet from Conservation International do Brasil, for their expertise and help with the financial administration of the Database; to the Universidade Federal de Minas Gerais (UFMG) for logistical support; to Felipe B. C. de Sousa and Elizangela M. dos Santos for their help with data tabulation; to Germán A. Bohorquez Mahecha, Federal University of Minas Gerais, for his comments and help with Colombian administrative divisions and localities; to Anthony B. Rylands and Thomas Brooks from the Center for Applied Biodiversity Science (CABS) at Conservation International (CI), for their incentive, comments and suggestions; to Roberto Cavalcanti from CI-Brasil for his suggestions and comments on the homepage; to Claudia M. Jacobi for her patience in revising the English version; to João P. R. Silva, Webmaster from ICBNet/UFMG, for his help with the homepage management, and to numerous researchers and colleagues who spontaneously contributed recent field records of the occurrence of primates.

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Bird Predation and Prey-transfer in Brown Capuchin Monkeys (*Cebus apella*)

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Introduction

In the last decade capuchin monkeys, *Cebus*, have received growing attention in the primatological literature due to some striking convergences between them and chimpanzees, *Pan*, such as: large brain size relative to body size, long life span, tool use skills, and food-sharing among group members (Fragaszy *et al.*, 1990; Visalberghi and McGrew, 1997). These similarities make capuchin monkeys an attractive model for validating hypotheses about the evolution of social life and cognition that are heavily based upon Old World primates (Parr *et al.*, 1997).

Food-sharing tendencies are of interest due to the view that cooperative hunting with subsequent meat sharing was a key factor in the adaptation and organisation of early human societies (Butynski, 1982; Anderson, 1986; McGrew and Feistner, 1992), and many studies have focused on the cooperative hunting and meat sharing of wild chimpanzees (Boesch, 1994). Some authors (e.g., Newcomer and De Farcy, 1985; Fragaszy, 1986) have reported predation on vertebrates by capuchin monkeys in different environmental conditions. However, the relation between predation and prey sharing has only been analysed for wild *C. capucinus.*

Rose (1997) reported predation on birds, coatis (*Nasua narica*), and squirrels (*Sciurus variegatoides*) by two groups of *C. capucinus* at Santa Rosa National Park, Costa Rica. She concluded that, although predation is a common event, food sharing is infrequent. Meat is the most commonly shared food, and the only food shared between adults (usually through falling scraps or abandoned carcasses). Perry and Rose (1994) analysed the sharing of captured coatis in three groups of *C. capucinus* at two sites in Costa Rica. They concluded that: a) among the species normally predated by capuchins, coatis are riskier because adults are larger than adult capuchins and normally defend their pups; and b) coati pups scream while being eaten, so it is impossible for a monkey to be rapid and furtive when eating them, giving plenty of opportunities for other monkeys to beg from the carcass owner.

The possible social value of food-sharing in captive groups of *C. apella* has been emphasised by de Waal (1997; 2000; de Waal *et al.*, 1993) who observed that the occurrence of this behavior is: a) related to affiliative relations and social tolerance between pairs of individuals, b) linked to previous events of food-sharing between the pair (even after a delayed period) and, c) is more frequent when cooperation