

# A SUMMARIZED HISTORY OF BRAZILIAN MAMMALOLOGY

## UNA HISTORIA RESUMIDA DE LA MASTOZOLOGÍA BRASILEÑA

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### ABSTRACT

The history of mammalogical studies in Brazil is summarized from its origins in the colonial period to the expansion of national collections and the development of graduate programs in the 20<sup>th</sup> Century. A selection of researchers and expeditions focusing on the study of Brazilian mammals is presented in the context of identification of main events, as well as past and current constraints to the full development of mammalogy in the country.

**Key words:** Brazil, collections, expeditions, mammals, researchers.

### RESUMEN

La historia de la mastozoología de Brasil se resume desde sus orígenes, en el periodo colonial, hasta la expansión de las colecciones nacionales y el desarrollo de programas de posgrado, en el siglo XX. Se presenta una selección de los investigadores y expediciones que se enfocaron en el estudio de los mamíferos brasileños, bajo el contexto de la identificación de eventos principales, así como las restricciones pasadas y presentes en el desarrollo de la mastozoología en el país.

**Palabras clave:** Brasil, colecciones, expediciones, mamíferos, investigadores.

### RESUMO

A história dos estudos sobre mamíferos no Brasil é resumida desde suas origens, no período colonial, à expansão das grandes coleções nacionais e ao desenvolvimento dos cursos de pós-graduação no século XX. Uma seleção de pesquisadores e expedições enfocando o estudo de mamíferos brasileiros é apresentada no sentido de identificar os principais eventos, bem como as restrições passadas e atuais ao pleno desenvolvimento da mastozoologia no país.

**Palavras chave:** Brasil, coleções, expedições, mamíferos, pesquisadores.

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## INTRODUCTION

Brazil is the largest country in South America, with an area of 8.5 million km<sup>2</sup> that harbors a high diversity of natural environments and a high biological diversity. The 701 mammal species recorded in the last comprehensive compilation (Paglia *et al.*, 2012) makes the country one of the most diversified in the world.

The country also harbors a large human population, which has grown exponentially to the current figure of more than 200 million. Since its first years in the onset of the 16<sup>th</sup> century, Brazil's economy has been based on agriculture (mainly monocultures), and cattle production, which have largely expanded in the recent decades at the expense of natural areas and landscapes. The recent industrialization boom of the country in the last 50 years has accentuated the degradation of natural areas due to the accompanying expansion of the agro industrial and energy sectors. These facts demand the need for public policies to qualify human resources in order to mitigate the impact of human activities on biodiversity, including its documentation, description and study.

Herein we sketch the history of Brazilian mammalogy from three aspects that we consider basic for the development of any branch of zoological research on a national scale: (1) the formation of public collections, (2) the training of human resources, and (3) the publication of original literature. We identify major historical facts that have determined the development of knowledge on Brazilian mammals, including main foreign expeditions and researchers, and their impact in mammalogy and taxonomy in general. The recent development of Brazilian mammalogy is analyzed in the light of the development of graduate courses in the country, and the capacity of Brazilian institutions to hire graduated mammalogists. In this context, and considering problems that still persist, we identify and discuss major constraints to the full development of mammalogy in Brazil.

## HISTORY

### Colonial Period

The discovery of Brazil was claimed by a Portuguese fleet under the command of Pedro Álvares Cabral (1467–1520), on April 22<sup>nd</sup>, 1500. Letters to King D. Manuel (1469–1521) by the celebrated chronicler Pero Vaz Caminha (1450–1500), and also by other members of the fleet described the particular features of the new land, its natives and animals, plants and landscapes. However, no mammal was referred to in these letters apart from the first record of the West Indian Manatee (*Trichechus manatus* Linnaeus, 1758), described by an anonymous chronicler of that fleet in the *Relação do Piloto Anônimo* (Malheiro Dias, 1923; Teixeira and Papavero, 2006, 2009).

A different version of the first report on the natural history of a Brazilian mammal refers to the fleet of Vicente Yáñez Pinzón (1462–1514) that would have reached the Brazilian northeast coast some months before Cabral (Oliveira, 1969; Guedes, 1975). A fragmentary report of this expedition is the oldest reference known of Brazilian nature and the first marsupial (a *Didelphis*) to be recorded by a European in the Americas (Teixeira and Papavero, 2002, 2009).

During the 16<sup>th</sup> and 17<sup>th</sup> centuries, the coast of Brazil was visited by explorers, pirates, corsairs, and settlers of several nationalities. Mammals were usually mentioned in anecdotal reports provided by the travelers and missionaries (e.g., Sousa, 1530; Pigafetta, 1536; Cabeza de Vaca, 1554; Staden, 1557; Thevet, 1558; Léry, 1578; Cardim, 1583–1601; Sousa, 1587). Some early observations were remarkable, such as the first Brazilian record of a vampire bat (*Desmodus rotundus*), and the precise description of its feeding behavior (Cabeza de Vaca, 1554). Some of these 16<sup>th</sup> century chronicles may have documented species that are currently extinct, such as the mention of “very big rats” in the description of the Island of Fernando de Noronha in 1503 that was attributed to Americo Vespucci (1454–1512). Such records, controversial given the lack of native rodents in that archipelago, has recently been corroborated by the discovery of *Noronomys vespucci*, an extinct sigmodontine rodent only known from bone fragments obtained in late Quaternary beach dunes on its main island (Carleton and Olson, 1999).

Notwithstanding the anecdotal character of these records, the analysis of such chronicles, as well as the fragmentary information on animal trade to Europe in these early years, are still relevant contri-

butions to the estimation of presumptive original ranges and species densities in “pre-colonial” times, particularly with respect to felids (Felidae) and primates (Primates), which comprised most of the traded species (e.g., Teixeira and Papavero, 2009). Likewise, reports by 16<sup>th</sup> and 17<sup>th</sup> centuries chroniclers on the amounts of mammals hunted for food by natives and Europeans also provide interesting estimates of local abundances in regions that were later impacted (e.g., van den Boogaart and Brienen, 1997). These former accounts may also include scattered reports of the interactions among wild mammals, such as those reported between capuchin monkeys (Cebidae) and peccaries (Tayassuidae) (Cabeza de Vaca, 1554).

With the slaves, initially brought from Africa to work in sugarcane plantations in northeastern Brazil, came part of the Brazilian cultural heritage. Europeans and Africans were foreign to the Neotropics with its particular biota highlighted by endemisms, offshoots and relicts of an evolutionary tree that had branched in semi-isolation during the Tertiary Period. Brazilian mammals were named by analogy to Old World species that bore some resemblance to them. Pero Lopes de Sosa (1497–1539), in his letter to the King of Portugal (Sousa, 1530), remarked that the “danta” or tapir (*Tapirus terrestris*) resembled young colts. Local species were sometimes referred to under Portuguese names for Old World animals, such as the fox (probably a Canidae), tiger (*Panthera onca*), or rabbit (*Sylvilagus brasiliensis*). Together with popular names, there came the old legends and folklore, such as tales registered in Persian bestiaries of the 13<sup>th</sup> century about porcupines launching quills upon an attacker, or hedgehogs that rolled over ripe fruits to carry home impaled on their spines.

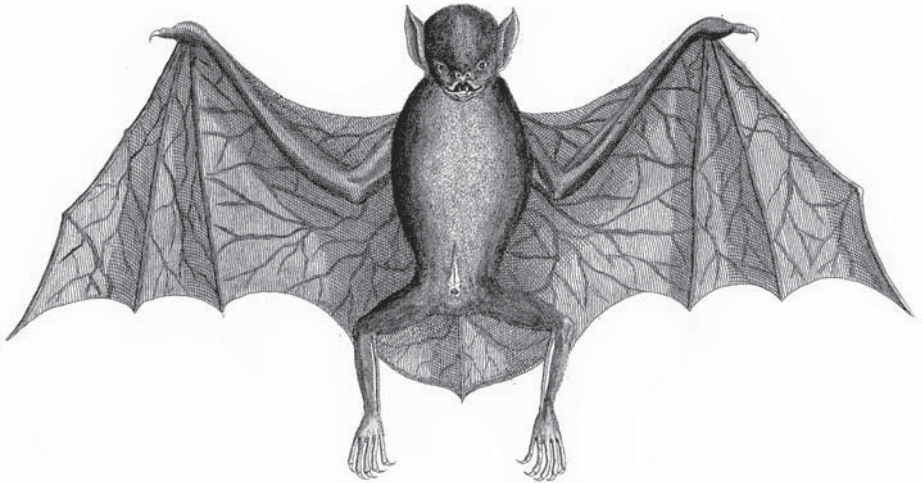
Indian names survived, though, preserved in chronicles and in the glossaries of aboriginal dialects compiled mainly by Jesuit missionaries who first established Indian missions and schools in Brazil.

Tupi-Guarani was one of six main groups of languages spoken by natives, and the most widespread on the coast. It was the basis of a general language practiced by many people, particularly in interior Brazil, until the beginning of the 20<sup>th</sup> century. Mammal native names have also been preserved in a large number of indigenous toponyms, most of them still in use, usually indicating the presence and local abundance of a particular mammal in a locality.

Between 1580 and 1640, the crowns of Portugal and Spain became united. Former treaties between Portugal and traditional enemies of Spain, such as The Netherlands, and England, were then not valid. In 1621, the Company of the West Indies was established in Leiden, and in 1630 a Dutch fleet attacked Pernambuco. Zacharias Wagenaer (1614–1668), a soldier with the Dutch army arrived in 1634. During the seven years of his residence in northeastern Brazil, he observed the animals and plants. His original manuscript was translated and published in Portuguese under the title of *Zoobiblion* (Wagener, 1964).

Prince Johannes Mauritius of Nassau (1604–1679), born in Dillenburg, in to-day Germany, arrived in Recife in 1638, as Governor. Nassau brought a German astronomer, Georg Marcgrave (1610–1648), and a physician-naturalist, Wilhelm Pies (1633–1702), who remained for seven years in Pernambuco. A botanical garden and a zoo were established. Paraíba, Pernambuco, and Rio Grande do Norte were the first Brazilian, and South American, provinces to be formally explored from a zoological point of view (Almeida *et al.*, 2011). Upon Marcgrave’s demands, Nassau had brought animals from Africa and Chile for comparison with the native species. The first drawing of the llama (*Lama glama*, from Chile) appears in Marcgrave’s book, where 46 terrestrial mammals are described. Marcgrave died young, but his descriptions of mammals and plants eventually became the first comprehensive work on the natural history of South America. In 1648, four years after Marcgrave’s premature death, his friend Johannes de Laet (1581–1649) published a folio under the title of *Historiae Rerum Naturalium Brasiliae* (Marcgrave, 1648; Figure 1). Part of this was Pies’ *De Medicina Brasiliensi*, which was reprinted as a separate volume in 1658 under the title *De Indiae Utiusque Re Naturali et Medica*. Pies’ descriptions of animals were poorer than Marcgrave’s. Some of Marcgrave’s specimens found their way into Seba’s collection, and were illustrated (Figure 2) in his *Thesaurus* (Seba, 1734–1765). The descriptions of mammals by Marcgrave were used by Carl Linnaeus (1707–1778) in his *Systema Naturae*. Linnaeus lived in Holland from 1735 to 1738, and stated his interest in the Dutch colonies in the introduction of his book.





**Figure 2.** *Noctilio leporinus* in a plate that appeared in the first volume of Albertus Seba in 1784.

After Linnaeus (1758), Martin Heinrich Karl von Lichtenstein (1780–1857) was the first mammalogist to comment on, or to validate species mentioned by Marcgrave (Lichtenstein, 1818). *Historiae Rerum Naturalium Brasiliae* lists 34 native mammals and *Theatrum Rerum Naturalium Brasiliae* depicts many of them in color. Brazilian editions of the latter were composed from the original colored plates, which had been lost for almost 40 years after the II World War, and that were found in Krakow, Poland in 1977 (Teixeira, 1993, 1995).

Thomas (1911) and several authors after him (Lönnerberg, 1913; Sanborn, 1930; Hamlett, 1939; Cabrera, 1958) fixed the type localities of several mammals described by Linnaeus as “Pernambuco” on the basis of Marcgrave’s original locality references. No less than 16 currently recognized species, most of them of medium to large size, had their Latin names based on Marcgrave’s descriptions and drawings, and their type localities consequently assigned to Pernambuco. The accuracy of his illustrations and descriptions is exemplified in the recent rediscovery of *Cebus flavius* (Schreber, 1774) based on Marcgrave’s Capuchin Monkey “caitaia” (Oliveira and Langguth, 2006). Therefore, Marcgrave’s compendium is the most important mammalian taxonomic treatise of pre-Linnaean times on the Brazilian fauna.

The prohibition of foreigners in Brazil dates from March 18<sup>th</sup>, 1604 (Nomura, 1998). Even after the restoration of the Portuguese Crown and the subsequent defeat of the Dutch in northeastern Brazil (1656), the colony would be closed to foreign explorers for the next 150 years.

England dominated World trade from the 18<sup>th</sup> to the 19<sup>th</sup> centuries. Natural products such as timber, spices, plants of economic or medicinal importance, gold, silver and gems, constituted a powerful attractive to all European nations. Treaties with Spain and arbitration by neutral parties, such as the Pope, were bent or broken in the rush of colonialism, and by the end of the 17<sup>th</sup> century the Portuguese had pushed the borders of the Brazilian colony to the upper reaches of the Amazon River in the north and to the Rio de la Plata in the southwest. A significant portion of this expansion was obtained by missionaries, particularly Jesuits, which eventually formed several indigenous missions in the La Plata basin in localities that are currently situated in Brazil, Paraguay, Uruguay and Argentina (Ollero *et al.*, 1989).



New territories meant not only new markets, but new sources of raw materials and natural products. Spain and Portugal began a systematic inventory of the New World. In 1783, Félix de Azara (1742–1821) was sent to the La Plata region to head a commission in charge of the demarcation of borders between the Spanish and Portuguese colonies. Azara remained for 18 years between La Plata and the Province of Paraguay, which then extended between "...le 22°, jusqu'au 29°, dégré de latitude méridionale, et depuis 56 degrés 20 minutes jusqu'á 61 degrés de longitude occidentale du méridien de Paris..." (Azara, 1801:LXXII), a region that today includes part of the Brazilian states of Rio Grande do Sul and Mato Grosso do Sul. He eventually wrote comprehensive manuscripts describing the birds, mammals and the natural history of this large Province, which he studied while developing his missions. Azara's (1801) treatise on the mammals from Paraguay was based on an original manuscript in Spanish sent by him some years before to his brother, who had it translated into French and arranged for its publication without the author's consent. After his return to Spain a year after the publication of the first edition. Azara published a Spanish edition of his treatise (Azara, 1802).

The species that Azara regarded as new were referred by their vernacular names. In Azara (1801), the vernacular names were maintained in the original form or, in some cases, translated into French. The first edition in French soon became a reference for the mammals of this region of South America. The species described were later given Latin names by several authors. It is important to emphasize that most, if not all, scientific names given to Azara descriptions usually refer to those reported in the first edition published in French. A comprehensive study on Azara's itineraries during the 18 years that he lived in South America (Mones and Klappenbauch, 1997) may eventually allow the refinement of type localities formerly referred to only as "Paraguay", including some Brazilian localities.

During the same years that Azara was in South America, four expeditions left Portugal with three heading to the African continent and one to Brazil that were directed to the description of natural products from the Portuguese colonies. One of the explorers was Alexandre Rodrigues Ferreira (1756–1815) who was born in Bahia, Brazil, and attended the University of Coimbra, Portugal. Singled out by the botanist Domenico Vandelli (1735–1816) as a promising field naturalist, Ferreira spent five years at the Museu da Ajuda in Lisbon, in preparation for the difficult mission that was given to him, the exploration of the Amazon and Mato Grosso. His first two years in Brazil were spent traveling along the Amazon River from the capital city of Pará to the headwaters of the Rio Negro on the Venezuelan border.

In 1787, Ferreira left for Mato Grosso where he spent the next four years in exploratory trips throughout the northeastern portion of unknown territories. In October 1792, he returned to Portugal but was not able to fully complete the study of the collections amassed during his stay in Brazil, part of which was in bad condition (Silva, 2002). His original manuscripts, as well as illustrations carefully prepared by two artists that accompanied him in his travels, remained unpublished for more than 170 years.

In 1808, Napoleonic armies invaded Portugal and entered Lisbon. Étienne Geoffroy Saint-Hilaire (1772–1844) was the bearer of an order from General Jean-Andoche Junot (1771–1813) demanding the transfer of all collections to the Muséum National d'Histoire Naturelle de Paris (Arelia and Miranda, 1991). Among Ferreira's zoological material were 76 specimens of mammals, including 12 primates (Primates), two bats (Chiroptera), 14 carnivores (Carnivora), two edentates (Cingulata), a sirenian (Sirenia) and several marsupials (Didelphimorphia) that were later described by Étienne and Isidore Geoffroy Saint-Hilaire (1805–1861) by René Primevère Lesson (1794–1849), and Anselme Gaëtan Desmarest (1784–1838).

With the discovery of precious metal and gems in the 17<sup>th</sup> century, Portugal had closed even further the Brazilian territory to trade, and its borders to all foreign travelers. Alexander von Humboldt (1769–1859), who was exploring Spanish colonies, had been denied a permit to visit the country by a Royal decree, which was sent from Lisbon to the Governor of Province of Pará in 1800.

An important exception was allowed by the end of the 18<sup>th</sup> century to Count Johann Centurius von Hoffmannsegg (1766–1849) of Berlin. He made two trips to Portugal to study botanical specimens, and succeeded in obtaining a special permit to send a collector to Brazil. The collector, Friedrich Wilhelm Sieber, arrived in Belém in 1801 and spent the following 12 years exploring the Amazon region from the

Atlantic coast to the Rio Negro (Stressmann, 1950). In 1806, he sent his first specimens to Berlin, and in the following year, Hoffmannsegg (1807) published an important work on the Primates.

Two other collectors supplied Hoffmannsegg with mammals: João da Silva Feijó (1760–1824), who had been in charge of the exploration of Cabo Verde Islands at the time when Rodrigues Ferreira left Portugal, and Francisco Agostinho Gomes (1769–1822), both former students at Coimbra (Ávila-Pires, 1967).

### **Vice-Kingdom and Imperial times**

In 1808, as French troops sent by Napoleon Bonaparte (1769–1821) invaded Lisbon, the Portuguese Court was transferred to Brazil. There, ports were declared open in that same year, and Brazil was elevated to the status of vice-reign with Portugal (and Algarves). Two schools of Medicine were created, one in the city of Rio de Janeiro, which was chosen to host the Court, and another in Salvador, the former capital of the colony. A Museum of Fine Arts, a National Library, a Printing House and a Museum of Natural History followed. Foreign naturalists roamed the country collecting specimens for European museums, most of which were recently created, and gathering new data for a revolution in biological thinking.

The collections amassed by Hoffmannsegg together with the specimens donated by the Gabinete de História Natural de Lisboa were incorporated in 1810 as the Museum für Naturkunde of Berlin University. Karl Wilhelm Illiger (1775–1813) was appointed its first director among 1810 and 1813. The works on mammals published by Illiger in 1811 and 1815 were based on that material.

Illiger died early and was succeeded by Martin von Lichtenstein, who directed the Museum from 1813 to 1857. He is the author of a study on the works of Marcgrave and Pies (Lichtenstein, 1818).

Ignaz Franz Werner von Olfers (1793–1871), who would later be the general director of the Royal Museums in Berlin (1839 to 1869), visited Brazil in 1817 as a Secretary of the Prussian Legation. In 1818, he published an important article on Brazilian mammals, which validated many names of species listed but not described by Illiger in 1815 (Hershkovitz, 1959).

These German explorations also profited from the presence in Brazil of Baron Wilhelm L. von Eschwege (1777–1855), who accompanied Dom João VI (1767–1826), king of Portugal, and his court to Brazil. While in Rio de Janeiro, he published a book entitled *Journal von Brasilien* (Eschwege, 1818), where Olfers's contribution appeared. Only recently was this important manuscript translated into Portuguese, including Olfers's chapter dedicated to the mammals. Eschwege's mission was the mapping of geologic formations, and the scientific exploration of mineral resources. The old village town of São João do Ypanema, today known as Iperó, in São Paulo state, was built in the vicinity of a very large iron deposit and became a Mecca for mammalogists and travelling naturalists.

The German Friedrich Sellow (1789–1831), who arrived in Brazil in 1814, was commissioned by the Russian consul, Grigory Langsdorff (1774–1852), as a plant collector. In the following two years he accompanied Prince Maximilian zu Wied-Neuwied (1782–1867) travelling along the coastal route that led from Rio de Janeiro to Salvador, Bahia. In 1816 he wrote to Lichtenstein offering his services and in the next year he met Olfers who was then a diplomat in Rio de Janeiro. In 1818 and 1819, Olfers and Sellow travelled together. For the rest of his life, Sellow worked in Brazil and was supported by a contract from the King of Portugal. Some of his specimens were deposited in the Museu Nacional, in Rio de Janeiro. In 1821, he travelled to Uruguay and southern Brazil with Peter Claussen (1804–1855), who was to play, years later, an unexpected role in the history of mammalian paleontology by directing Peter Wilhelm Lund to the fossiliferous limestone caves of Minas Gerais (Ávila-Pires, 1975).

Another German, Georg Wilhelm Freyreiss (1789–1825), arrived in Brazil in 1813 from Saint Petersburg with a recommendation to Lorenz Westin, consul of Sweden and Norway in Rio de Janeiro. Freyreiss worked with Olfers and collected for Langsdorff. He also travelled with Eschwege and Maximilian zu Wied-Neuwied. Some of his specimens were sent to the Russian Academy of Sciences where, together with the material assembled by Langsdorff's expedition, formed the basis of the Zoological Museum (now Institute) founded in 1832 (Abramov and Baranova, 2008).

In 1815, Prince Maximilian zu Wied-Neuwied arrived in Rio de Janeiro. His studies were one of the foremost contributions to Brazilian mammalogy. Precise data on the collecting localities

together with precise information on the geographical ranges of the species described make his accounts valuable to taxonomists and zoogeographers.

Mammals were collected along a transect across the coastal forest of eastern Brazil, with two incursions in Minas Gerais and Bahia (Bockermann, 1957). The specimens were taken to Wied-Neuwied's museum, and duplicates were sent to Munich, Berlin, Leiden and Wien. His personal collection was acquired in 1865 by the trustees of the American Museum of Natural History, which was inaugurated that year in New York (Ávila-Pires, 1965).

The botanist Augustin François César Prouvençal de Saint-Hilaire (1779–1853) spent six years in Brazil (among 1816 to 1822), and his very first trip was made in the company of Langsdorff. He sent to the Muséum National d'Histoire Naturelle de Paris several new species of mammals, which were described by Frédéric Cuvier (1773–1838) and Isidore Geoffroy Saint-Hilaire (1805–1861). Among these was the rock cavy of the dry scrub (caatingas), described by Wied-Neuwied, and for which Cuvier erected the genus *Kerodon*.

In 1817, Brazilian Emperor Dom Pedro I (1798–1834) married Princess Maria Leopoldina of Austria (1797–1826). She arrived in Rio de Janeiro with an illustrious entourage of painters and scientists. Two naturalists made lasting contributions to Brazilian mammalogy: Johann B. von Spix (1781–1826) from Bavaria and Johann Natterer (1787–1843) from Wien. Spix travelled with the botanist Carl Friedrich Philipp von Martius (1794–1868) from 1817 to 1820 and collected 85 species of mammals. Their travel account and Spix zoological contributions were published about the same time as Wied-Neuwied's. With Eschwege they visited the mining districts in Minas Gerais, and then north to the Amazons. Spix died young having published on the Chiroptera and Primates collected in Brazil. The bulk of their specimens remained in Munich with some "duplicates" being deposited in Leiden where they are still well preserved. Natterer arrived in 1817 and remained 18 years in Brazil, having raised a family there. His vast zoological collections included 1,146 specimens of mammals. Saint-Hilaire met Natterer at Ypanema and described his indefatigable work as taxidermist and observer. His itinerary included a year of residence in Ypanema, nine months in Mato Grosso, and six years in the Amazon region. Back in Wien, Natterer began to prepare a monograph on the Brazilian mammals with Johann Andreas Wagner (1797–1861) of Munich. His manuscript was lost in a fire that destroyed the library of Wien Museum in 1848. His brother, Joseph (1776–1852), also a curator of the Museum, compiled a file on his collections. The mammals obtained by Natterer were studied by Pelzeln (1883). The specimens that were sent to Leiden were listed in Schlegel (1876) and Jentink (1888, 1892) catalogues.

Peter Wilhelm Lund (1801–1880) left his native Denmark to Brazil in 1825, for reasons of health. After three years as a botanist in Brazil, he returned to Europe. Having visited several museums making notes on Brazilian material, he returned to Rio de Janeiro in 1835. With Ludwig Riedel (1790–1861), a former companion of Langsdorff, he resumed his travels. In the interior of Minas Gerais he met Peter Claussen by accident, who took him to see the fossil deposits in the limestone caves. That would be one of the starting points for the study of fossil mammals in the New World. Large collections of fossil and recent mammals were amassed and studied by Lund in the region around Lagoa Santa, and sent to the Lund Museum in Copenhagen under the care of Johannes Theodor Reinhardt (1816–1882), who spent some time in the field with Lund. His several monographs published on the material from Lagoa Santa, were translated into Portuguese and assembled in a volume by Paula Couto (1950). Lund collection of Pleistocene and recent mammals is one of the most important for mammalogists concerned with the taxonomy of Brazilian species.

Herluf Winge (1857–1923) was the first and to date the most proficuous revisor of Lund's works and collections, having published a treatise on Lund's material (Winge, 1887, 1893, 1895, 1895–1896a, 1895–1896b, 1906–1915, 1915).

The expeditions inaugurated by Alfred Russel Wallace (1823–1919) and Henry Walter Bates (1825–1892) were more subject than object directed. Their aim was to produce material evidence to support ideas and theories, rather than collect rare or exotic specimens along adventurous routes. In 1848 they arrived in Belém. Bates remained 11 years in the Amazon region, and the few mammals



collected by him were sent to the British Museum, and described by John E. Gray (1800–1875). Wallace spent four years collecting along the Amazon and Negro Rivers. His specimens were carefully labeled indicating exact localities, and he established the role of those large rivers as zoogeographical barriers, “During my residence in the Amazon district I took every opportunity of determining the limits of species, and I soon found that the Amazon, the Rio Negro and the Madeira formed the limits beyond which certain species never passed” (Ávila-Pires, 1974).

A fire destroyed the ship that was to bring Wallace, his collections and notes, back to England. Few specimens, mostly from the lower Amazon River, which were sent earlier to London, survived. With the help of a box of drawings, a diary, maps and letters, Wallace produced one of the most interesting travel accounts ever written on the Amazon region.

From 1850 to 1852, Karl Hermann Konrad Burmeister (1807–1892) explored the eastern and central areas of Brazil. Six months were spent at Lagoa Santa with Lund and Reinhardt. Good descriptions and fine illustrations are characteristics of his works. Burmeister returned to Europe and later was invited to direct the National Museum of Argentina, where he worked for 30 years, and greatly contributed to our knowledge of mammalian paleontology. He published on Brazilian mammals (Burmeister, 1853, 1854) and brought from Argentina the skeleton of the giant sloth still on display at the entrance of Museu Nacional, in Rio de Janeiro (Lacerda, 1905; Mello-Leitão, 1941).

From 1863 to 1865, Reinhold Hensel (1826–1881) worked in southern Brazil and some years later he published an important account of the mammals of Rio Grande do Sul (Hensel, 1872). Accounts of the expeditions and mammals described from Rio Grande do Sul were published by Ávila-Pires (1987, 1994). Hensel made an important contribution to Mammalogy with his proposed analysis of individual variation in craniometry (Ávila-Pires, 2011).

Alexander Agassiz left his native Switzerland to study in Munich, where he was given the task of describing an important collection of fossil fishes made by Johann B. von Spix in Brazil (Ávila-Pires, 1965; Agassiz, 1868). In 1865, as director of the Museum of Comparative Zoology, Harvard University (USA), Agassiz accepted the invitation extended to him by Nathaniel Thayer Jr. (1808–1883) to organize an expedition to Brazil to study the geographical distribution of fresh water fishes. In charge of the mammals and birds was Joel Asaph Allen (1838–1921), who would occupy later the post of Curator of Mammals and Birds at the American Museum of Natural History in New York (Allen, 1916a). Allen wrote one of the descriptive chapters in the book on Brazilian geology written by Charles Frederick Hartt (1840–1878), and published a list of 60 specimens and 29 species of mammals that resulted from his efforts (Hartt, 1870).

Herbert H. Smith (1851–1919) was a student at Cornell University (USA) when Hartt, a former member of Agassiz’ Expedition, took a group of students to visit the tropics in 1870 (Morgan Expedition). Smith returned four times to Brazil and in addition to two travel accounts he left a collection of 450 mammals, which are now at the Academy of Natural Sciences in Philadelphia and at the American Museum of Natural History.

Despite the notable advances in the knowledge of Brazilian natural history that followed the opening of the country to scientific exploration since the arrival of the court in 1808, a retrospective view of the monarchic period shows that this progress was not reflected in the qualification of native mammalogists. Almost all contributions regarding Brazilian mammals had been made by foreign scientists. In accordance, most specimens obtained in expeditions throughout the country were dispatched to foreign museums, although there are records of partial collections or duplicates deposited at Brazilian institutions, but which were never studied and were eventually lost (Netto, 1870). It was not unusual that mammal collections at this time were generally restricted to mounted skeletons and skins for exhibition purposes (Allen, 1916). Descriptions did not include designation of types, and faded specimens were sometimes discarded and substituted by newer individuals.

The oldest Brazilian journal publishing in Zoology is the *Archivos do Museu Nacional*, edited for the first time in 1876. In its first issue there is a list of mammal species then represented in the Mammal Collection of the Museu Nacional, almost exclusively a list of exhibition specimens, a significant part of which of exotic origin.

**Earlier Republican times (1889–1929): First diversification of Brazilian natural history museums**

In 1889, Brazil became a republican federation and, in the years that followed, imperial institutions were remodeled. The Museu Nacional collections were transferred to the former imperial palace (Lacerda, 1905).

In 1884 Swiss born naturalist Emilio Augusto Goeldi (1859–1917) arrived in Rio de Janeiro (Kury, 2009) and in the following year he joined the Museu Nacional where he remained until 1890. In 1893, he published a popular book on the Mammals of Brazil in Portuguese (Goeldi, 1893). In 1894, he was commissioned Director of the Museu Paraense in Belém, Pará. Among the important accomplishments of his successful administration, Goeldi published a catalogue of the mammals of the Museu Paraense collection (Goeldi and Hagmann, 1904), and a study on the development of antlers in Brazilian cervids (Cervidae) (Goeldi, 1902), among others. From 1901 on, Goeldi organized systematic shipments of duplicates to the Swiss natural history museum in Bern and in 1907 he returned to Europe (Estevão, 1938; Crispino *et al.*, 2006). Marie Emile Sneath (1868–1929), a leading ornithologist who also directed the Goeldi Museum (Sanjad, 2009), was responsible for extensive collections of mammals (Junghans, 2009).

In 1893, Hermann von Ihering (1850–1930), a German naturalist living in Rio Grande do Sul since 1890, was commissioned as director of the Museu Paulista, which had been established shortly before in São Paulo. He kept the position for 25 years, after which he left Brazil. Ihering published several papers on Brazilian mammals, which appeared in the *Revista do Museu Paulista*. Hermann Luderwaldt and Ernst Garbe were responsible for the collections and published a few papers on mammals.

Since the end of 19<sup>th</sup> century, the Republican government sponsored a project to build a telegraph line linking Rio de Janeiro to the hinterland states of Mato Grosso and Amazonas. It was later named “Comissão Rondon” for Cândido Mariano da Silva Rondon (1865–1958), the leader of the project, Alípio de Miranda Ribeiro (1874–1939), a zoologist of the Museu Nacional, was appointed for this Commission, which then became the first serious and systematic effort to build vertebrate collections in a Brazilian institution. Miranda Ribeiro not only provided reports of this important survey (Miranda Ribeiro, 1914, 1916), but throughout his prolific career also authored important revisions that varied from cervids (Cervidae) to cetaceans (Cetacea) and marsupials (Didelphimorphia) (Miranda Ribeiro, 1919, 1931, 1936a, b). He also renovated the exhibition halls and the study collections in the Museu Nacional. A bibliography and reprint of some of his works appeared in a posthumous fest volume of the *Arquivos do Museu Nacional* (Travassos, 1951).

During earlier Republican times several foreign expeditions continued to explore the country. In 1913, former President of the United States, Theodore Roosevelt (1858–1919) decided to combine a political trip to South America with some adventure hunting. The American Museum of Natural History obliged him by sending along two seasoned explorers, George K. Cherrie (1865–1948) and Leo E. Miller (1887–1952).

By 1910, Frank M. Chapman (1864–1945), Curator of Birds of the American Museum of Natural History had begun a systematic survey of the high plateaus of South America in order to demonstrate his theory of “life zones”. During the following twenty years he sponsored the work of several collectors (Miller, Holt, Kaemper, and Cherrie), and of large field parties (Roosevelt, Chapman, and Tate). Leo Miller spent almost six continuous years in South America (Miller, 1918). Thus, Roosevelt’s desire to explore unmapped regions helped Chapman’s research program.

In Brazil, the Rondon cycle of exploring expeditions was in full progress. It was decided that Roosevelt’s party was to descend and map a river discovered in Mato Grosso in 1909 by Rondon and Miranda Ribeiro, then called “River of Doubt” and later renamed “Rio Roosevelt”. The mammals collected during the expedition (Roosevelt, 1914; Allen 1914, 1916b, c) were deposited in the American Museum of Natural History. A list of the material that remained in Brazil was provided by Miranda Ribeiro (1918).

The last quarter of the 19<sup>th</sup> century and the first quarter of 20<sup>th</sup> century witnessed the outstanding career of the British mammalogist Oldfield Thomas (1858–1929). Along his prolific career, he proposed around 2,900 new names for genera, species and subspecies (Hill, 1990), many of which were for South American (and Brazilian) mammals. To amass one of the largest mammal collections in the World, Thomas hired collectors on most continents. One of these who worked

in several parts of Brazil was Alphonse Robert from France. Many other naturalists, among them Hermann von Ihering, Marie Emilie Snethlage and Emílio Augusto Goeldi sent specimens to the British Museum to be identified and described by Oldfield Thomas.

From 1913 to 1914, the Field Museum of Natural History had a collector in the Amazon, Robert H. Becker, and an expedition was mounted (Day, 1915) with Becker and George K. Cherrie in charge of mammals and birds. A total of 325 specimens from Peru, Bolivia and Brazil were collected and described by Wilfred H. Osgood (1916).

George H. H. Tate (1894–1953) led several expeditions to South America as part of the Chapman project. In 1927 and 1929 he explored the northern portion of Amazonia with the help of Rondon (Viveiros, 1958). His first expedition to Belém and Roraima resulted in a collection of 550 mammals. The second explored the upper reaches of the Rio Negro and Venezuela, obtaining 500 specimens (Tate, 1939).

### **1930–1969: The first Brazilian universities**

The two schools of medicine in Rio de Janeiro and Salvador, founded by Dom João VI as early as 1808 were the first institutions of graduate studies in Brazil. Natural sciences were introduced in the curricula of the Escola Politécnica, which was created in Rio de Janeiro in 1874.

It was nevertheless not earlier than the second decade of 20<sup>th</sup> century that the first University was created in Brazil. The “Universidade do Brasil” originated in Rio de Janeiro from the fusion of Escola Politécnica, the School of Medicine and the Faculty of Law in 1920. By 1946, the Museu Nacional was also incorporated in the Universidade do Brasil, currently Universidade Federal do Rio de Janeiro (UFRJ).

The University of São Paulo dates from 1934. In 1939, the zoological collections of the Museu Paulista were transferred to a new building, and incorporated as the “Departamento de Zoologia da Secretaria de Agricultura do Estado de São Paulo” (Pinto, 1945).

Embryology of Brazilian marsupials was the object of investigation by a German zoologist, Ernst Bresslau (1877–1935), who had visited the country in 1905, 1913 and returned in 1934 as professor of the University of São Paulo, dying there in 1935. His assistant, Paulo Schirch remained in Rio de Janeiro, and published on mammals (Schirch, 1932); Hermann Pole was part of this group.

Olivério Pinto (1896–1981), ornithologist then in charge of the Museu Paulista, contributed a few papers on mammals (e.g., Pinto, 1931), and Carlos Octaviano da Cunha Vieira (1912–1985), who joined that institution in 1939 as curator of mammals until his death in 1955. Among his contributions to the *Arquivos de Zoologia and Papéis Avulsos* is a monograph on Brazilian bats (Vieira, 1942), and a catalogue of Brazilian mammals (Vieira, 1955).

In 1922 in Ecuador, Chapman hired Carlos Olalla and his sons, and turned them into skillful collectors. Until 1931, “Olalla and sons” and later “Olalla brothers” worked methodically down the Amazon River to Belém, Pará. Large series of mammals were sent to New York, but little was published. In their correspondence with Chapman and Tate, the Olalla brothers described the collecting localities. Their maps, drawings, and comments are an invaluable source of information for mammalogists who wish to reconstitute the physiognomy of the regions visited by those collectors. In 1940, Alfonso M. Olalla joined the Museu de Zoologia de São Paulo and the collections were greatly enlarged with the acquisition of Olalla’s Amazonian material. In 1944, Eladio da Cruz Lima (1900–1945), a lawyer, published the first and only volume of his monumental projected study on the “Mammals of Amazonia” (Lima, 1944), a contribution from the Museu Paraense Emílio Goeldi (MPEG).

Around 2,000 mammal specimens from Bolivia and Brazil (Amazonas and Para states) were also sent by Alfonso Olalla to Count Nils Gyldenstolpe in Sweden, between 1935 and 1937. A complete list of these specimens was published by Patterson (1992).

In the state of Paraná in 1943, André Mayer was hired as taxidermist of the former Museu Paranaense, the institution founded in 1876 that was the seed of the Museu de História Natural Capão da Imbuia (MHNCI). Mayer organized the first study collection of mammals, and was responsible for most of the mammals represented in that collection (Lorini and Persson, 1990).

In the Museu Nacional, Alípio de Miranda Ribeiro (1874–1939) was succeeded in 1939 by João Moojen de Oliveira (1904–1985). In the Museu Nacional he published important seminal works on the mammals from Northeastern Brazil, a guide to the capture and preparation of small mammals (Moojen, 1943) and a monograph on the rodents of Brazil (Moojen, 1952). He completed his PhD thesis at the University of Kansas (Moojen, 1948) under the guidance of Eugene Raymond Hall (1902–1986). Moojen was responsible for the increase of the mammal collections, its appropriate storage, and the introduction of modern methods of study. Most of the material assembled by Moojen in the Museu Nacional was obtained in projects related to the study of mammals involved in enzootic cycles, particularly yellow fever (the Serviço de Estudos e Pesquisas sobre a Febre Amarela) and bubonic plague (the Serviço Nacional de Peste) (Oliveira and Franco, 2005). The first, sponsored by the Rockefeller Foundation, included extensive fieldwork in several regions of Brazil by experienced collectors, such as Ralph M. Gilmore and Gentil Dutra, and inaugurated ecological field studies with mammals in the country (Gilmore, 1943; Davis, 1945).

Important series derived from the Yellow Fever collections were partially sent to North American institutions, such as the American Museum of Natural History and the Smithsonian Institution. The Instituto Oswaldo Cruz contributed a great deal through parasitological studies, and joint expeditions with the Museu Nacional.

With the help of the Rockefeller Foundation, which was interested in yellow fever, and the Brazilian Plague Service, the mammal collection in the Museu Nacional expanded to estimated 80,000 skins and skulls by the mid-1950s. Moojen also took part in the construction of the new capital of Brazil in the late 1950s and early 1960s (Ávila-Pires, 2005). He was responsible for the implementation of a zoo and botanical park, and the initial nucleus of the mammal collection at the University of Brasília.

Also in the Museu Nacional, the paleomammalogist Carlos de Paula Couto (1910–1982) was responsible for the Brazilian addition to the works of Lund with a treatise on mammalian paleontology (Paula Couto, 1953, 1979) and many other monographic studies revealing the odd Tertiary mammalian fauna of the Itaboraian karst.

In Belém, Instituto Evandro Chagas personnel did work on mammals as reservoirs of arbovirus. In 1955, the Museu Goeldi hired a professional mammalogist, Cory Teixeira de Carvalho, a former student of Moojen, and the collections were notably enlarged. Carvalho left the Museu Goeldi in 1959 for the Museu de Zoologia da Universidade de São Paulo where he worked until 1969. Cory T. de Carvalho succeeded Vieira and worked there until 1969 when he joined the Forestry Service. He published several monographs on the mammals from the Amazon region (Carvalho, 1957, 1958, 1961, 1962, 1965).

From 1967 to 1969 the Royal Geographical Society, Royal Society and National Research Council in Brazil (CNPq) sponsored an ecological study of an area in eastern Mato Grosso, the Xavantina-Cachimbo Expedition. The mammals were studied by Ian R. Bishop and Ruth Jackson, and collections were deposited in the British Museum, London (Bishop, 1974).

Under the auspices of the World Health Organization, a research team headed by Marcel Baltazard (1908–1971) from the Institute Pasteur of Iran (Teheran) and Francis Petter (1923–2012) from the Muséum National d'Histoire Naturelle de Paris developed a research project on bubonic plague in the region of Exu, Pernambuco between 1967 and 1971. The mammal collections were sent to the Paris Museum with the relevant information on the life histories of rodents published by Karimi *et al.* (1976). The history of this project was the subject of a dissertation by Tavares (2007).

In 1969, the Departamento de Zoologia was transferred to the University of São Paulo under the name Museu de Zoologia da Universidade de São Paulo (MZUSP).

### **1970–2000: First graduate courses in zoology**

The main research funding agency in Brazil, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), was created in 1951. In 1962 the government of São Paulo created the largest state funding agency, Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP). In 1969–1970 the Brazilian Post-graduate program (Coordenação de Aperfeiçoamento de Pessoal de

Nível Superior, CAPES) was established following a model partially inspired by the graduate programs of the United States and also from France and Germany.

Earlier in that decade, the first graduate courses in biology, mainly focused on genetics, were created at the Universidade de São Paulo (USP) by Oswaldo Frota-Pessoa (1917–2010), and at the Universidade Federal do Rio Grande do Sul (UFRGS) by Francisco Salzano (n. 1928). Some students initially focused on cytogenetics eventually developed important groups of research in mammal cytotaxonomy and molecular systematics. Examples are Yatiyo Yonenaga-Yassuda (USP), Margarete Mattevi (UFRGS), Horacio Schneider (UFPA) and Hector Seuanez (UFRJ).

The first graduate programs in zoology were created in the University of São Paulo (1970) and in the Museu Nacional, UFRJ (1972). Other graduate programs in related areas (e.g., ecology), which contributed with relevant studies in mammals, followed: Universidade Estadual de Campinas (UNICAMP, in 1976) and Universidade de Brasília (UnB, in 1976). A recent account of the history of mammalogical studies developed as theses and dissertations between 1985 and 2010 in the UNICAMP (Setz, 2011) allows an estimation of the impact of graduate courses in the development of mammalogy-oriented researchers in the country. During this period no less than 70 theses or dissertations, mainly on feeding ecology and community structure, but also on other aspects of the biology of primates, bats and small mammals, have been developed, 64 of which were in the Graduate Program in Ecology, accounting for 13 % of the total number of dissertations and theses concluded in that program.

Regional collections started to be formed at universities as a result of the research conducted by graduate programs, but also from the research effort of isolated researchers: Universidade Federal Rural do Rio de Janeiro (UFRRJ), in the charge of Adriano L. Peracchi; Universidade Estadual Paulista, São José do Rio Preto, under the care of Luiz D. Vizotto and Valdir A. Taddei; Universidade Federal de Santa Catarina (UFSC), with Alfredo Ximenez; and Universidade Federal da Paraíba (UFPB), with Alfredo Langguth.

The assembling of the current mammal collections at Instituto Nacional de Pesquisas da Amazônia (INPA) dates from 1976. During the 1980s, Robin C. Best, researcher in the Laboratório de Mamíferos Aquáticos, developed the vertebrate collections as a result of surveys in areas inundated by hydroelectric dams, particularly those from UHE Balbina in Rio Uatumã, state of Amazonas, and Cachoeira Porteira in Rio Trombetas, Pará.

Mammalogy in the country's museums was full of ups and downs, with periods of great scientific activity, and epochs of virtual abandon. During the 1970's and 1980's it was certainly the case for the three largest institutions. Since 1959, and for the next two decades, no mammalogist was in charge of mammals at Museu Paraense Emílio Goeldi. The curation of mammals was internally accounted for by Fernando da Costa Novaes (1927–2004), an ornithologist who had been a student of João Moojen in the Museu Nacional. A similar situation occurred in the Museu de Zoologia da Universidade de São Paulo for 25 years starting in 1969 when no mammalogist was in charge of the collection. The curation of mammals was taken in the period by the Museum director, Paulo Vanzolini (1924–2013).

During most of the 1960's and in the first years that followed Moojen's retirement (1969), Fernando Dias de Ávila-Pires took the curatorship of the mammals collection of the Museu Nacional. By 1976, Ávila-Pires left the Museu Nacional to take part in the graduate programs in ecology at the University of Campinas (1976) and later in the Universidade Federal do Rio Grande do Sul (1978). Moojen would return to the Museu Nacional as a visitor professor from 1979 to 1985, the year of his death. There was not much research undertaken and dissertations were usually not converted in publications. Infrastructure problems related to the old building in which the collections were stored aggravated their condition, and due to the stagnant situation and lack of qualified personnel the collection was closed several times. In spite of these restrictions, an important addition to the mammal collection of the Museu Nacional, namely the transfer of the part of the collection obtained during the yellow fever project that was still kept in the Rockefeller facility at the Instituto Oswaldo Cruz, in Rio de Janeiro, took place in the early 1970s. This constitutes one of the finest collections of neotropical mammals, particularly of primates, obtained in several regions of the country along the decades of 1930–1960.



After his retirement from the Museu Nacional, Carlos de Paula Couto, a mammal paleontologist, contributed to the establishment of a successful graduate program in geosciences at the Universidade Federal do Rio Grande do Sul, which he directed until his death in 1982. Three of his students, Jorge Ferigollo, Castor Cartelle and Alceu Ranzi, later formed important groups of paleontological research on mammals respectively at the Fundação Zoobotânica do Rio Grande do Sul and Universidade Federal do Rio Grande do Sul, Pontifícia Universidade Católica de Minas Gerais, and Universidade Federal do Acre.

Despite the increase in the number of graduate courses, the development of new mammalogists during the late 1970s and early 1980s was still slow. This generated a period of great stagnation in terms of the research in institutions, particularly the three major museums, resulting in the progressive emptying of these institutions. After a false boom in the early 1970s, Brazil's economy in the late 1970s and the early 1980s was sinking into a deep recession. Vacancies opened by retirement were not filled, and the consequence was the progressive abandonment of collections during these years.

Despite these restrictions, some research centers managed to be established, such as the Centro de Primatologia do Rio de Janeiro by Ademar Coimbra Filho, and the Centro Nacional de Primatas by the Ministry of Health, both in 1979.

An important project focusing on the ecology of small mammals of the Caatinga of northeastern Brazil was developed under the auspices of the Brazilian Academy of Sciences between 1977 and 1979 by Michael Mares and his graduate students, M. Willig, K. Streilen, and T. Lacher, from the Carnegie Museum of Natural History (Mares *et al.*, 1981). The collections assembled in Exu, Pernambuco, were partially deposited in that museum and in the Museu de Zoologia da Universidade de São Paulo.

In the Universidade de Brasília, Cleber Alho (PhD in Ecology, University of North Carolina, 1977) started a research program in the ecology of Cerrado mammals, which he developed together with his students and associates, among was Gustavo Fonseca, from the Universidade Federal de Minas Gerais (UFMG), where an important regional collection of mammals also started to be formed. This nucleus of mammalogists settled in Minas Gerais state included several primatology-oriented mammalogists, such as Celio Valle and Ney Carnevali.

It is relevant to note that, with few exceptions, the bulk of mammal-oriented graduate projects developed in Brazil until the 1990s referred to ecological or genetic studies. This tendency was the outcome of a progressive worldwide shift from the traditional taxonomic perspective that had prevailed in mammalogical studies until the 1960s, which influenced the creation of most graduate courses encompassing mammalogical studies in Brazil during these decades. The progressive departure from a museum-based approach was also the consequence of the lack of representative collections in most of the universities in which graduate programs started to be formed, and of the already mentioned concomitant emptying of the major collections. Few taxonomic and systematic studies were developed between the 1960s and 1990s in Brazil as a result of theses and dissertations, and the consequence was that there was soon a lack of taxonomists and museum-oriented professionals in mammalogy in those years in the country.

In 1982, Rui Cerqueira (PhD Zoology, University of London), was hired by the Department of Ecology of the Universidade Federal do Rio de Janeiro, and started a research program on the ecology and systematics of mammals. Cerqueira and his students have since then developed an important nucleus of vertebrate research in Rio de Janeiro, primarily focused on the ecology of small mammals of eastern Brazil, but also with a taxonomic and systematic museum-based approach. A summary of their first ecological studies, based on the extensive material deposited in the Museu Nacional by the Serviço Nacional de Peste, has been summarized by Cerqueira (2005). Together with morphometric studies developed on the basis of the same collection during the 1990s by Sergio Furtado dos Reis (PhD, Michigan State University) and his students, these studies document a retaken of the relevance of collections in mammalogical studies in Brazil.

Between 1989 and 1993, Alfredo Langguth, who had developed a research program in mammalogy and the nucleus of a regional collection associated to the Graduate Program in Ecology and Systematics of the Universidade Federal da Paraíba (created in 1980), was hired by Universidade Federal do Rio de Janeiro and assumed the curation of mammals in the Museu Nacional. This was also an important period in the reorganization and reestablishment of scientific research in the largest mammal collection in the country.

The last two decades of the 20<sup>th</sup> century still witnessed important expeditions of foreign museums to both the Atlantic forest and the Amazon region, but now including young Brazilian mammalogists. A series of expeditions led by Philip Hershkovitz (1909–1997), from the Field Museum of Natural History (Chicago, USA), took place in 1984 and in 1987 at Brasília and Rio de Janeiro. These first expeditions were carried out with the participation of Jader Marinho Filho, then recently hired at the Universidade de Brasília, and graduate students of the Museu Nacional and University of Brasília. Part of the material collected was deposited in the collections of these institutions. Hershkovitz would return to Brazil for a last field trip in 1992 to the Caparaó National Park accompanied by Alfredo Langguth and his students at the Museu Nacional. The main results of this expedition were published by Bonvicino *et al.* (1997) and Hershkovitz (1998). Alfredo Langguth returned to Universidade Federal da Paraíba in 1993, where he continued his efforts to develop a nucleus of mammalogists and an important collection in northeastern Brazil.

Between August 1991 and June 1992 an expedition along the Rio Juruá, in the western Amazon of Brazil was undertaken by James L. Patton (Museum of Vertebrate Zoology, MVZ, University of California, USA), Jay R. Malcolm, Maria Nazareth F. da Silva, Claude Gascón and Carlos A Peres under the auspices of the Museu Goeldi and CNPq. The major aims of this expedition were to revisit Wallace's riverine barrier hypothesis, while integrating molecular and cytogenetic approaches to mammalian taxonomy (Patton *et al.*, 2000). The mammals (around 3,000 specimens, deposited in the Museo Paraense Emilio Goeldi, MPEG; Instituto Nacional de Pesquisas da Amazônia, INPA, and Museum of Vertebrate Zoology, University of California, at Berkeley, MVZ) were described by Patton *et al.* (2000).

A relevant aspect regarding the formation of mammalogy-oriented researchers in Brazil in the last two decades of the 20<sup>th</sup> century was a policy stimulating and supporting full-term PhDs abroad. Cerqueira (2008) provided a comprehensive analysis of the impact of graduate studies in Brazil in the exponential growth in number of PhDs in mammalogy from 1985. It is also during this decade that the yearly percent of mammalogy-oriented PhDs obtained in Brazil surpassed those obtained abroad. In addition to the graduate programs mentioned above, several Brazilian students had pursued their PhD degree in traditional North American and European institutions. Despite the fact that they represented a relatively small fraction of the mammalogy oriented PhDs concluded between 1965 and 2008 (Cerqueira, 2008), the impact of these graduates in the recent development of mammalogy in Brazil is relevant of mention. It was only during the 1990s that a growing number of graduate students started to develop taxonomic studies on mammals as theses and dissertations. The opportunity to work in the main world museums and universities has opened the possibility for comparative studies at a broader scale. Analyses encompassing a wider sampling of taxa, both in systematic and taxonomic studies, often were accompanied with a field counterpart in Brazil to fill in important sampling gaps.

As an example, a series of expeditions was undertaken in different parts of Brazil by James L. Patton (University of California, at Berkeley) and/or by his Brazilian students during the 1990s to obtain material for taxonomic reviews developed as theses or dissertations. These collections, partially deposited in the Museu Nacional (MN), Museu de Zoologia da Universidade de São Paulo (MZUSP), INPA, MPEG, Universidade Federal de Minas Gerais (UFMG), and in MVZ (Berkeley), are particularly relevant as resulting from a resampling of type localities of several obscure taxa with karyological and molecular data associated with the voucher specimens. Some of these students were later hired by Brazilian universities and created or developed important graduate nuclei in mammalogical studies in the country with a strong classical museum-oriented approach, but also combining more recent techniques such as the use of genetic and morphometric tools.

In the last decade of the 20<sup>th</sup> century the situation in the three main museums of the country started to change with regard to the structural conditions of buildings and the rejuvenation of personnel in charge of mammal collections. In the Museu Nacional, a new facility was built to accommodate vertebrate collections, and the collection of mammals was transferred to it in 1995. Still in this decade three new mammalogists holding PhDs were hired in charge of the Mammal collection. Those in charge of the Mammal collection in the Goeldi Museum also obtained their PhDs in this decade, and by the end of 1999, a graduated mammalogist was appointed curator of mammals of the Museu de Zoologia da USP after almost 30 years of vacancy. As most other zoologists hired in charge of collections, these curators were also faculty

members or researchers participating in graduate programs. This condition has prompted an expansion of the number of graduate students working in the major collections, which contributed to the development of independent nuclei of mammal research in several universities in the following years.

### **Brazilian Mammal Societies**

The primatologists created the first national society in a branch of mammalogy in 1978, congregating with zoologists, geneticists, anthropologists, sociologists, and ethologists. An account of the history of primatology in Brazil and the background of the formation of the “Sociedade Brasileira de Primatologia” was summarized by Coimbra-Filho (2004).

The “Sociedade Brasileira de Mastozoologia” (SBMz) was created in 1985 to “...congregate students and interested layman in Mammalogy; to increment the communication among these students; to stimulate the contact with national and international similar societies; to represent the Brazilian mammalogists in relation to the national and international scientific communities, and with respect to governmental and private entities; to care for the preservation of the Brazilian mammals and their habitats, to attend consults of public and private institutions, to disseminate the knowledge on mammals to the Brazilian community; to stimulate the creation of mammal courses at undergraduate and graduate levels, as well as the concession of scholarships and grants for the formation of mammalogists in the country, and to establish and care for ethic and scientific standards in what concerns Brazilian Mammalogy”.

For several years the society’s meetings occurred during the Brazilian congresses of Zoology, but from the year 2000 on, the society organizes its own biannual meetings. It publishes the newsletter *Boletim da Sociedade Brasileira de Mastozoologia* since 1985 (four issues per year). More recently the SBMz has organized symposia and courses and has supported the participation of graduate students in international and national meetings and symposia.

The “Sociedade Brasileira para o Estudo dos Quirópteros” (SBEQ) was created in 2006. It organizes official annual meetings (EBEQs) and bat symposia, these last usually during related congresses. This society supports the publication the scientific journal *Chiroptera Neotropical* as well as books on mammals and bats.

### **Brazilian Mammalogy in the third millennium**

The most notable feature regarding the development of Mammalogy (as well as other branches of Zoology) in Brazil in the first decade of the third millennium was the proliferation of graduate programs in several states of the federation, as a result of a governmental policy of expansion and diversification of Federal Universities’ campuses across the country. The second and third generations of Brazilian graduate students, as well as those returned from foreign universities, have started to fill these positions. By the end of the first decade of the 21<sup>st</sup> century, in addition to the three major mammal collections (MN, MZUSP, and MPEG), which accounted for an estimated 172,000 specimens (respectively estimated 100,000, 40,000 and 32,000 specimens) there were six collections varying in number of specimens between 6,000 and 12,000, seven collections varying from 1,000 and 6,000 and 12 collections with less than one thousand specimens in the country.

### **Current constraints to the development of Mammalogy in Brazil**

Notwithstanding the positive effects of an increasing number of research institutions, graduate courses, students, and collections across the country, several factors still present constraints to the development of Brazilian mammalogy, particularly in what concerns mammal inventories and taxonomic and systematic studies developed in the country:

1. “An increasing departure from the specimen-based approach in surveys and related studies as a consequence of the criminalization of collecting activities”. The crescent criminalization of collecting activities is a fact that limits deposition of specimens in collections and the development of specimen-based taxonomic studies. Such restrictions affect more notably the scientific collecting of mammals and birds, but are not restricted to these taxa. In Brazil, the legislation related to scientific collecting was recently improved with the implementation of “Medida Provisória 154”, published in 2006, which regulated and

speeded the concession of collecting permits and licenses, but these are often very limited in terms of the taxa and number of specimens allowed, resulting in a weak sampling of the variability in regional studies.

2. “Rapid pace of local extinctions of habitat types and their mammals, determining a deficient representation of mammalian diversity in national collections”. The notable expansion of Brazil’s economy in the last 50 years has been accompanied by the accentuated degradation of natural areas due to the expansion of the agroindustrial and energy matrices. Despite the existence of a legislation that demands environmental impact reports (RIMA), long term inventories of mammals in areas that will be completely modified, prior to the implementation of projects, are usually very restrict. Thus, comprehensive inventories previous to the impact are rare, determining that our knowledge on the mammalian diversity still increases at a much slower rate than its destruction. Such inventories could represent an important increase of specimens to fulfill the large sampling gaps that remain in the immense Brazilian territory, but these opportunities are usually lost, with few specimens being directed to collections.

“Weak documentation, low availability and inadequate maintenance of collections, resulting in loss of specimens and data”. Mammal collections demand space, adequate storage conditions, and technically qualified people for preparation and care of specimens and for the perpetuation of original information associated with them. Most regional collections were originally formed by the initiative of isolated researchers, with few people trained in taxidermy and curatorial techniques, lack of adequate facilities to organize and store specimens, and few traditions associated with good museum practices. Frequently, regional collections are lost due to the lack of adequate space or to changes in the policies of use of space in institutions. Likewise, even the largest collections lack adequate facilities with minimal conditions including insect-proof cases, anti-fire and anti-flood systems, electric installation and acclimatization systems adequate to maintain temperature and humidity at acceptable levels. Recent efforts by the federal government to define directions and strategies for the modernization of biological collections in Brazil have been notably biased, in terms of resources, towards the consolidation of integrated systems for digitalization of data at the expense of the implementation of minimal curatorial procedures and storage conditions in collections across the country.

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