DOI 10.1515/mammalia-2012-0121 — Mammalia 2013; 77(4): 409–424

Cláudia Regina da Silva*, Ana Carolina Moreira Martins, Isai Jorge de Castro, Enrico Bernard, Elizandra Matos Cardoso, Danielle dos Santos Lima, Renato Gregorin, Rogério Vieira Rossi, Alexandre Reis Percequillo and Keliane da Cruz Castro

Mammals of Amapá State, Eastern Brazilian Amazonia: a revised taxonomic list with comments on species distributions

Abstract: The Guiana Shield has large, preserved areas with high biological diversity. However, the knowledge of this biodiversity differs among the regions with the Brazilian portion poorly known compared to the French Guiana, Suriname, Guyana, and Venezuela. In the Amapá State, the information on mammals is very heterogeneous and represents a gap in the knowledge of the distribution and diversity of some groups. We compiled a list of the mammals of the Amapá based on the inventories, voucher specimens deposited in the collection Fauna of Amapá at Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, and previous published studies. We present a list of 181 mammal species. Chiroptera was the order with the highest number of species (88) followed by Rodentia (32). The list includes 17 new occurrences: 16 for Amapá (five marsupials, eight bats, one canid, one cetacea and one rodent) and one for Brazil (one rodent). This species list is the most complete taxonomic review for the Amapá, contributes to the knowledge of mammal diversity north of the Amazon River, and helps increase the precision of the species ranges in the Guianas and the eastern portion of the Amazon.

Keywords: diversity; Guiana Shield; inventory; new occurrences.

***Corresponding author: Cláudia Regina da Silva,** Laboratório de Mamíferos, Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá (IEPA), Rodovia JK, Km 10, s/n, bairro Fazendinha, CEP 68912-250, Macapá, Amapá, Brazil, e-mail: crsilva.ap@gmail.com; and Programa de Pós-Graduação em Genética, Conservação e Biologia Evolutiva, Instituto Nacional de Pesquisas da Amazônia (INPA), Avenida André Araújo, n. 2936, bairro Petrópolis, CEP 69.060-000, Manaus, Amazonas, Brazil

Ana Carolina Moreira Martins: Programa de Pós-Graduação em Ecologia, Universidade Federal de Brasília (UnB), Campus Universitário Darcy Ribeiro, CEP 70910-900, Brasília, Distrito Federal, Brazil

Isai Jorge de Castro, Elizandra Matos Cardoso, Danielle dos Santos Lima and Keliane da Cruz Castro: Laboratório de Mamíferos, Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá (IEPA), Rodovia JK, Km 10, s/n, bairro Fazendinha, CEP 68912-250, Macapá, Amapá, Brazil

Isai Jorge de Castro and Keliane da Cruz Castro: Programa de Pós-Graduação em Biodiversidade Tropical, Universidade Federal do Amapá (UNIFAP), Rodovia Juscelino Kubitschek, km-02, bairro Jardim Marco Zero, CEP 68.902-280, Macapá, Amapá, Brazil

Enrico Bernard: Departamento de Zoologia, Universidade Federal de Pernambuco (UFPE), Rua Nelson Chaves s/n, Cidade Universitária, CEP 50. 670-420, Recife, Pernambuco, Brazil

Elizandra Matos Cardoso: Universidade do Estado do Amapá (UEAP), Avenida Presidente Vargas, n. 650, bairro Centro, CEP 68.906-970, Macapá, Amapá, Brazil

Danielle dos Santos Lima: Grupo de Pesquisa em Mamíferos Aquáticos Amazônicos, Instituto de Desenvolvimento Sustentável Mamirauá (IDSM), Estrada do Bexiga, n. 2.584, bairro Fonte Boa, CEP 69.470-000, Tefé, Amazonas, Brazil

Renato Gregorin: Departamento de Biologia, Universidade Federal de Lavras (UFLA), Caixa Postal 3037, CEP 37.200-000, Lavras, Minas Gerais, Brazil

Rogério Vieira Rossi: Universidade Federal do Mato Grosso (UFMT), Av. Fernando Corrêa da Costa, 2.367, bairro Boa Esperança, CEP 78.060-900, Cuiabá, Mato Grosso, Brazil

Alexandre Reis Percequillo: Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ), Universidade de São Paulo (USP), Avenida Pádua Dias n. 11, Caixa Postal 9, CEP 13.418-900, Piracicaba, São Paulo, Brazil

Introduction

The tropical forests harbor almost 50% of the Earth's biodiversity in only 7% of the terrestrial surface area (Whitmore 1998). The Amazon is the largest and most diverse tropical forest in the world with over six million square kilometers across nine countries of South America (Silva et al. 2005). It has several regions with different levels of conservation and knowledge (Silva et al. 2005, Lim et al. 2005). The endemic regions of the Amazon Basin have been proposed based mainly on the distribution of taxa, such as the angiosperms (Prance 1982), vertebrates (Webb 1978), amphibians (Duellman 1982), birds (Haffer 1974, Cracraft 1985, Ribas et al. 2012), and non-volant mammals (Patton et al. 2000, Voss et al. 2001, Costa 2003, Patton and Costa 2003, Steiner and Catzeflis

2004). The main endemic regions are Imeri (northcentral Amazon), Inambari (southwestern Amazon), Napo (northwestern Amazon), Belém-Pará (southeastern Amazon), and Guiana (northeastern Amazon) (Haffer 1974, Cracraft 1985, Patton et al. 2000, Silva et al. 2005). The Guiana region comprises the northeastern part of the Amazon from the Orinoco, Casiquiare, and Negro rivers in the west to the Amazon River in the south (Hershkovitz 1969, Eisenberg 1989, Voss et al. 2001). This region comprises southeastern Venezuela, Guyana, Suriname, French Guiana, and northern Brazil, including the states of Amapá and Roraima, and the northern portion of Amazonas and Pará.

Several inventories have documented a high diversity of mammals and high degree of endemism in this region (Voss and Emmons 1996, Barnett and Cunha 1998, Robinson 1998, Simmons and Voss 1998, Voss et al. 2001, Sanderson and Ignácio 2002, Sampaio et al. 2003, Trolle 2003, Lim and Engstrom 2005). The recent inventories in Amapá have also documented a high diversity (Martins et al. 2006, Martins and Bernard 2008, Silva 2008, Martins et al. 2011). However, a comprehensive list of the mammal species and habitats is still lacking. In the past 7 years, efforts to improve the knowledge on the mammal diversity in Amapá, mainly for the rodents, marsupials, and bats, added new species to the list of Carvalho (1962), which comprised 62 species.

The recent inventories began in 2004 with the project 'Inventários Biológicos no Corredor de Biodiversidade do Amapá' and explored mainly *terra firme* forest reserves (Bernard 2008). The biological inventories were conducted primarily for the management plans of the reserves with flooded fields, mangroves, and floodplain forests (Table 1). The savannas, which have been only recently studied, have been sampled mainly in association with the private companies that requested the environmental assessments. Despite the large protected areas in the state, poaching, water buffalo farming in floodplain forests and flooded fields (Monteiro 2009), and the expansion of agriculture and urban areas in the savannas (Oliveira 2009) are the emerging issues that may affect the wild mammal populations. The mammal fauna is important to the ecological processes related to the forest dynamics, such as seed dispersal (Charles-Dominique et al. 1981, Booman et al. 2009, Grünewald et al. 2010), pollination (Wester et al. 2009), and seed predation (Lambert et al. 2005). In addition, the severe alterations to the mammal assemblages directly affect the livelihood of the human populations, as some mammals are game species (Parry et al. 2009), indicators of environmental quality (Zocche et al. 2010), and vectors of tropical diseases (Maia da Silva et al. 2008, Thoisy et al. 2009). In the present study, our objective was to present a species list of the mammals of Amapá, report the occurrence of the mammal species in the protected areas, and contribute to the knowledge of the mammals in the endemic region of the Guianas and eastern Amazon.

Materials and methods

Study area

The predominant vegetation of the Amapá is the *terra firme* forest, which covers over 70% of its territory. In the rest of the state (the eastern band), the predominant vegetation is composed of the savannas, flooded fields, and mangroves (IBGE 2004). The large preserved areas of the *terra firme* may still be found in the state, where the history of the environmental change and impact is recent and concentrated along Highway BR156 and on the coast, where water buffalos are raised (Monteiro 2009, Oliveira 2009). The state has 12 protected areas (except municipal and private reserves) and five indigenous reserves (Wajãpi, Uaçá, Galibi, Juminã, and Parque Indígena do Tumucumaque). The savannas may be found in Área de Proteção Ambiental do Rio Curiaú (APA Curiaú), Floresta Estadual do Amapá (FLOTA Amapá), and Reserva Extrativista do Rio Cajari (RESEX Cajari). The western portion of Amapá is covered by large areas of the *terra firme* forest, which are protected by six reserves: Parque Nacional Montanhas do Tumucumaque (PARNA Tumucumaque), Floresta Nacional do Amapá (FLONA Amapá), FLOTA Amapá, Reserva do Desenvolvimento Sustentável do Rio Iratapuru (RDS Iratapuru), RESEX Cajari, and Estação Ecológica do Jari (ESEC Jari). The coastal environments, mangroves, and flooded fields are also protected by seven reserves: Parque Nacional do Cabo Orange (PARNA Cabo Orange), Estação Ecológica Maracá-Jipioca (ESEC Maracá), Reserva Biológica do Parazinho (REBIO Parazinho), Reserva Biológica do Lago Piratuba (REBIO Piratuba), APA Curiaú, Área de Proteção Ambiental da Fazendinha (APA Fazendinha), and RESEX Cajari. Herein, we present information on the occurrence of the mammals in the seven reserves (Table 1): PARNA Tumucumaque, FLONA Amapá, REBIO Piratuba, REBIO Parazinho, APA Curiaú, RESEX Cajari, and RDS Iratapuru. These areas were sampled as part of the research projects and inventories for the management plans. The other sampling events resulted from the academic studies, environmental assessment reports, and joint efforts with the private sector.

Table 1 The study sites (with geographic coordinates), year sampled, vegetation type, collection method, and sampling effort used in the mammal inventories carried out in the state of Amapá, northern Brazil, from 2004 to 2010.

Study site	Locality	Latitude (decimal degrees)	Longitude (decimal degrees)	Year	Vegetation	Sampling effort			
						Sherman and cage traps (night traps)	Pitfalls (night buckets)	Visual census (h)	Mist nets (m^2 h)
1	Igarapé do Braço (FLONA Amapá)	1.308091	-51.587944	2004	*Terra firme* forest	1500	700	60	16,272
2	Amapari River (PARNA Tumucumaque)	1.595748	-52.492150	2004	*Terra firme* forest	1800	792	55.40	9792
3	Jari River (RDS Iratapuru)	0.288852	-53.0998	2004	*Terra firme* forest	1800	792	64	16,200
4	Mapaone River (PARNA Tumucumaque)	0.288852	-55.0998	2005	*Terra firme* forest	1650	700	62	12,720
5	Igarapé Santo Antônio (FLONA Amapá)	1.12781	-51.879581	2005	*Terra firme* forest	1640	720	62	17,010
6	Igarapé Baliza (RDS Iratapuru)	0.307789	-52.4515	2005	*Terra firme* forest	1640	720	60	19,089
7	Cupixi River (RDS Iratapuru)	0.582343	-52.332199	2005	*Terra firme* forest	1560	720	60	21,114
8	Anotaie River (PARNA Tumucumaque)	3.22032	-52.027901	2005	*Terra firme* forest	1500	700	60	21,096
9	Mutum River (PARNA Tumucumaque)	2.19333	-51.98902	2006	*Terra firme* forest	1500	700	60	19,920
10	Anacui River (PARNA Tumucumaque)	3.85395	-52.757702	2006	*Terra firme* forest	1500	700	62	19,800
11	Savanna; Ferreira Gomes	1.02524	-51.161598	2006	Savanna and riparian forest	1500	700	60	17,832
12	Araqueçaua River (REBIO Piratuba)	1.4871	-49.8833	2006	Mangrove	750	–	17	8112
13	Maresias Lake (REBIO Piratuba)	1.4982	- 49.5781	2006	Mangrove	600	–	34	8019
14	Macarry Farm, surroundings of REBIO Piratuba	1.4974	-49.1375	2006	Flooded fields	500	–	26	10,008
15	Highway BR 156; Maracá River	-0.1509	-51.7438	2006	Savanna	4000	1400	240	–
16	Highway BR 156; Laranjal do Jari	-0.710733	-52.39848	2006	*Terra firme* forest	4000	1400	240	–
17	Marinho Village (RESEX Cajari)	-0.5989	-52.2426	2007	*Terra firme* forest	4000	1400	240	–
18	Santo Antônio Waterfall; Jari River	-0.5905	-52.5313	2007, 2008 and 2009	*Terra firme* forest	4940	3212	162	52,056
19	Itapeuara; Jari River	-0.492243	-52.693001	2008 and 2009	*Terra firme* forest	4480	2112	144	19,920
20	Horto Matapi; Matapi River	0.4844	-51.2465	2008	Savanna, riparian forest and *Eucalyptus* plantation	4200	3880	228.3	36.624
21	Horto São Bento; Aporema River	1.3024	-50.7674	2008	Flooded fields and forest islands	2950	–	130.88	77.112
22	Caldeirão Waterfall; Araguari River	0.814676	-51.318501	2009	*Terra firme* forest	4000	1600	130	37.200
23	Ferreira Gomes; Araguari River	0.874676	-51.194901	2009	Savanna and riparian forest	3500	1600	100	37.056
24	Highway BR 156; Vila Nova	-0.155045	-51.548901	2010	Savanna and riparian forest	2880	1440	227	147.744
25	Highway BR 156 (RESEX Cajari)	-0.8833	-51.8500	2010	*Terra firme* forest	2880	1440	220	174.744
26	PPBio Plot (FLONA Amapá)	-1.06852	-43.1100	2010 and 2011	*Terra firme* forest	7500	4000	–	
27	APA Curiaú	0.11667	-51.0500	2007 and 2008	Savanna and floodplain forest				212,400
28	Araguari River/Tabaco Village (REBIO Piratuba)	1.32281	-50.288601	2007	Floodplain forest		–	–	14,520

(**Table 1** Continued)

Study site	Locality	Latitude (decimal degrees)	Longitude (decimal degrees)	Year	Vegetation	Sampling effort			
						Sherman and cage traps (night traps)	Pitfalls (night buckets)	Visual census (h)	Mist nets (m^2 h)
29	Milagre de Jesus and Bom Amigo Villages (REBIO Piratuba)	1.2267	-50.090801	2007	Floodplain forest		–	–	27,864
30	Terra Firme and Lago Novo Villages (REBIO Piratuba)	1.18133056	-50.56000833	2008	*Terra firme* forest flooded fields		–	–	14,520
31	Sucuriju River (REBIO Piratuba)	1.65828	-49.9674	2007 and 2008	Mangrove and floodplain forest		–	–	26,616
32	Lakes region (REBIO Piratuba)	1.43783	-50.575901	2009	Flooded fields and forest islands		–	–	15,163.2

Data collection

The species list was based on the data compiled from Carvalho (1962), Peracchi et al. (1984), Martins et al. (2006), Griffiths and Gardner (2008), Martins and Bernard (2008), Silva (2008), Castro (2009) and Martins et al. (2011). The unpublished inventories between 2004 and 2011 complemented this list (Table 1 and Figure 1). The voucher specimens were deposited in the collection Fauna of Amapá (CCFA), located at Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá (IEPA). This material comprised skin and skull, and fluid-preserved specimens. The voucher specimens deposited before 2004 were also included in the species list. The record of *Echimys chrysurus* Zimmermann 1780 was based on a specimen from Museu Paraense Emilio Goeldi (MPEG 15186), and the record of *Pseudoryzomys* sp. Hershkovitz 1962 relates to the two specimens housed at the Museu Nacional da Universidade Federal do Rio de Janeiro (MNRJ 60713 and 60714).

The nonvolant small mammals were collected with the conventional traps (Sherman and wire mesh cages), pitfalls, air guns, and by hand. The collections were authorized by the federal and state licenses (IBAMA 2/2004, 75/2004, 143/2004, 135/2005, 100/2005, 32/2005, 3/2005, 295/2006, 81/2007, 256/2009, 19140-1, SEMA 1/2008, 2/2009, 16/2009). The sampling effort was calculated by multiplying the number of traps by the working days (Table 1). To sample the medium and large mammals, we used visual census, indirect records (traces, vocalizations, and burrows), and, occasionally, shooting with guns. We used mist nets to collect the bats (most were 12-m long), placed in the understory (up to 3 m above the ground), along previously opened trails. The sampling effort was calculated as the area of each net multiplied by the time of exposure, number of nights, and number of nets following Straube and Bianconi (2002).

Taxonomic considerations

For the bats and marsupials, the nomenclature follows Gardner (2008). There were some exceptions: the genus *Platyrrhinus* Saussure 1860 was followed by the most recent revisions by Velazco (2005), Velazco and Gardner (2009), Velazco and Patterson (2008), and Velazco et al. (2010); the name *Marmosa* Gray 1821 for the marsupials was assigned to *Micoureus* Lesson 1842 (Voss and Jansa 2009); *Monodelphis touan* (Shaw 1800) instead of *Monodelphis brevicaudata* Erxleben 1777 (Pavan et al. 2012). For the other groups, we followed Wilson and Reeder (2005)

with the following exceptions: *Mazama nemorivaga* Cuvier 1817 as valid species and not as a subspecies of *Mazama gouazoubira* Fischer 1814 (Rossi et al. 2010); *Aotus infulatus* (Kuhl 1820) as valid and not as a subspecies of *Aotus azarae* Humboldt 1811 (Hershkovitz 1983); *Chiropotes sagulatus* (Traill 1821) as valid species from the previously treated as *Chiropotes chiropotes* (Humboldt 1811) (see Silva Jr. and Figueiredo 2002, Silva Jr. et al. 2008); we followed Voss (2011) for *Coendou melanurus* (Wagner 1842); and considered the taxonomic arrangements proposed by Weksler et al. (2006) for the rodents previously assigned to *Oryzomys* Baird 1857 by Lynch-Alfaro et al. (2012) to the primates allocated in *Cebus*. We did not consider the record of *Platyrrhinus lineatus* E. Geoffroy 1810 (Martins et al. 2006) because Velazco and Patterson (2008) revised the genus based on the phylogenetic data and confirmed the occurrence of this species only in the southwestern Brazilian Amazon. We did not consider the record of *Eptesicus fuscus* Beauvois, 1796 by Piccinini (1974) because it was later corrected and the specimen identified as *E. furinalis* D'Orbigny 1847 (Mok et al. 1982).

Results and discussion

Excluding the exotic species, we recorded a total of 181 mammal species in Amapá. When we compare our data to the list of Lim et al. (2005), excluding five marine species, the remaining 178 species represent 64% of the 275 species of the nonmarine mammals recorded for the Guiana region (excluding the Brazilian portion). The most diverse order in the Amapá was Chiroptera with 88 species or 48.6% of all the mammal species recorded in the state. Rodentia was the second order in terms of the number of species and representing 17.6% of the total. The other orders together corresponded to 33.9% of all the species (Table 2).

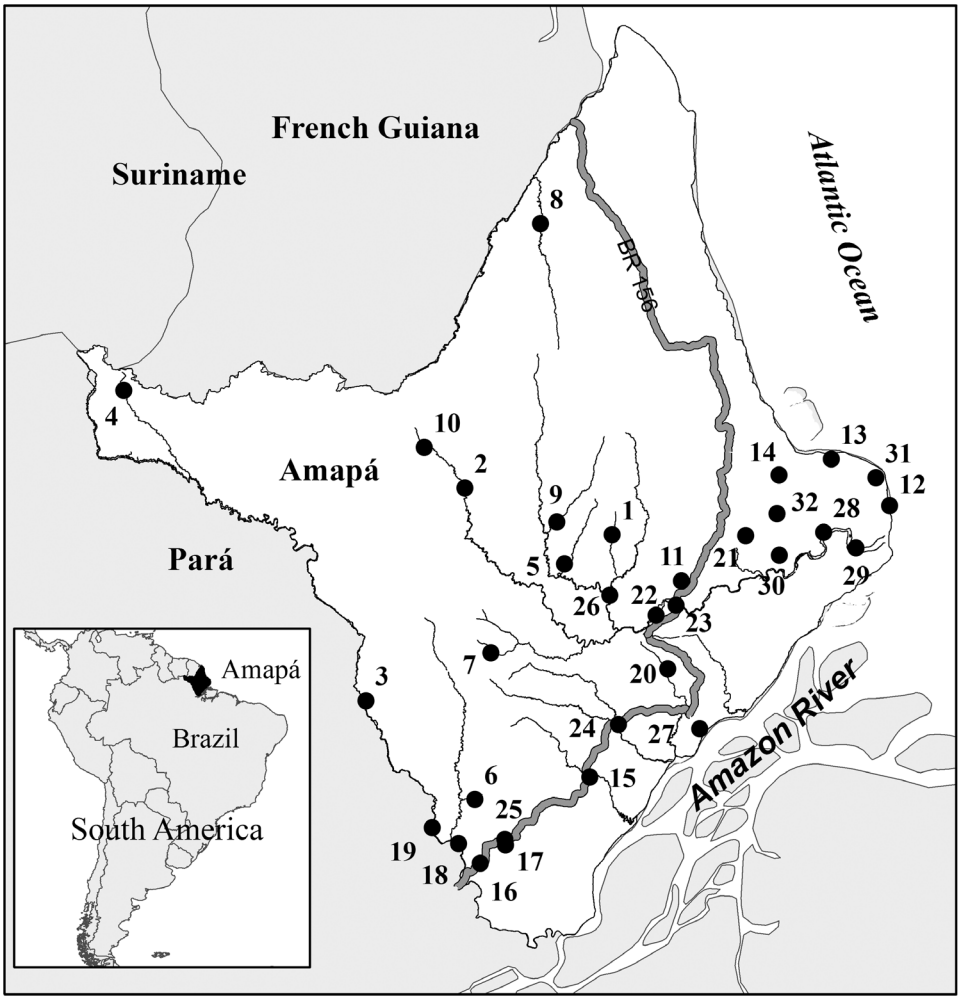

Figure 1 The location of the study sites in the state of Amapá, northern Brazil. The numbers of the sampling localities can be seen in Table 1.

Table 2 The mammal species recorded in the state of Amapá, eastern Brazilian Amazon, for each order.

Order	Number of species	Percentage[1] (%)
Didelphimorphia	15	8.3
Sirenia	2	1.1
Cingulata	5	2.8
Pilosa	5	2.8
Primates	10	5.5
Chiroptera	88	48.6
Carnivora	13	7.2
Cetacea	5	2.8
Artiodactyla	5	2.8
Perissodactyla	1	0.5
Rodentia	32	17.7
Total	181	100

[1]The percentages are calculated based on the total number of species.

We document 17 new occurrences, including 16 for the Amapá State: five marsupials: *Cryptonanus* sp. Voss, Lunde and Jansa, 2005, *Didelphis imperfecta* Mondolfi and Perez-Hernandez 1984, *Gracilinanus emiliae* (Thomas 1909), *Hyladelphys kalinowskii* (Hershkovitz 1992), and *Marmosa lepida* (Thomas 1888); eight bats: *Cormura brevirostris* (Wagner 1843), *Peropteryx leucoptera* Peters, 1869, *P. trinitatis* (Miller 1899), *Lophostoma carrikeri* (Allen 1910), *Vampyriscus brocki* (Peterson 1968), *Furipterus horrens* Cuvier 1828, *Cynomops planirostris* (Peters 1866), and *Eumops delticus* Thomas 1923; one canid: *Cerdocyon thous* (Linnaeus 1766); one cetacean: *Balaenoptera bonaerensis* (Burmeister 1867) and one rodent: *Pseudoryzomys* sp., see Silva et al. (2012) for more information. In addition, we documented a new record of a rodent species for Brazil: *Isothrix sinnamariensis* (Vié, Volobouev, Patton and Granjon 1996) (Table 3). We also added two primate species, *Alouatta belzebul* and *Aotus infulatus*, to the list presented by Lim et al. (2005) for the Guiana region.

We recorded 15 species of Didelphimorphia (Table 3), among them five new occurrences for Amapá. We captured the *Cryptonanus* sp. (IEPA 2077) at a single locality in the southeastern region of the state (Figure 1, PA 15). The specimen has not yet been identified at the species level but this is the first record for the Amazon. Our record of *Didelphis imperfecta* (IEPA 1144, 2415 and 2984) is the second for Brazil; this species was previously known only from Monte Roraima, in Roraima State (Cerqueira and Tribe 2008). We recorded *D. imperfecta* at three localities on the coast of Amapá in the *terra firme* forest, flooded fields, and savannas (Figure 1, PA 17, 20 and 21). *Gracilinanus emiliae* has been documented in French Guiana, Suriname, Guyana, Colombia, Venezuela, and northern Brazil in Pará State (Creighton and Gardner 2008a). We collected two specimens of *G. emiliae* (IEPA 2376 and 3454) in a savanna (Figure 1, PA 23) and another one in the *terra firme* forest (Figure1, PA 26). Based on the marginal localities in Gardner (2008), *Hyladelphys kalinowskii* occurs in Peru, Brazil (Amazonas State), French Guiana, and Guyana. However, this species is represented by very few specimens in the collections (Voss et al. 2001, Astua 2006). The specimen of *H. kalinowskii* (IEPA 1049) presented here, a female captured in March 2005, was collected by D. S. Ferreira in the rural settlement of Nova Canaã, municipality of Porto Grande, Amapá. This is the second voucher specimen in the Brazilian collections. *Marmosa lepida* is known from Bolivia, Peru, Ecuador, Colombia, Guyana, Suriname, French Guiana, and Brazil, in the states of Amazonas and Pará (Lim et al. 2005, Rossi 2005, Creighton and Gardner 2008b). We document the first record (IEPA 493) for the state of Amapá (Figure 1, PA 5). *Chironectes minimus* (Zimmermann 1780) was the only species in the order recorded solely by observation. This record was from the Marinho creek in the southern portion of Amapá (Figure 1, PA 17). *Marmosops parvidens* (Tate 1931) was broadly documented in the state (Figure 1, PA 1, 5, 7, 9, 10, 11, 17, 18, 19, 20, 23, 24, 26). The first record for this marsupial was Parque Tumucumaque by Silva (2008).

Two species of the manatee were recorded, including the Amazonian *Trichechus inunguis* (Natterer 1883) in the region of the mouth of the Amazon River and the marine *T. manatus* (Linnaeus 1758) with records from the northern coast of Amapá. These animals have been hunted on the coast. One individual was photographed harpooned in 2008 at the mouth of the Uaçá River in the Atlantic coast (Oiapoque bay) in the north of Amapá State.

Five species of Pilosa were recorded, including *Myrmecophaga tridactyla* (Linnaeus 1758). This species is considered vulnerable by the IUCN (2012), and we recorded it in three different habitat types (Table 3). *Tamandua tetradactyla* (Linnaeus 1758) is broadly documented throughout the state. The black coloration form without a vest was dominant in the records (Figure 1, PA 11, 17, 18, 20, 21, 23, 24, and 27). The typical yellow coloration with or without the dark vest has not been collected in Amapá. The voucher specimens deposited in the collection of CCFA are all black (IEPA 2061, 2378, and 2835). However, a yellow individual with a black vest was observed on the banks of the Anacui River (Figure 1, PA 10).

We recorded five species of Cingulata in Amapá including *Euphractus sexcinctus* (Linnaeus 1758) (IEPA 3090) in the savanna of the central region of the state (Figure 1, PA 11). *Priodontes maximus* (Kerr 1792), listed as

Table 3 The list of the mammal species recorded in the state of Amapá, northern Brazil, habitats where they were collected, and conservation status according to IUCN (2012).

Classification	Sampled habitats			Status
	Terra firme forest	Savanna	Floodable habitat	
Didelphimorphia				
Didelphidae				
Caluromys philander		X	X	LC
Chironectes minimus	X			LC
Cryptonanus sp.[2]		X		
Didelphis imperfecta[2]	X	X		LC
Didelphis marsupialis	X	X	X	LC
Gracilinanus emiliae[2]	X	X		DD
Hyladelphys kalinowskii[2]	X			LC
Marmosa demerarae	X	X		LC
Marmosa lepida[2]	X			LC
Marmosa murina	X		X	LC
Marmosops parvidens	X			LC
Marmosops pinheiroi	X		X	LC
Metachirus nudicaudatus	X			LC
Monodelphis touan	X	X	X	LC
Philander opossum	X	X	X	LC
Sirenia				
Trichechidae				
Trichechus inunguis	X		X	VU
Trichechus manatus			X	VU
Pilosa				
Myrmecophagidae				
Cyclopes didactylus	X	X	X	LC
Myrmecophaga tridactyla	X	X		VU
Tamandua tetradactyla	X	X	X	LC
Bradypodidae				
Bradypus tridactylus	X	X	X	LC
Megalonychidae				
Choloepus didactylus	X			LC
Cingulata				
Dasypodidae				
Cabassous unicinctus	X	X		LC
Dasypus kappleri	X			LC
Dasypus novemcinctus	X	X	X	LC
Euphractus sexcinctus		X		LC
Priodontes maximus	X	X		VU
Primates				
Cebidae				
Sapajus apella	X	X	X	LC
Cebus olivaceus	X	X	X	LC
Saguinus midas	X	X		LC
Saimiri sciureus	X	X	X	LC
Aotidae				
Aotus infulatus		X	X	LC
Pitheciidae				
Chiropotes sagulatus	X			LC
Pithecia pithecia	X			LC
Atelidae				
Alouatta belzebul		X	X	VU
Alouatta macconnelli	X	X	X	LC
Ateles paniscus	X			VU
Chiroptera				
Emballunoridae				

(**Table 3** Continued)

Classification	Sampled habitats			Status
	Terra firme forest	Savanna	Floodable habitat	
Centronycteris maximilliani	X			LC
Cormura brevirostris[2]			X	LC
Diclidurus albus	X		X	LC
Diclidurus scutatus	X		X	LC
Peropteryx leucoptera[2]			X	LC
Peropteryx macrotis			X	LC
Peropteryx trinitatis[2]			X	DD
Rhynchonycteris naso	X	X	X	LC
Saccopteryx bilineata	X		X	LC
Saccopteryx canescens			X	LC
Saccopteryx leptura	X	X	X	LC
Phyllostomidae				
Ametrida centurio	X	X	X	LC
Anoura caudifer			X	LC
Anoura geoffroyi	X		X	LC
Artibeus cinereus	X	X	X	LC
Artibeus concolor	X	X	X	LC
Artibeus gnomus	X		X	LC
Artibeus lituratus	X	X	X	LC
Artibeus obscurus	X	X	X	LC
Artibeus planirostris	X	X	X	LC
Carollia brevicauda	X	X	X	LC
Carollia perspicillata	X	X	X	LC
Chiroderma trinitatum	X	X		LC
Chiroderma villosum	X	X		LC
Choeroniscus minor	X		X	LC
Chrotopterus auritus	X	X	X	LC
Desmodus rotundus	X	X	X	LC
Diaemus youngi	X		X	LC
Diphylla ecaudata	X		X	LC
Glyphonycteris sylvestris	X			LC
Glossophaga longirostris[2]		X	X	DD
Glossophaga soricina	X	X	X	LC
Lampronycteris brachyotis	X		X	LC
Lichonycteris degener	X			NE
Lionycteris spurelli	X			LC
Lonchophylla thomasi	X	X	X	LC
Lonchorhina inusitata				DD
Lophostoma brasiliense	X			LC
Lophostoma carrikeri[2]	X			LC
Lophostoma schulzi	X			LC
Lophostoma silvicolum	X	X	X	LC
Macrophyllum macrophyllum	X		X	LC
Mesophylla macconnelli			X	LC
Micronycteris megalotis			X	LC
Micronycteris microtis	X		X	LC
Micronycteris minuta	X		X	LC
Micronycteris schmidtorum	X	X		LC
Micronycteris hirsuta[2]	X			LC
Mimon bennettii	X			LC
Mimon crenulatum	X	X	X	LC
Phylloderma stenops	X	X	X	LC
Phyllostomus discolor	X	X	X	LC
Phyllostomus elongatus	X	X	X	LC
Phyllostomus hastatus	X		X	LC

(**Table 3** Continued)

Classification	Sampled habitats			Status
	Terra firme forest	Savanna	Floodable habitat	
Platyrrhinus brachycephalus	X	X	X	LC
Platyrrhinus incarum	X	X	X	NE
Rhinophylla pumilio	X	X	X	LC
Sturnira lilium	X	X	X	LC
Sturnira tildae	X	X	X	LC
Tonatia saurophila	X		X	LC
Trachops cirrhosus	X	X	X	LC
Trinycteris nicefori	X		X	LC
Uroderma bilobatum	X	X	X	LC
Uroderma magnirostrum	X	X	X	LC
Vampyriscus bidens	X	X		LC
Vampyriscus brocki[2]	X	X		LC
Vampyressa thyone	X			LC
Vampyrodes caraccioli	X		X	LC
Vampyrum spectrum	X			NT
Thyropteridae				
Thyroptera tricolor	X		X	LC
Vespertilionidae				
Eptesicus brasiliensis	X		X	LC
Eptesicus furinalis	X		X	LC
Lasiuris blossevillii			X	LC
Myotis albescens	X		X	LC
Myotis nigricans			X	LC
Myotis riparius	X		X	LC
Noctilionidae				
Noctilio albiventris		X	X	LC
Noctilio leporinus	X		X	LC
Mormoopidae				
Pteronotus parnellii	X	X	X	LC
Pteronotus personatus			X	LC
Furipteridae				
Furipterus horrens[2]			X	LC
Molossidae				
Cynomops planirostris[2]	X	X	X	LC
Eumops delticus[2]		X	X	NE
Eumops trumbulli			X	LC
Molossus rufus	X			LC
Molossus molossus	X	X	X	LC
Nyctinomops laticaudatus			X	LC
Promops nasutus	X			LC
Carnivora				
Felidae				
Leopardus pardalis	X	X		LC
Panthera onca	X	X	X	NT
Puma yagouaroundi		X	X	LC
Puma concolor	X	X	X	LC
Canidae				
Cerdocyon thous[2]	X	X		LC
Speothos venaticus	X	X		NT
Mustelidae				
Eira barbara	X	X	X	LC
Galictis vittata	X	X	X	LC
Lontra longicaudis	X	X	X	DD
Pteronura brasiliensis	X	X	X	EN

(**Table 3** Continued)

Classification	Sampled habitats			Status
	Terra firme forest	Savanna	Floodable habitat	
Procyonidae				
Nasua nasua	X	X	X	LC
Potos flavus	X	X	X	LC
Procyon cancrivorus	X		X	LC
Perissodactyla				
Tapiridae				
Tapirus terrestris	X	X	X	VU
Artiodactyla				
Tayassuidae				
Pecari tajacu	X	X	X	LC
Tayassu pecari	X	X		NT
Cervidae				
Mazama americana	X	X	X	DD
Mazama nemorivaga	X	X	X	LC
Odocoileus virginianus		X	X	LC
Cetacea				
Baleonopteridae				
Balaenoptera bonaerensis			X	DD
Delphinidae				
Sotalia fluviatilis			X	DD
Sotalia guianensis			X	DD
Tursiops truncatus			X	LC
Iniidae				
Inia geoffrensis			X	DD
Rodentia				
Sciuridae				
Sciurillus pusillus	X			DD
Guerlinguetus aestuans	X			LC
Cricetidae				
Euryoryzomys macconnelli	X			LC
Holochilus sciureus	X			LC
Hylaeamys megacephalus	X			LC
Hylaeamys yunganus	X			LC
Neacomys dubosti	X			LC
Neacomys paracou	X			LC
Nectomys melanius			X	LC
Neusticomys oyapocki	X			DD
Oecomys auyantepui	X	X		LC
Oecomys bicolor	X	X	X	LC
Oecomys rex	X			LC
Oecomys rutilus	X			LC
Oecomys sp.	X			
Oligoryzomys sp.		X		
Pseudoryzomys sp.		X		
Sigmodon alstoni		X		LC
Zygodontomys brevicauda		X		LC
Caviidae				
Hydrochoerus hydrochaeris	X	X	X	LC
Cuniculidae				
Cuniculus paca	X	X	X	LC
Dasyproctidae				
Dasyprocta leporina	X	X	X	LC
Myoprocta acouchy	X		X	LC
Erethizontidae				
Coendou prehensilis	X	X	X	LC
Coendou melanurus	X			

(**Table 3** Continued)

Classification	Sampled habitats			Status
	Terra firme forest	Savanna	Floodable habitat	
Echimyidae				
Echimys chrysurus	X			LC
Isothrix sinnamariensis[3]	X			LC
Makalata didelphoides	X			LC
Makalata sp.			X	LC
Mesomys hispidus	X		X	LC
Proechimys cuvieri	X	X	X	LC
Proechimys guyannensis	X	X	X	LC

[1]EN, endangered; VU, vulnerable; NT, near threatened; LC, least concern; DD, data deficient; NE, not evaluated.
[2]New occurrence for the state of Amapá.
[3]New occurrence for Brazil.

vulnerable (IUCN 2012), was recorded in the areas of the *terra firme* forest and savanna (Figure 1, PA 10 and 11); and *Cabassous unicinctus* (Linnaeus 1758) (IEPA 1541), a rare species in the state, was recorded in the *terra firme* forest and savanna (Figure 1, PA 18 and 20).

Of the 88 bat species recorded, eight are new records to Amapá. The family Emballonuridae had three new occurrences: *Cormura brevirostris* (IEPA 1243) was recognized from the states of Pará, Amazonas, Maranhão, and Rondônia (Bernard et al. 2011), *Peropteryx leucoptera* (IEPA 1696) occurring in Amazonas, Pará, and Piauí (Peracchi et al. 2010), and *Peropteryx trinitatis* (IEPA 1272) known to Pará and Maranhão (Hood and Gardner 2008). These three species were captured in a floodplain forest in the APA Curiaú (Figure 1, PA 27), municipality of Macapá. We also recorded for the first time in Amapá, the species *Furipterus horrens* (IEPA 071) at the mouth of the Jari River on the border with the Pará State (Figure 1, PA 18). In Brazil, this species occurs in the Amazon (Amazonas and Pará; Bernard et al. 2011), Caatinga, and Atlantic Forest (Reis et al. 2010). For Molossidae, there are two new records for Amapá: *Cynomops planirostris* (IEPA 980) captured in the flooded fields of REBIO Piratuba (Figure 1, PA 32) and *Eumops delticus* (IEPA 1255) captured in the savanna of APA Curiaú (Figure 1, PA 27). In the Amazon, *C. planirostris* was known from the state of Mato Grosso (Pine et al. 1970). Eger (2008) considered the whole Amazon, which extends to southeastern Brazil, as a potential area of occurrence for this species. Likewise, the expected geographic distribution of *Eumops delticus* includes southwestern Colombia along the Amazon River to the southern Bahia State in Brazil (Eger 2008). For the family Phyllostomidae, there were two new records for Amapá, including *Lophostoma carrikeri*, which was known for the states of Amazonas, Pará, Roraima, Goiás, and Piauí. We captured this species (IEPA 2936) in the *terra firme* forest of RESEX Cajari close to Highway BR156 (Figure 1, PA 25), which extended its range to the eastern Amazon. Similarly for *Vampyriscus brocki* (IEPA 2118), until then recorded only in the states of Amazonas and Pará (Bernard et al. 2011, Peracchi et al. 2011), we recorded it in the savanna (Figure 1, PA 20).

Ten species of primates are known from the state, including *Alouatta belzebul* recorded on the coast between Macapá and the mouth of the Araguari River (IEPA 35 and 36). This species was collected in the municipality of Itaubal in 1988 and reported by Silva Junior et al. (2008). These records for Amapá represent a range extension, as the species had been previously recorded only to the south of the Amazon River. *A. belzebul* was recorded in sympatry with *Alouatta macconnelli* (Elliot 1910) on the central coast of Amapá (Costa-Neto pers. comm.). It was recorded in the floodplain forest, flooded fields, and savannas. *Aotus infulatus* is in the list of Carvalho (1962) under the name *Aotus trivirgatus* (Humboldt 1811). The current records place this species only on the coast of Amapá, in areas of the savanna, flooded field, and floodplain forest (Silva Junior et al. 2008).

We recorded 13 species of Carnivora, including the canid *Cerdocyon thous*, a new occurrence for Amapá. This canid has a broad distribution, but the records from northern Brazil are restricted to the Pará State (Machado and Hingst-Zaher 2009). Michalski and Peres (2005) reported the species in disturbed areas of the Amazonian Forest in Mato Grosso, and the map of the potential distribution published by Courtenay and Maffei (2008) included only the states of Acre and Amazonas as areas where the species is absent. *C. thous* was recorded mainly in the savannas (Figure 1, PA 11, 20), but we also recorded it in a floodplain forest (Figure 1, PA 27). The only specimen

deposited in the collection (IEPA 3603) resulted from a roadkill on Highway AP 70 within the savanna of APA Curiaú. We recorded three carnivore species listed on the IUCN (2012) red list: *Panthera onca* (Linnaeus 1758) and *Speothos venaticus* (Lund 1842), listed as near threatened, and *Pteronura brasiliensis* (Gmelin 1788) listed as endangered.

Regarding the ungulates, *Tapirus terrestris* (Linnaeus 1758) (Perissodactyla) is listed as vulnerable by IUCN (2012) and was recorded in the *terra firme* forest, savanna, and floodable forest. Five species of Artiodactyla were recorded, including three cervids: *Odocoileus virginianus*, *Mazama americana* (Erxleben 1777), and *Mazama nemorivaga* (Cuvier 1817). There were also two peccaries: *Tayassu pecari* (Link 1795) and *Pecari tajacu* (Linnaeus 1758). These species have a broad distribution in the state, except for *O. virginianus*, which occurs only on the coast in the savannas and flooded fields, and *T. pecari*, listed as near threatened by IUCN (2012), which is apparently absent from most open environments due to hunting.

Five Cetacea species were recorded in the state, including a new record of *Balaenoptera bonaerensis* in EEP, an island of lacustrine-marine influence, in April 2009. Although the northernmost record of *B. bonaerensis* on the eastern coast of South America was made in Suriname (Husson 1978, Rice 1998), this species has been rarely observed on the Brazilian coast, and its occurrence is apparently atypical. The most frequent records of this species were made at the tropical and subtropical latitudes (Zerbini et al. 1997).

Rodentia was the second largest order with 32 species. The occurrence of *Isothrix sinnamariensis* (IEPA 1509) in Brazil is interesting, but not totally unexpected, as this echimyid was known from French Guiana (Vié et al. 1996), Guyana (Lim et al. 2007), and Suriname (Lim and Joemratie 2011). Our specimen was collected in an area of managed Brazil nut trees (*Bertholletia excelsa*) in RESEX Cajari (Figure 1, PA 17), municipality of Laranjal do Jari, southern Amapá. The two specimens of *Pseudoryzomys* sp. were captured by Nunes (2001) in the savanna, São Bento Farm locality, also sampled by us (Figure 1, PA 21). Although the specimens have not yet been identified at the species level, this is the first record for the genus in Amapá. We recorded also *Zygodontomys brevicauda* (Allen and Chapman 1893) (IEPA 1626) and *Sigmodon alstoni* (Thomas 1881) (IEPA 2786), which are found in the savannas within the municipality of Ferreira Gomes (Figure 1, PA 23). *Z. brevicauda* was also recorded in the areas of savanna in contact with the *Eucalyptus* plantations (Figure 1, PA 20). This rodent was abundant in these plantations, as it was found in over 50% of the captures with the Sherman and cage traps. The *Oligoryzomys* sp. was recorded in the savanna on the coast (Figure 1, PA 15, 20, 22, 23, and 24). Based on a molecular analysis of the specimens deposited in CCFA (IEPA 2481, IEPA 2888, IEPA 3040, and IEPA 3536) and the sequences deposited in the GenBank, we found that the sequences were similar to the specimen named as *Oligoryzomys* sp. collected in São Bento Farm, municipality of Tartarugalzinho (Miranda et al. 2009). This specimen was grouped in a phylogenetic study with *Oligoryzomys fulvescens* (Saussure 1860) and *Oligoryzomys messorius* (Thomas 1901), both of which occur in the Amazon, and with *Oligoryzomys moojeni* Weksler and Bonvicino 2005, which is known from the Cerrado (Miranda et al. 2009). These authors state that a complete morphological description of *Oligoryzomys* sp. is needed for a correct taxonomic identification. Five species of *Oecomys* Thomas 1906 were recorded for Amapá: *Oecomys rex* (Thomas 1910) (IEPA 1539), *Oecomys rutilus* (Anthony 1921) (IEPA 1532), *Oecomys bicolor* (Thomas 1860) (IEPA 1612), *Oecomys auyantepui* (Tate 1939) (IEPA 1134), and *Oecomys* sp. (IEPA 1611). The latter is probably an undescribed species (Flores 2010), that was captured in the *terra firme* forest, savanna, and flooded habitats (Figure 1, PA 10, 18, 19, 20, 21). *O. rutilus* (Figure 1, PA 9, 10, 17, 18, 26), *O. rex* (Figure 1, PA 18), and *O. auyantepui* (Figure 1, PA 17, 18, 19, 26) were recorded only in the *terra firme* forest. *O. bicolor* was recorded in the *terra firme* forest (Figure 1, PA 5, 18, 26), savanna (Figure 1, PA 20, 22, 23), and flooded area (Figure 1, PA 21). In the municipality of Cachoeira Santo Antônio, southern Amapá (PA 18), all the five species of *Oecomys* were captured in sympatry. *Neusticomys oyapocki* (Dubost and Peter 1978), whose first occurrence for Amapá was reported by Nunes (2002), was captured in the southern region on the banks of the Jari River and in the central region in the FLONA Amapá (Figure 1, PA 18, 26). We recorded two species of *Makalata*. One had a broad distribution in areas of the *terra firme* forest (Figure 1, PA 1, 3, 5, 6, 9, 10, 16, 26) and was referred to as *Makalata didelphoides* (Desmarest 1817) (IEPA 926, IEPA 1146, IEPA 1147), although the karyotype 2N=72 (Leão et al. unpublished data) differs from that described by Lima et al. (1998). In the coastal region of mangroves and floodable fields (Figure 1, PA 13, 14, 21, 29), we recorded the *Makalata* sp. (IEPA 2713, IEPA 2715, IEPA 2571). These specimens differ from *M. didelphoides* by morphological and genetic characters (Duque et al. 2010).

Excluding the aquatic mammals, 137 species were recorded in the *terra firme* forest, 86 in the savannas, and 116 in the floodable environments, such as the fields and floodplain forests (Table 3). Most *terra firme* areas of Amapá are reserves, which cover large continuous

areas and protect the habitats of endemic species, such as *Ateles paniscus* (Linnaeus 1758), *Chiropotes sagulatus*, and *Oecomys rutilus*. In these environments, we recorded 26 species not found in any other habitats (Table 3). The savannas are more vulnerable to the environmental alterations because they are intensively occupied by humans, and only a few noncontinuous areas are protected (Sanaioti et al. 1997). This scenario represents a risk for the natural populations and endemic species, such as *Pseudoryzomys* sp., *Sigmodon alstoni*, *Zygodontomys brevicauda*, *Cryptonanus* sp., and *Euphractus sexcinctus*. This habitat has a few endemic species, but it is important for the species that are biologically and taxonomically poorly known. The situation of the floodable habitats is similar, but there are more and larger reserves protecting these habitats. We recorded 20 species only in this habitat, mainly bats (Table 3).

We predict that more species will be soon added to the mammal list of Amapá, as *Mustela* sp. (Linnaeus 1758) and *Leopardus tigrinus* (Schreber 1775). Both species have already been observed in the state, but confirmation through the voucher specimens is still needed. More inventories and long-term studies, employing detailed analysis of morphologic variation coupled with a molecular approach will contribute to a better classification of the species in the different habitats, which will help to define the endemism, conservation status, and distribution of the mammals in Amapá.

Acknowledgements: We thank Adriano Peracchi and Daniela Dias for the identification of the bats; Tamara Flores, Yuri Leite, Gilson E. Y. Ximenes, Marcelo Weksler, and Cibele Bonvicino identified some rodents; Caroline Duque sequenced the tissue samples of *Makalata*; Suely Marques-Aguiar gave us access to the mammal collection of Museu Paraense Emilio Goeldi; José de Souza Silva Junior helped us during the visits; Cleusa Yoshiko Nagamashi and her research group for analyzing the karyotypes of the rodents and marsupials, Dayse Swellen Silva Ferreira and Carlos Eduardo Costa Campos who collected the *Hyladelphys kalinowskii*, and Claudia Funi for drawing the map. We thank François Catzeflis and two anonymous reviewers for the many useful comments on the manuscript.

Received November 8, 2012; accepted March 26, 2013; previously published online April 22, 2013

References

Astua, D. 2006. Range extension and first Brazilian record of the rare *Hyladelphys kalinowskii* (Hershkovitz, 1992) (Didelphimorphia, Didelphidae). Mammalia 70: 174–176.

Barnett, A.A. and C.A. Cunha. 1998. Small mammals of Ilha de Maracá. In: (W. Milliken and J. Ratter, eds.) Maracá: the biodiversity and environment of an Amazonian rainforest. John Wiley and Sons Ltd, Baffins Lane, Chichester, England. pp. 189–210.

Bernard, E. 2008. Inventários Biológicos Rápidos no Parque Nacional Montanhas do Tumucumaque, Amapá, Brasil. RAP Bulletin of Biological Assessment 48. Conservation International, Arlington, VA. pp. 149.

Bernard, E., V.C. Tavares and E. Sampaio. 2011. Compilação atualizada das espécies de morcegos (Chiroptera) para a Amazônia Brasileira. Biota Neotrop. 11: 35–46.

Booman, G.C., P. Laterra, V. Comparatore and N. Murillo. 2009. Post-dispersal predation of weed seeds by small vertebrates: interactive influences of neighbor land use and local environment. Agric. Ecosyst. Environ. 129: 277–285.

Carvalho, C.T. 1962. Lista preliminar dos mamíferos do Amapá. Pap. Avulsos do Dep. de Zool, São Paulo, 15: 283–297.

Castro, I.J. 2009. Assembléia de morcegos (Mammalia: Chiroptera) da Área de Proteção Ambiental do Rio Curiaú, Amapá. Universidade Federal do Amapá, Macapá (Master's Thesis). pp. 78.

Cerqueira, R. and C.J. Tribe. 2008. Genus *Didelphis* Linnaeus, 1758. In: (Gardner, A.L., ed.) Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London. pp. 17–25.

Charles-Dominique, P., M. Atramentowicz, M. Charles-Dominique, Gérard, H., A. Hladik, C.M. Hladik and M.F Prévost. 1981. Les mammifères frugivores nocturnes d'une forêt guyanaise: interrelations plantes-animaux. Rev. Ecol. Terre Vie 35: 341–435.

Costa, L.P. 2003. The historical bridge between the Amazon and the Atlantic Forest of Brazil: a study of molecular phylogeography with small mammals. J. Biogeogr. 30: 71–86.

Courtenay, O. and L. Maffei. 2008. *Cerdocyon thous*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. http://www.iucnredlist.org. Accessed on 20 July 2012.

Cracraft, J. 1985. Deep-history biogeography: retrieving the historical pattern of evolving continental biotas. Syst. Zool. 37: 396–427.

Creighton, G.K. and A.L. Gardner. 2008a. Genus *Gracilinanus* Gardner and Creighton, 1989. In: (Gardner, A.L., ed.) Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London. pp. 43–50.

Creighton, G.K. and A.L. Gardner. 2008b. Genus *Marmosa* Gray, 1821. In: (A.L. Gardner, ed.), Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London, pp. 51–61.

Duellman, W.E. 1982. Quaternary climatic-ecological fluctuations in the lowland tropics: frog and forests. In: (G.T. Prance, ed.), Biological diversification in the tropics. Columbia University Press, New York. pp. 389–401.

Duque, C.C., C.R. Silva, G.E. Iack-Ximenes and Y.L.R. Leite. 2010. Variação genética e morfológica em *Makalata didelphoides* (Rodentia, Echimyidae) do Amapá. In: V Congresso Brasileiro de Mastozoologia, 2010, São Pedro, SP. Resumos. pp. 896–897.

Eger, J.L. 2008. Family Molossidae. In: (A.L. Gardner, ed.) Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London. pp. 399–440.

Eisenberg, J.F. 1989. Mammals of the Neotropics. The northern Neotropics. The University of Chicago Press, Chicago. pp. 449.

Flores, T.A. 2010. Diversidade morfológica e molecular do gênero *Oecomys* Thomas, 1906 (Rodentia: Cricetidae) na Amazônia Oriental brasileira. Universidade Federal do Pará. Belém, Pará. (Master's Thesis). pp. 113.

Gardner, A.L. 2008. Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. The University of Chicago Press, Chicago and London. pp. 669.

Griffiths, T.A. and A.L. Gardner. 2008. Subfamily Lonchophyllinae Griffiths, 1982. In: (A.L. Gardner, ed.) Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London, pp. 244–255.

Grünewald, C., N. Breitbach and K. Böhning-Gaese. 2010. Tree visitation and seed dispersal of wild cherries by terrestrial mammals along a human land-use gradient. Basic Appl. Ecol. 11: 532–541.

Haffer, J. 1974. Avian speciation in tropical South America. Publ. Nuttall Ornith. Club. 14: 1–390.

Hershkovitz, P. 1969. The evolution of mammals of the Neotropical region: a zoogeographic and ecological review. Q. Rev. Biol. 44: 1–70.

Hershkovitz, P. 1983. Two new species of the night monkeys, genus *Aotus* (Cebidae, Platyrrhini): a preliminary report on *Aotus* taxonomy. Am. J. Primatol. 4: 209–248.

Hood, C. and A.L. Gardner. 2008. Family Emballonuridae Gervais, 1856. In: (A.L. Gardner, ed.) Mammals of South America, Volume I. Marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago and London. pp. 188–207.

Husson, A.M. 1978. The mammals of Suriname. Zoölogische Monographeieen van het Rijksmuseum van Natuurlijke Historie, Leiden. pp. 569.

IBGE. 2004. IBGE, Instituto Brasileiro de Geografia e Estatística. Mapa de Vegetação do Brasil, 2ª edição. Escala 1: 5.000.000.

IUCN. 2012. The IUCN Red List of Threatened Species. Version 2012.2. Available at: http://www.iucnredlist.org. Accessed on October 20, 2012.

Lambert, T.D., J.R. Malcolm and B.L. Zimmerman. 2005. Effects of mahogany (*Swietenia macrophylla*) logging on small mammal communities, habitat structure, and seed predation in the southeastern Amazon Basin. Forest Ecol. Manage. 206: 381–398.

Lim, B.K. and M.D. Engstrom. 2005. Mammals of Iwokrama Forest. Proc. Acad. Nat. Sci. Philadelphia 154: 71–108.

Lim, B.K. and S. Joemratie. 2011. Rapid Assessment Program (RAP) survey of small mammals in the Kwamalasamutu region of Suriname. In: (B.J. O'Shea, L.E. Alonso and T.H. Larsen, eds.) A rapid biological assessment of the Kwamalasamutu region, Suriname. Conservation International, Arlington, VA, USA. pp. 144–149.

Lim, B.K., M.D. Engstrom and J.G Ochoa. 2005. Mammals. In: (Hollowell, T. and R.P. Reynolds, eds.) Checklist of the terrestrial vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington. 13: 77–92.

Lim, B.K., M.D. Engstrom, J.C Patton and J.W. Bickham. 2007. Systematic relationships of the Guianan brush-tailed rat (*Isothrix sinnamariensis*) and its first occurrence in Guyana. Mammalia 70: 120–125.

Lima, J.F.S., A. Languth and L.C. Sousa. 1998. The karyotype of *Makalata didelphoides* (Rodentia, Echimyidae). Z. Säugetierk. 63: 315–318.

Lynch-Alfaro, J.W., J.P. Boubli, L.E. Olson, A. Di Fiore, B. Wilson, G.A. Gutierrez-Espeleta, K.L. Chiou, M. Schulte, S. Neitzel, V. Ross, D. Schwochow, M.T.T. Nguyen, I. Farias, C.H. and Janson, M.E. Alfaro. 2012. Explosive Pleistocene range expansion leads to widespread Amazonian sympatry between robust and gracile capuchin monkeys. J. Biogeogr. 39: 272–288.

Machado, F.A. and E. Hingst-Zaher. 2009. Investigating South American biogeographic history using patterns of skull shape variation on *Cerdocyon thous* (Mammalia: Canidae). Biol. J. Linnean Soc. 98: 77–84.

Maia da Silva, F., R.D. Naiff, A. Marcili, M. Gordo, J.A. D'Affonseca Neto, M.F. Naiff, A.M.R. Franco, M. Campaner, V. Valente, S.A. Valente, E.P. Camargo, M.M.G. Teixeira and M.A. Miles. 2008. Infection rates and genotypes of *Trypanosoma rangeli* and *T. cruzi* infecting free-ranging *Saguinus bicolor* (Callitrichidae), a critically endangered primate of the Amazon Rainforest. Acta Trop. 107: 168–173.

Martins, A.C.M. and E. Bernard. 2008. Inventários rápidos de morcegos no Parque Nacional Montanhas do Tumucumaque: Resultados das Expedições I a V e Síntese. In: (E. Bernard, ed.) Inventários Biológicos Rápidos no Parque Nacional Montanhas do Tumucumaque, Amapá, Brasil. RAP Bull. Bio. Assess. Conservation International, Arlington, VA. 48:59–65.

Martins, A.C.M., E. Bernard and R. Gregorin. 2006. Rapid biological surveys of bats (Mammalia, Chiroptera) in three conservation units in Amapá, Brazil. Rev. Bras. Zool. 23: 1175–1184.

Martins, A.C.M., E. Bernard, R. Gregorin and W.A.S. Silva. 2011. Filling data gaps on the diversity and distribution of Amazonian bats (Chiroptera): The case of Amapá, eastern most Brazil. Rev. Bras. Zool. 28: 177–185.

Michalski, F. and C.A. Peres. 2005. Anthropogenic determinants of primate and carnivore local extinctions in a fragmented forest landscape of Southern Amazonia. Biol. Conserv. 124: 383–396.

Miranda, G.B., L.F.B. Oliveira, J. Andrades-Miranda, A. Langguth, S.M. Callegari-Jacques and M.S. Mattevi. 2009. Phylogenetic and phylogeographic patterns in Sigmodontine rodents of the genus *Oligoryzomys*. J. Hered. 100: 309–321.

Mok, W.Y., D.E. Wilson, L.A. Lacey and R.C.C. Luizão. 1982. Lista atualizada de quirópteros da Amazônia brasileira. Acta Amaz. 12: 814–23.

Monteiro, F.J.C. 2009. Impactos Ambientais causados pelos búfalos asselvajados nos campos inundáveis da Estação Maracá-Jipioca (Costa Atlântica do Amapá). Universidade Federal do Amapá, Macapá–Amapá (Master's Thesis). pp. 50.

Nunes, A. 2001. Gradientes estruturais dos hábitats em savanas amazônicas: implicações sobre a distribuição e ocorrência das espécies de pequenos mamíferos (Rodentia, Didelphimorphia). Universidade Federal do Rio de Janeiro, Rio de Janeiro (Doctor's Dissertation). pp. 129.

Nunes, A. 2002. First record of *Neusticomys oyapocki* (Muridae, Sigmodontinae) from the Brazilian Amazon. Mammalia 66: 445–447.

Oliveira, C.P. 2008. Método de Avaliação por Múltiplos Critérios como Apoio ao Planejamento Ambiental: aplicação experimental no Cerrado Central do Amapá, Brasil. Universidade Federal do Amapá, Macapá–Amapá (Master's Thesis). pp. 50.

Parry, L., J. Barlowand and C.A. Peres. 2009. Allocation of hunting effort by Amazonian smallholders: implications for conserving wildlife in mixed-use landscapes. Biol. Conserv. 142: 1777–1786.

Patton, J.L. and L.P. Costa. 2003. Molecular phylogeography and species limits in rainforest didelphid marsupials of South America. In: (M. Jones, C. Dickiman and M. Archer, eds.) Predators with pouches: the biology of carnivorous marsupials. CSIRO Publishing, Collingwood, Victoria. pp. 63–81.

Patton, J.L., M.N.F. Silva and J.R. Malcolm. 2000. Mammals of the Rio Juruá and the evolutionary and ecological diversification of Amazonia. Bull. Am. Mus. Nat. Hist. 244: 1–306.

Pavan, S.E., R.V. Rossi and H. Schneider. 2012. Species diversity in the *Monodelphis brevicaudata* complex (Didelphimorphia: Didelphidae) inferred from molecular and morphological data, with the description of a new species. Zool. J. Linn. Soc.-Lond. 165: 190–223.

Peracchi, A.L., L.R. Sansão and A.M.Tanurre. 1984. Quirópteros do Território Federal do Amapá, Brasil (Mammalia: Chiroptera). Arq. Univ. Fed. Rural do Rio de Janeiro. 7: 89–100.

Peracchi, A.L., P.H. Gallo, D. Dias, I.P. Lima and N.R. Reis. 2010. Ordem Chiroptera. In: (N.R. Reis, A.L. Peracchi, M.N. Fregonezi and B.K. Rossaneis, eds.) Mamíferos do Brasil: Guia de identificação, 1ª edição. Technical Books, Rio de Janeiro, Brazil. pp. 293–461

Peracchi, A.L., I.P. Lima, N.R. Reis, M.R. Nogueira and H. Ortêncio-Filho. 2011. Ordem Chiroptera. In: (N.R. Reis, A.L. Peracchi, W.A. Pedro and I.P. Lima, eds.) Mamíferos do Brasil, 2ªedição. Editora da Universidade Estadual de Londrina, Londrina, Brazil. pp. 155–234.

Piccinini, R.S. 1974. Lista provisória dos quirópteros da coleção do Museu Paraense Emílio Goeldi (Chiroptera). Bol. Mus. Paraense Emílio Goeldi, Nova Série Zool., Belém 77: 132.

Pine, R.H., I.R. Bishop and R.L. Jackson. 1970. Preliminary list of mammals of the Xavantina/Cachimbo expedition (Central Brazil). Trans. R. Soc. Trop. Med. Hyg. 64: 668–670.

Prance, G.T. 1982. Forest refuges: evidence from woody angiosperms. In: (G.T. Prance, ed.) Biological diversification in the tropics. Columbia University Press, New York. pp. 137–158.

Reis, N.R., A.L. Peracchi, M.N. Fregonezi and B.K. Rossaneis. 2010. Mamíferos do Brasil: Guia de Identificação. 1ª edição. Technical Books, Rio de Janeiro, Brazil. pp. 560.

Ribas, C.C., A. Aleixo, A.C.R. Nogueira, C.Y Miyaki and J. Cracraft. 2012. A palaeobiogeographic model for biotic diversification within Amazonia over the past three million years. Proc. Royal Soc. B 279: 681–689.

Rice, D.W. 1998. Marine mammals of the world: systematic and distribution. Soc. Marine Mammalogy, 4: 1–231 (special publication).

Robinson, F. 1998. The bats of the Ilha de Maracá. In: (W. Milliken and J.A. Ratter, eds.) Maracá: the biodiversity and environment of an Amazonian rainforest, John Wiley and Sons, Chichester. pp. 165–187.

Rossi, R.V. 2005. Revisão taxonômica de Marmosa Gray, 1821 (Didelphimorphia, Didelphidae). Instituto de Biociências, Universidade de São Paulo. São Paulo (Doctor's Dissertation). pp. 357.

Rossi, R.V., R. Bodmer, J.M.B. Duarte and R.G. Trovati. 2010. Amazonian brown brocket deer *Mazama nemorivaga* (Cuvier 1817). In: (J.M.B. Duarte and S. Gonzalez, eds.) Neotropical cervidology: biology and medicine of Latin American deer. IUCN/FUNEP, Gland, pp[A1]. 202–210.

Sampaio, E.M., E.K.V. Kalko, E. Bernard, B. Rodríguez-Herrera and C.O. Handley Jr. 2003. A biodiversity assessment of bats (Chiroptera) in a tropical lowland rainforest of central Amazonia, including methodological and conservation considerations. Stud. Neotr. Fauna Environ. 38: 17–31.

Sanderson, J. and L. Ignácio. 2002. Non-volant mammal survey. Results from the Eastern Kanaku Montains Lower Kwitaro River, Guyana. In: (J.R. Montambault and O. Missa, eds.) A biodiversity assessment of the Eastern Kanuku Mountains, Lower Kwitaro River. RAP Bull. Bio. Assess. 26. Conservation International, Washington, DC. pp. 47–50.

Sanaioti, T.M., S. Bridgewater and J.A. Ratter. 1997. A floristic study of the savanna vegetation of the state of Amapa, Brazil, and suggestions for its conservation. Bol. Mus. Paraense Emilio Goeldi, Bot. 13: 3–29.

Silva, C.R. 2008. Inventários rápidos de mamíferos não-voadores no Parque Nacional Montanhas do Tumucumaque: resultados das Expedições I a V e síntese. In: (E. Bernard, ed.) Inventários Biológicos Rápidos no Parque Nacional Montanhas do Tumucumaque, Amapá, Brasil. RAP Bull. Bio. Assess. 48. Conservation International, Arlington, VA. pp. 51–57.

Silva Jr., J.S. and W.M.B. Figueiredo. 2002. Revisão sistemática dos cuxiús, gênero *Chiropotes* Lesson, 1840 (Primates, Pitheciidae), no Livro de Resumos: X Congresso Brasileiro de Primatologia, p.21. Sociedade Brasileira de Primatologia, Belém.

Silva J.M.C., A.B. Rylands and G.A.B Fonseca. 2005. O destino das áreas de endemismo da Amazônia. Megadiversidade 1: 124–131.

Silva Jr., J.S., C.R. Silva and T.P. Kasecker. 2008. Primatas do Amapá: Guia de Identificação de Bolso.Série "Guias de Bolso Tropicais". Conservation International. Panamericana Editorial Ltda., Bogotá, Colômbia. Disponível em: http://www.biodiversidadedoamapa.net/publicacoes/PRIMATES_OF_AMAPA.pdf.

Silva, C.R., A.C.M. Martins, I.J. Castro and E.M. Cardoso. 2012. Guia de mamíferos do Estado do Amapá. 1. Edição. IEPA, Macapá, Brazil. pp. 301.

Simmons, N.B. and R.S. Voss. 1998. The mammals of Paracou, French Guiana: a Neotropical lowland rainforest fauna, Part 1. Bats. Bull. Am. Mus. Nat. Hist., 237: 1–219.

Steiner, C. and F.M. Catzeflis. 2004. Genetic variation and geographical structure of five mouse-sized opossums (Marsupialia, Didelphidae) throughout the Guiana region. J. Biogeogr. 31: 959–973.

Straube, F.C. and G.V. Bianconi. 2002. Sobre a grandeza e a unidade utilizada para estimar esforço de captura com utilização de redes-de-neblina. Chirop. Neotr. 8: 150–152.

Thoisy, B., V. Lacoste, A. Germain, J. Muñoz-Jordán, C. Colón, J.F. Mauffrey, M. Delaval, F. Catzeflis, M. Kazanji, S. Matheus, P. Dussart, J. Morvan, A.A Setién, X. Deparis and A. Lavergne.

2009. Dengue Infection in Neotropical Forest Mammals. Vector-Borne Zoonot. Dis. 9: 157–170.
Trolle, M. 2003. Mammal survey in the Rio Jauaperí region, Rio Negro Basin, the Amazon, Brazil. Mammalia 67: 75–83.
Velazco, P.M. 2005. Morphological phylogeny of the bat genus *Platyrrhinus* Saussure, 1860 (Chiroptera: Phyllostomidae) with the description of four new species. Field. Zool. 105: 1–53.
Velazco, P.M. and A.L. Gardner. 2009. A new species of *Platyrrhinus* (Chiroptera: Phyllostomidae) from western Colombia and Ecuador, with emended diagnoses of *Paquilus*, *P. dorsalis* and *P. umbratus*. Proc. Biol. Soc. Washington 122:249–281.
Velazco, P.M. and B.D. Patterson. 2008. Phylogenetics and biogeography of the broad-nosed bats, Genus *Platyrrhinus* (Chiroptera: Phyllostomidae). Mol. Phylogenet. Evol. 49: 749–759.
Velazco, P.M.; C.C. Aires, A.P. Carmignotto and A.M. Bezerra. 2010. Mammalia, Chiroptera, Phyllostomidae, *Vampyrodes caraccioli* (Thomas, 1889): range extension and revised distribution map. Check List 6: 49–51.
Vié, J.C., V. Volobouev and J.L. Patton. 1996. A new species of *Isothrix* (Rodentia: Echimyidae) from French Guiana. Mammalia 60: 393–406.
Voss, R.S. 2011. Revisionary notes on Neotropical porcupines (Rodentia: Erethizontidae). An annotated checklist of the species of *Coendou* Lacépède, 1799. Am. Mus. Novit. 3720: 1–36.
Voss, R.S. and L.H. Emmons. 1996. Mammalian diversity in Neotropical lowland rainforest: a preliminary assessment. Bull. Am. Mus. Nat. Hist. 230: 1–115.
Voss, R.S. and S.A. Jansa. 2009. Phylogenetic relationships and classification of didelphid marsupials, an extant radiation of New World metatherian mammals. Bol. Am. Mus. Nat. Hist. 322: 1–177.
Voss, R.S., D. Lunde and N. Simmons. 2001. The Mammals of Paracou, French Guiana: a Neotropical lowland rainforest fauna Part 2. Nonvolant species. Bull. Am. Mus. Nat. Hist. 263: 1–236.
Voss, R.S., D.P. Lunde and S.A. Jansa. 2005. On the contents of *Gracilinanus* Gardner and Creighton, 1989, with the description of a previously unrecognized clade of small didelphid marsupials. Am. Mus. Novit. 3482: 1–34.
Webb, S.D. 1978. A history of savanna vertebrates in the new world. Part II: South America and the great interchange. Annu. Rev. Ecol. Syst. 9: 393–426.
Weksler, M., A.R. Percequillo and R.S. Voss. 2006. Ten new genera of Oryzomyine rodents (Cricetidae: Sigmodontinae). Am. Mus. Novit. 3537: 1–29.
Wester, P., R. Stanway and A. Pauw. 2009. Mice pollinate the Pagoda Lily, *Whiteheadia bifolia* (Hyacinthaceae) – first field observations with photographic documentation of rodent pollination in South Africa. S. Afr. J. Bot. 75: 713–719.
Wilson, D.E. and D.M. Reeder (eds.). 2005. Mammal species of the world: a taxonomic and geographic reference. 3rd edition. Johns Hopkins University Press, Baltimore. pp. 2181.
Whitmore, T.C. 1998. An introduction to Tropical Rain Forests. 2nd edition. Oxford University Press, New York. pp. 282.
Zerbini, A.N., E.R. Secchi, S. Siciliano and P.C. Simões-Lopes. 1997. A review of the occurrence and distribution of whales of the genus *Balaenoptera* along the Brazilian coast. Rep. Int. Whal. Commn. 47: 407–417.
Zocche, J.J., D.D. Leffa, A.P. Damiani, F. Carvalho, R.A. Mendonça, C.E.I. Santos, L.A. Boufleur, J.F. Dias and V.M. Andrade. 2010. Heavy metals and DNA damage in blood cells of insectivore bats in coal mining areas of Catarinense coal basin, Brazil. Environ. Res. 110: 684–691.