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Problems in the interpretation of Brazilian archaeofaunas: Different contexts and the important role of taphonomy

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Abstract

Studies on Brazilian archaeofauna from prehistoric and historic sites have attempted to explain human settlement and cultural trajectories in different geographical regions. However, only since 1999 have taphonomical criteria been developed during Brazilian zooarchaeological investigations. Wide ecosystem diversity results in the differential preservation of faunal remains. Until the end of the 20th century, many zooarchaeological studies presented insufficient information on complex predator–prey interaction systems in many regions, mostly from the Amazonian lowlands and the highlands of the Central Plateau. Animal remains might have been the result of natural predation, and they are often found mixed within anthropic material that could distort interpretation of deposits. Thus, there are major problems in defining diagnostic criteria to distinguish natural from cultural marks.

Taphonomic analyses are needed to explain faunal remains in order to understand the particularities of human–animal relationships in Brazilian prehistory. Zooarchaeological and taphonomical data are presented from five human occupation sites dating from 9000 to 1000 BP to verify human–fauna relationships and natural deposits in three different regions of Brazil. These sites illustrate both natural and anthropic contexts.

1. Introduction and environmental background

Brazil is the largest and most populous country in Latin America, and the fifth largest in the world in both geographical area and population. Its territory covers 8,514,877 km^2 in South America. It is located in the Neotropical ecozone of South America and is considered as a megadiverse country, presenting a miscellany of ecosystems and biomes and transition zones with micro-environments that often result in many endemic species (Fig. 1).

The Amazon rainforest (Brazilian Portuguese: *Floresta Amazônica* or *Amazônia*; Spanish: *Selva Amazónica* or *Amazonía*) is a moist broadleaf forest in the Amazon Basin of South America. The area, also known as Amazonia or the Amazon Basin, covers seven million km^2, though the forest itself occupies some 5.5 million km^2, located within nine nations: Brazil (with 60% of the rainforest), Colombia, Peru, Venezuela, Ecuador, Bolivia, Guyana, Suriname, and French Guiana. States or departments in four nations bear the name Amazonas. The Amazon represents over half of the planet's remaining rainforest and comprises the largest and most species-rich tract of tropical rainforest in the world. Wet tropical forests are the most species-rich biome, and tropical forests in the Americas are consistently more species-rich than the wet forests in Africa and Asia. The Amazonian rainforests have unparalleled biodiversity. More than $\frac{1}{3}$rd of all species in the world live in this region. The region is home to about 2.5 million insect species, tens of thousands of plants, and some 2000 birds and mammals. At the present time, at least 40,000 plant species, 3000 fish, 427 amphibians, 378 reptiles, 1294 birds, and 427 mammal species have been scientifically classified in the region. Scientists have described between 96,660 and 128,843 invertebrate species in Brazil alone. The diversity of plant species is the highest on Earth with some experts estimating that 1 km^2 may contain over 75,000 types of trees and 150,000 species of higher plants. One square kilometre of Amazon rainforest can contain about 90,790 ton of living

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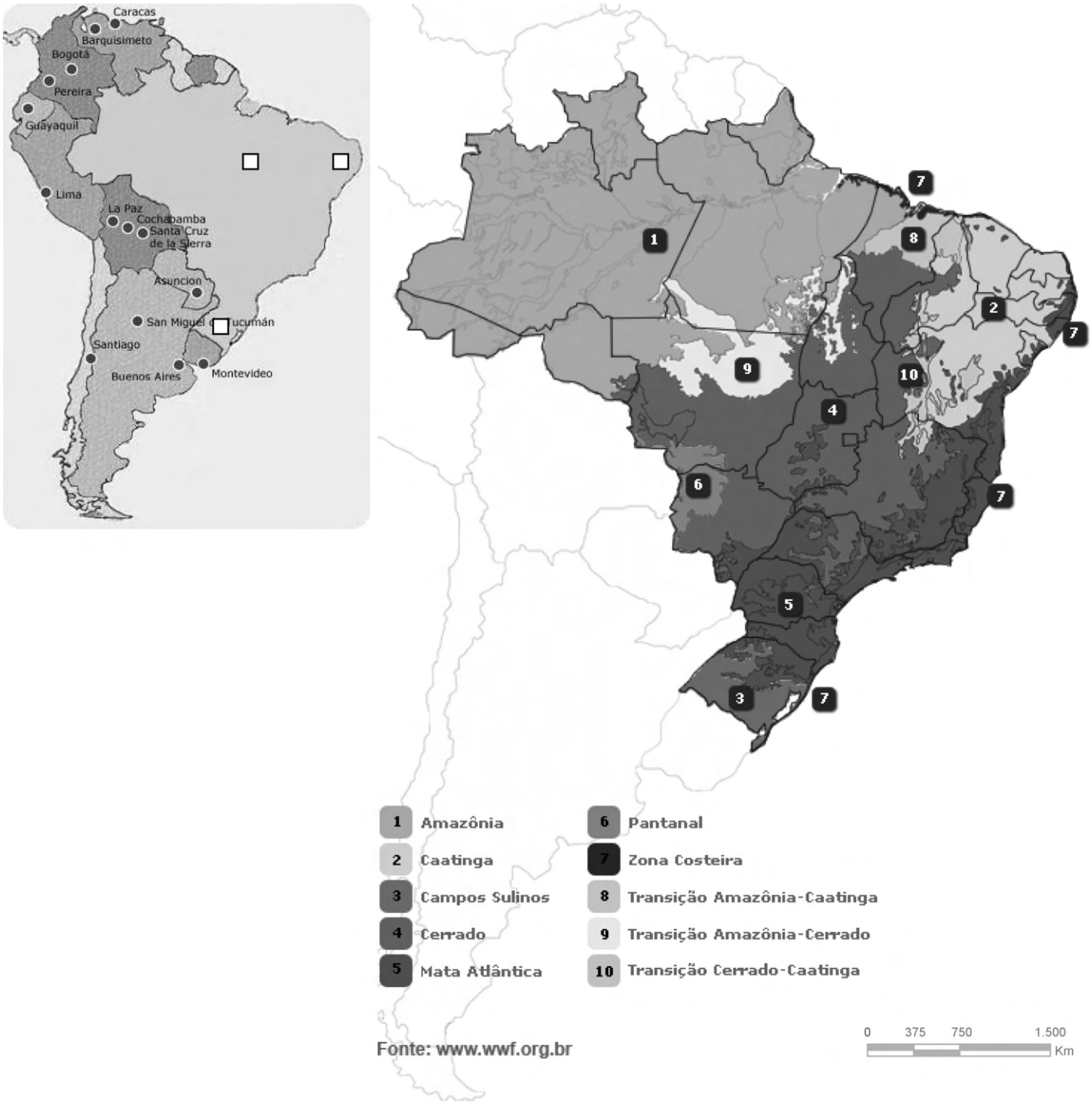


Fig. 1. Location of study areas (white squares) with Brazil's ecosystems according to WWF Brazil data: (1) Amazonia, (2) Caatinga, (3) southern grassland, (4) Cerrado, (5) rainforest, (6) Pantanal, (7) coast zone, (8) transition Amazonia–Caatinga (ecotone), (9) transition Amazonia–Cerrado (ecotone), and (10) transition Cerrado–Caatinga (ecotone).

plants. This constitutes the largest collection of living plants and animal species in the world. One in five of all the birds in the world live in the rainforests of the Amazon. To date, an estimated 438,000 species of plants of economic and social interest have been registered in the region with many more remaining to be discovered or catalogued.

The Caatinga moist forest enclaves are a tropical moist forest ecoregion of northeastern Brazil, which forms a series of discontinuous, island-like enclaves in the dry Caatinga xeric shrubland and thorn forests and Cerrado savannas. The Caatinga moist forest enclaves cover an area of 4800 km^2. These enclaves are found mostly on four major regional plateaus, the Chapada do Araripe, Serra de Ibiapaba, Serra de Baturité, and Serra da Borborema. The enclaves are found on windward slopes and plateaus between 600 and 800 m elevation. The main vegetation

type is semi-deciduous forest with four strata of vegetation and emergent trees taller than 30 m. The forest is generally similar in composition to the Atlantic forests further east, but includes species from the Caatinga, Cerrado, and Amazonia as well. The Caatinga is home to several endemic species of birds, including Lear's macaw or indigo macaw (*Anodorhynchus leari*), Spix's macaw or little blue macaw (*Cyanopsitta spixii*), and moustached woodcreeper (*Xiphocolaptes falcirostris*), and mammals, such as rock cavy (*Kerodon rupestris*), wild cavy (*Galea spixii*), and the micro-rodents of the Sigmodontinae subfamily. This area is also home of macromammals such as red brocket deer (*Mazama americana*), grey brocket deer (*Mazama gouazoubira*), including both peccaries species (*Tayassu pecari* and *Pecari tajacu*), and some carnivores such as *Puma concolor* and many species of *Felis* genera.

The Atlantic forest (*Mata Atlântica* in Portuguese) is a region of tropical and subtropical moist forest, tropical dry forest, tropical savannas, and mangrove forests which extends along the Atlantic coast of Brazil from Rio Grande do Norte State in the north to Rio Grande do Sul State in the south, and inland as far as Paraguay and the Misiones Province of Argentina. The Atlantic forest region includes forests of several variations. The coastal restingas are low forests which grow on stabilized coastal dunes. The coastal forests, also known as Atlantic moist forests, are evergreen tropical forests. Inland are the interior forests, also known as the Atlantic semi-deciduous forests, where many trees drop their leaves during the dry season. Further inland are the Atlantic dry forests, which form a transition between the arid Caatinga to the northeast and the Cerrado savannas to the east. Montane moist forests occur in the Serra do Mar and across the mountains and plateaus of southern Brazil, and are home to Araucaria and evergreen trees of the laurel (Lauraceae) and myrtle (Myrtaceae) families. Shrubby montane savannas occur at the highest elevations. The Atlantic forest is unusual in that it extends as a true tropical rainforest to latitudes as high as 24°S, as the trade winds produce precipitation throughout the southern winter. The Atlantic forest is now designated a World Biosphere Reserve, which contains a large number of highly endangered species including the well-known marmosets and golden lion tamarins. It has been extensively cleared since colonial times, above all in the northeast region, mainly for the farming of sugar cane and for urban settlements. The remnant is estimated to be less than 10% of the original and that is often broken into hilltop islands.

2. Brazilian archaeofaunal studies

The study of past animal diversity and variability is important to understand faunal evidences from Brazilian archaeological sites, although for several years animal remains were recorded by simple checklists, omitting other evidence that attests to human–prey links (Garcia, 1972; Abrahão-Schorr, 1976; Moreira, 1983/1984a, 1983/1984b; Schmitz and Jacobus, 1983/1984; Jacobus, 1985; Lima, 1988; Beltrão and Locks, 1989; Gazzaneo, 1990; Moreira et al., 1991; Alves and Calleffo, 1996). However, by the beginning of this decade, Brazilian zooarchaeologists awoke to the problems related to the origin of the faunal deposits in archaeological sites (De Castilho and Simões-Lopes, 2001; Queiroz, 2001; De Castilho, 2005; De Queiroz and De Carvalho, 2005; Rosa, 2006).

Studies on systems of human–fauna interaction from archaeological sites are still limited to some regions (northeast, southeast, and south). Some of these contexts were discussed by Andrade Lima (1991), Figuti (1989, 1992, 1993), Kipnis (1998), Queiroz and Chaix (1999), Queiroz (2001), De Castilho (2005), De Queiroz and De Carvalho (2005), and Santos (2006).

Some biocultural data were recorded by the study of zooarchaeological samples in all of the major regions in the country. In the *Amazonian region*, some relevant contributions have been offered by Da Silveira (1994), Magalhães (1994, 1998), Moraes-Santos et al. (1999), Queiroz (2001), and Toledo et al. (1999a, 1999b). In the *northeast region*, there are some data from the Pleistocene (De Lumley et al., 1987; Guérin, 1991, 1993; Guérin et al., 1993, 1996; Faure et al., 1999) and Holocene (Beltrão and Locks, 1989; Lima, 1991; Queiroz and Cardoso, 1995/1996; Locks et al., 1997; Rosa, 1997). In the highlands of the *central-west region*, there is further information about human occupation (Abrahão-Schorr, 1976; Vilhena Vialou et al., 1995; Kipnis, 1998; Cartelle, 1999). In the coastal area of the *southeast region*, important data have been presented, particularly for the shellmound sites known as "sambaquis" (Garcia, 1970, 1972; Uchôa and Garcia, 1971; Souza Cunha and Locks Guimarães, 1978, 1981; Mendonça de Souza and Mendonça de Souza, 1981/1982; Souza Cunha et al., 1981, 1986; Vogel and Veríssimo, 1981, 1982; Mendonça de Souza et al., 1983/1984; Vogel, 1983, 1987; Vogel and Kneip, 1983; Moreira, 1984; Andrade Lima et al., 1986; Kneip, 1987; Figuti, 1989, 1993; Veloso and Prous, 1991; Veloso and Resende, 1992; Gaspar, 1998). The *south region* has data both from shellmounds and continental sites (Tiburtius et al., 1949; Tiburtius and Bigarella, 1953; Gazzaneo et al., 1989; Schmitz et al., 1989; Jankowski, 1992; Rosa, 1996; Hilbert and González, 1999; Jacobus, 1999; Queiroz, 2001, 2004; Silva and Rosa, 2006; Teixeira, 2006).

All of these works show a lack of taphonomical criteria relating the prey to animal or anthropic predation. This information is very important in understanding human strategies of settlement and cultural processes in the last 9000 years in the plains and plateaus of oriental South America.

A major problem is presented in many prehistoric sites in Brazil due to mixing of natural and anthropic accumulations, above all those retrieved from caves and rock-shelters. The following questions can be posed:

- How can the origin of the faunal deposits recovered from Brazilian prehistorical sites be determined?

- Which criteria have been used by humans to choose animals for subsistence or cultural purposes?

Natural deposits are important indicators of palaeofauna frequencies, variability, and evolution of the ecosystem and ecotone zones. In the case of faunal remains recovered from archaeological sites, they may serve as markers of ecological interactions in past periods (e.g. natural predation, scavenging), while anthropic samples can indicate human cultural processes in many contexts (cooking, rituals, artefact manages).

This study discusses the importance of animals in natural and human cultural processes in three different regions in the country through taphonomical analysis in five archaeofaunal samples. New comparative data about Holocene fauna are presented from Amazonia, Caatinga, and the southern rainforest. Zooarchaeological and taphonomical data available from five pre-Colombian sites spanning some 9000–1000 BP are summarized to explain the role of taphonomy in understanding human–animal relationships in the three different regions of Brazil.

3. Materials and methods

The zooarchaeological material presented here is derived from three geographical regions of the country (north, northeast, and south) delimited according to their environmental and chronological characteristics (Fig. 2 and Table 1). Information recovered from the five archaeological sites represents an important reference for the study of the palaeofauna and of the palaeoenvironments in the studied areas. Faunal assemblages were analyzed following taphonomic diagnoses to understand processes and agents of animal deposits. A short description of the archaeological sites allows evaluation of the respective contexts.

Fig. 2. Brazilian geographical regions with the location of the archaeological sites studied in this paper: (1) Gruta do Gavião, (2) Gruta do Pequiá, (3) Pedra do Alexandre, (4) Alcobaça, (5) Afonso Garivaldino Rodrigues (RS-TQ-58) (modified from CityBrazil).

Table 1
Location, depositional context, and radiocarbon dates of the archaeological sites

Archaeological sites	Location	Context	Chronological sequences (BP)
Gruta do Gavião (PA-AT-69)	Parauapebas-PA	Cave, hearths	8140±130 (teledyne isotopes 1-14, 912) 8065±360 (Geochron Labs. GX-12510) 7925±45 (Geochron Labs. GX-1251) 6905±50 (Geochron Labs. GX-12509) 4860±100 (teledyne isotopes 1-14, 911) 3605±160 (Geochron Labs. GX-12512) 2900±90 (teledyne isotopes 1-14, 910)
Gruta do Pequiá (PA-AT-81)	Parauapebas-PA	Cave, hearths	9000±50 (beta analytic 110699) 8520±50 (beta analytic 110701) 8340±50 (beta analytic 110702) 8119±50 (beta analytic 110700)
Pedra do Alexandre	Carnaúba dos Dantas-RN	Rockshelter, burials, hearths	9400±90 (CSIC1051) 8280±30 (CSIC965) 6010±60 (CSIC1052) 5790±60 (CSIC1060) 4710±25 (CSIC943) 4160±70 (CSIC1054) 2890±25 (CSIC966) 2750±40 (CSIC1053) 2620±60 (CSIC1061)
Alcobaça	Buíque-PE	Rockshelter, burials, hearths	4697±30 (CSIC2214) 4243±26 (CSIC1708) 2690±25 (CSIC1335) 2405±30 (CSIC928) 1873±24 (CSIC338) 1812±26 (CSIC538) 1785±49 (CSIC103) 1766±24 (CSIC176) 1561±25 (CSIC384) 1234±24 (CSIC2131) 1172±28 (CSIC1810)
Afonso Garivaldino Rodrigues (RS-TQ-58)	Montenegro-RS	Rockshelter, hearths, bone/antler/teeth/shell tools	9439±360 (beta analytic 44739) 8290±130 (beta analytic 32183) 8020±150 (beta analytic 33458) 7520±350 (beta analytic 44740)

According to Da Silveira (1994) and Magalhães (1994), Gruta do Gavião cave was located in the Parauapebas municipality, in the Carajás subregion in southeastern Pará State. The geographical coordinates of the site are 06°06′15″S and 50°07′13″W (Toledo et al., 1999b). This underground cave was destroyed completely after archaeological investigation due to exploitation of ferruginous rock by the Companhia Vale do Rio Doce (CVRD). The archaeological area was 600 m asl and its total surface was 280 m^2. The present vegetation at the entry of the cave is a mixture of humid savanna (named "canga" in the region) and tropical forest. Inside the site, some roots caused infiltration during the rainy period. According to Da Silveira (1994), the present vertebrate biodiversity in the vicinity was decreased due to the anthropic activities.

Gruta do Pequiá archaeological site was also located in Parauapebas. Its geographical coordinates are 06°01′30″S and 50°11′30″W (Toledo et al., 1999b). Site description and chronology was recovered from Magalhães (1994). The archaeological area is located on a layer of iron that was also exploited by CVRD. The Gruta do Pequiá had three galleries and an external marchioness, measuring 28.5 m length. The main room was 72 m long and 3.5 m high. Structured hearths were scattered horizontally inside the cave. They were frequent in all layers of human occupation, with more abundant faunal remains than in the entry area.

Pedra do Alexandre archaeological site is located in the municipality of Carnaúba Dantas, in the Seridó subregion in Rio Grande do Norte State. Its geographical coordinates are 6°32′S and 36°31′W. The main archaeological area is formed by a rockshelter in sandstone, in accelerated phase of decomposition. The site is at an altitude of 50 m. The total surface of the excavations is 200 m^2 under an arch of 15 m height. Some blocks fallen on soil prevented excavations in the internal part of the shelter. The explored zone, in the centre of the site, corresponds more or less to a third of the total surface (Queiroz, 2001). The landscape of Seridó is characteristic of the Caatinga region in Brazil. This biotope is in old valleys. In spite of these semi-arid

conditions, the water resources permitted human survival in prehistoric periods. The archaeological context of Pedra do Alexandre is particularly characterized by the presence of human burials in several chronological levels, as well as structured hearths and of lithic tools (quartz scrapers and a polished axe). Rock paintings with zoomorphic and geometric motives have been recorded as well. Funeral furniture, made of long bones of cervids (metapods) and long bones of birds (pendants and whistles), has been recovered in three burials.

Alcobaça archaeological site is located in the municipality of Buíque, in the semi-arid region of the State of Pernambuco. Its coordinates are 8°32′24″S and 37°11′39″W. It is a rockshelter that has the configuration of a small amphitheatre. The archaeological area has geochemical and environmental characteristics permitting sedimentary surfaces from the disintegration of karstic rocks, favourable to rockshelter formation. The dominant vegetation in the surroundings of the site is Caatinga. An area of 2 m^2 has been dug and three archaeological layers have been inventoried, which contained structured hearths.

Afonso Garivaldino Rodrigues (also named RS-TQ-58) is a rockshelter site, located in the Montenegro municipality, in the region of the central depression of Rio Grande do Sul State. This geological depression separates the plateau of the plain into the south. Basaltic rocks form the rockshelter. The site geographical coordinates are 29°34′5″S and 51°38′45″W. The altitude of the site is 72 m. The shelter opening is situated at the north. The rockshelter measures 21.40 m wide, 8.50 m deep, and 8.60 m high. Several hearths have been recorded. The site presents a stratigraphy divided into four periods (phases) that have been established in southern Brazil. The oldest (fourth) belongs to the ''Uruguai'' phase, according to the typology of the tips of projectiles (bifaces). The second is comparable to the ''Umbu'' phase, based on the type of raw material of the tips as well as the typology. The third has not been defined well, but seems to belong to the ''Araponga'' phase because of the typology of the jagged tips and scrapers. The fourth, most recent period is named ''Taquara'', and its main characteristic is the presence of ceramics. Thus, the archaeological material recovered from the excavations is richer in variety than in quantity with animal bones and teeth, including some used as tools.

In general, archaeofaunal assemblages had particular attributes: well-preserved bones, in spite of high fragmentation, and an abundance of microvertebrates. Several bones were burnt in diverse combustion contexts and

Table 2
Genera and species quantification by NR and MNI by stratigraphic level and chronology from Gruta do Gavião archaeological site (revised and modified from Queiroz, 2001)

Levels (cm)	Surface		5–10		10–20		15–20		20–30		25–30		30–40		35–40	
Chronology (years BP)	–		6905±50		8140±130		4860±100		2900±90		3605±160		7925±45		8065±360	
Quantification	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI
Mazama sp.	3	1	4	2	2	1	8	3	3	1	6	2	4	1	2	1
Tayassu pecari	3	1	2	1	2	1	5	2	2	1	7	2	3	1	2	1
Pecari tajacu	1	1	1	1	1	1	2	1	2	1	2	1	1	1	1	1
Agouti paca	14	5	11	3	5	2	21	7	21	8	18	8	9	3	8	3
Dasyprocta sp.	13	5	13	5	8	3	24	9	28	10	22	7	11	3	9	3
Coendou prehensilis	1	1	1	1	1	1	2	1	2	1	2	1	1	1	0	0
Dactylomys dactylinus	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Echimys sp.	0	0	3	1	1	1	3	2	1	1	1	1	1	1	0	0
Proechimys sp.	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
Akodon sp.	0	0	13	6	11	5	9	4	6	2	6	3	22	8	11	4
Oryzomys sp.	48	20	52	20	63	21	77	24	41	19	33	12	31	12	22	10
Oxymycterus sp.	39	18	46	15	38	14	89	22	87	21	63	14	31	11	34	11
Rhipidomys sp.	55	14	59	13	41	14	36	10	88	20	45	11	37	10	33	10
Rattus rattus	68	12	43	11	37	11	29	13	74	15	38	9	29	11	26	9
Didelphis sp.	0	0	0	0	3	1	6	3	2	1	2	1	2	2	2	1
Monodelphis sp.	12	7	13	7	9	5	11	6	4	2	4	3	5	3	3	1
Philander sp.	0	0	0	0	1	1	2	2	2	1	1	1	2	1	1	1
Bradypus variegatus	0	0	0	0	1	1	3	1	1	1	1	1	1	1	0	0
Dasypus sp.	0	0	1	1	1	1	2	1	2	2	2	1	1	1	1	1
Euphractus sp.	0	0	1	1	2	1	1	1	2	1	1	1	1	1	0	0
Nasua nasua	0	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0
Panthera onca	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0
Alouatta belzebul	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0
Cebus apella	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Ameiva ameiva	3	1	3	1	1	1	8	3	8	3	6	2	1	1	1	1
Tupinambis teguixin	6	2	7	2	5	1	11	3	6	1	12	3	7	2	3	1
Tropidurus sp.	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0
Hoplias sp.	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1

presented different surface modifications. The inventory and the interpretation of these indications are important to understand the formation of the bone accumulations and the role played by the humans in this process.

According to Queiroz (2001), zooarchaeological data were recorded by faunal checklists with quantification by the number of remains (NR) and minimum number of individuals (MNI), indicated by the paired elements. Mammal body size average was defined by three variables: small: body length less than 600 mm; medium: body length from 600 to 950 mm; large: from 951 mm. Mammal age groups were defined by two criteria: (1) teeth eruption with three categories: juvenile: presence of only deciduous teeth, subadult: both deciduous and definitive teeth present, adult: definitive teeth only; and (2) long bone fusion with three categories range: juvenile: no fusioned long bone, subadult: some growth cartilage still present, adult: complete fusion of long bone.

Taphonomical studies used criteria for distinguishing anthropic and natural marks established by Miller (1975), Behrensmeyer (1978), Hill (1979a, 1979b), Korth (1979), Andrews and Nesbit Evans (1983), Denys (1985, 1987), Johnson (1985, 1989), Bonnichsen and Sorg (1989), Buikstra and Swegle (1989), Marshall (1989), Andrews (1990), David (1990), Blasco Sancho (1992), and Lyman (1994). The taphonomical observations were obtained by using a stereomicroscope.

4. Results and discussion

The reduced samples studied in the Amazonian region are limited to the few well-known data on past human–animal relationships. The high biodiversity in this area makes possible several predator–prey chains in nature. With potential human activities added to this system, the series of interactions certainly will increase. This results in a fastidious problem during faunal analyses because in both Gruta do Gavião and Gruta do Pequiá, mixed natural and anthropic faunal accumulations are present. A large reference collection is required. The zoology collections from Museu Paraense Emílio Goeldi were utilized as a comparative reference.

For the Amazonian samples, differences between bone cortical modifications, commonly made by natural predation, and those from human cooking activities were difficult using macroscopical criteria, particularly digestion, chewing, and gnawing marks from large carnivores. Many uncertainties still exist about the natural history of several species related to this biome, the largest of the country. The environment does not only support animal

Table 4
Absolute frequency of bone surface modifications by natural, human, and uncertain causes in major faunal taxa from Gruta do Gavião archaeological site (revised and modified from Queiroz, 2001)

Cause of modification	Taxa			
	Mammals	Birds	Reptiles	Amphibians, fishes
Natural				
Iron oxide impregnation	297	19	13	6
Weathering	169	84	9	0
Human				
Burnt stage 1 (light)	215	172	13	2
Burnt stage 2 (carbonization)	289	211	6	7
Burnt stage 3 (incinerated)	186	120	13	2
Burnt stage 4 (differential)	192	95	5	0
Uncertain (*natural or human*)				
Gnawing	245	44	12	0
Chewing	72	11	6	0
Digestion	12	7	2	0

Table 3
Genera and species quantification by NR and MNI by stratigraphic level and chronology from Gruta do Pequiá archaeological site (revised and modified from Queiroz, 2001)

Layer/level (cm)	Surface		I/20		II/25		III/40–50		IV/+55		V/+55	
Chronology (years BP)	–		8119±50		8340±50		8520±50, 9000±50		+9000±50		+9000±50	
Quantification	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI
Mazama sp.	0	0	1	1	0	0	0	0	2	1	2	1
Ozotocerus bezoarticus	0	0	2	1	0	0	0	0	0	0	0	0
Tayassu pecari	1	1	2	1	0	0	1	1	2	1	0	0
Agouti paca	2	1	12	5	0	0	1	1	1	1	0	0
Dasyprocta sp.	2	1	5	2	3	1	1	1	1	1	0	0
Oxymycterus cf. *amazonicus*	0	0	0	0	0	0	2	2	0	0	0	0
Mus musculus	0	0	1	1	2	1	0	0	0	0	0	0
Rattus rattus	2	1	5	3	0	0	0	0	0	0	0	0
Bradypus variegatus	0	0	1	1	0	0	0	0	0	0	0	0
Dasypus sp.	0	0	1	1	0	0	0	0	0	0	1	1
Ateles sp.	0	0	0	0	0	0	1	1	0	0	0	0
Tupinambis sp.	0	0	0	0	0	0	0	0	0	0	1	1
Boa sp.	0	0	0	0	0	0	1	1	0	0	0	0
Eunectes sp.	0	0	2	1	1	1	1	1	1	1	0	0

Table 5
Absolute frequency of bone surface modifications by natural, human, and uncertain causes in major faunal taxa from Gruta do Pequiá archaeological site (revised and modified from Queiroz, 2001)

Cause of modification	Taxa			
	Mammals	Birds	Reptiles	Amphibians, fishes
Natural				
Iron oxide impregnation	67	19	13	0
Weathering	59	14	9	0
Human				
Burnt stage 1 (light)	45	20	3	2
Burnt stage 2 (carbonization)	89	61	13	0
Burnt stage 3 (incinerated)	86	42	6	0
Burnt stage 4 (differential)	72	15	4	0
Uncertain (*natural or human*)				
Gnawing	35	27	12	0
Chewing	22	11	6	0
Digestion	09	4	2	0

and human subsistence, it also causes damage to archaeological remains. High rates of humidity in the air, correlated with the elevated acidity in a large portion of Amazonian soils, do not allow for preservation of organic matter in many cases. Additionally, archaeofaunal samples from open air sites are damaged by weathering.

Earlier reports on the archaeofauna checklists from Amazonian archaeological sites were offered by Ribeiro et al. (1989) from the State of Roraima. Even so, a first attempt using a systematic approach on the archaeofauna was conducted by Da Silveira (1994), in Gruta do Gavião.

Until the present, there was no systematic study that identified the depositional context of animal remains, whether anthropic or due to natural predation. Most studies to date attribute faunal remains to human behaviour because they were found in archaeological contexts. Queiroz (2001) analysed the vertebrate remains from two caves located in the Carajás region, reviewing Da Silveira's studies on the Gruta do Gavião (Table 2) and initiating investigations on the Gruta do Pequiá (Table 3).

Table 6
Genera and species quantification by NR and MNI by stratigraphic level and chronology from Pedra do Alexandre archaeological site (revised and modified from Queiroz, 2001)

Layer/level	Surface		I/1 and 2		II/1		II/3		III/1		I/3	
Chronology (years BP)	–		2620±60, 2750±40, 2860±25		2890±25, 4160±70, 4710±25		5790±60, 6010±60		8280±30		9400±35, 9400±90	
Quantification	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI
Kerodon rupestris	24	14	45	19	27	13	18	8	13	6	9	4
Galea spixii	18	9	39	17	22	10	16	9	11	5	8	4
Thrichomys apereoides	12	5	33	12	26	14	16	7	12	5	6	3
Euphractus cf. *sexcinctus*	1	1	2	1	2	1	1	1	1	1	0	0
Iguana iguana	0	0	2	1	2	1	1	1	0	0	0	0
Tropidurus sp.	6	2	10	4	11	5	8	3	4	2	1	1
Ameiva ameiva	8	3	16	6	21	8	11	5	8	4	5	2
Tupinambis merianae	11	4	22	9	16	9	12	7	4	1	3	1

Table 7
Genera and species quantification by NR and MNI by stratigraphic level and chronology from Alcobaça archaeological site (revised and modified from Queiroz, 2001)

Layer/level	Surface		I/1		II/2–5	
Chronology (years BP)	–		Between 888±25 and 1561±25		Between 1766±24 and 1785±49	
Quantification	NR	MNI	NR	MNI	NR	MNI
Kerodon rupestris	12	2	53	6	38	4
Galea spixii	7	2	14	6	14	4
Thrichomys apereoides	15	6	14	5	22	9
Echimys sp.	0	0	2	2	0	0
Didelphis sp.	0	0	2	1	5	1
Monodelphis sp.	1	1	1	1	2	1
Philander sp.	0	0	0	0	2	1
Euphractus cf. *sexcinctus*	0	0	1	1	1	1
Tropidurus sp.	1	1	2	1	2	1
Ameiva ameiva	0	0	0	0	2	1
Tupinambis merianae	0	0	1	1	7	1

The author employed macroscopic analyses and taphonomic approaches for distinguishing natural (as sediment impregnations, trampling fractures, weathering, and other) and human modifications on bony surfaces (cutmarks, bone artefacts, burnt pieces from structured hearths) (Tables 4 and 5). However, the results indicate a tendency to consider some medium and large sized species as a part of human subsistence, although other analyses may be conducted in order to establish the real potential of the agents and process of archaeofaunal assemblage formation and the importance to the progress of human cultural trajectory in Amazonia.

Faunal assemblages were recovered from the two rock-shelters located in the northeast region: Pedra do Alexandre (State of Rio Grande do Norte) (Table 6) and Alcobaça (State of Pernambuco) (Table 7) were composed essentially of endemic fauna that is mainly characterized by small animals (''microfauna''). Large animals were virtually absent in the archaeological remains from hearths. They seem to have held different significance for the human groups that settled in the region, as representations are frequently found in rock paintings.

Human burials were found close to hearths in both sites. Nonetheless, they did not disturb the stratigraphic layers.

Several observations were made from visible modifications on the osteological assemblage of microfauna from these sites (Tables 8 and 9), including evidence of cutmarks and disarticulation. Human activities were indicated by the intentional burning of animal remains. The presence of deep transverse streaks, situated on bone epiphysis and in a portion of diaphysis with a remarkable profile in a ''V'' shape, was common. These marks were most likely made by small tools, as quartz and flint chips are very numerous among lithic pieces. Normally, these marks are often confused with trampling streaks.

A rare case of osteopathy of osteomyelitis was noted on a ''rock cavy'' rodent (*K. rupestris*) (Fig. 3). Rodent gnawing was recorded as an indicator of bioturbation.

Bone assemblages from Garivaldino Rodrigues (RS-TQ-58) (State of Rio Grande do Sul) are quite variable

Table 8
Absolute frequency of bone surface modifications by natural, human, and uncertain causes and a pathology case reported (osteomyelitis) in major faunal taxa from Pedra do Alexandre archaeological site (revised and modified from Queiroz, 2001)

Cause of modification	Taxa			
	Mammals	Birds	Reptiles	Amphibians, fishes
Natural				
Sediment impregnation	34	0	6	0
Weathering	5	0	2	0
Human				
Cutmarks and disarticulation	25	0	0	0
Burnt stage 1 (light)	48	0	14	1
Burnt stage 2 (carbonization)	214	0	31	2
Burnt stage 3 (incinerated)	211	0	18	0
Burnt stage 4 (differential)	45	0	6	0
Uncertain (*natural or human*)				
Gnawing	42	0	11	0
Chewing	1	0	0	0
Digestion	3	0	0	0
Osteopathology case (*osteomyelitis*)	01	0	0	0

Table 9
Absolute frequency of bone surface modifications by natural, human, and uncertain causes in major faunal taxa from Alcobaça archaeological site (revised and modified from Queiroz, 2001)

Cause of modification	Taxa			
	Mammals	Birds	Reptiles	Amphibians, fishes
Natural				
Sediment impregnation	34	0	11	0
Weathering	5	0	9	0
Trampling	31	1	9	0
Human				
Cutmarks and disarticulation	29	0	0	0
Burnt stage 1 (light)	48	1	11	1
Burnt stage 2 (carbonization)	199	4	17	4
Burnt stage 3 (incinerated)	220	0	21	1
Burnt stage 4 (differential)	45	0	4	1
Uncertain (*natural or human*)				
Gnawing	51	3	12	0
Digestion	2	0	0	0

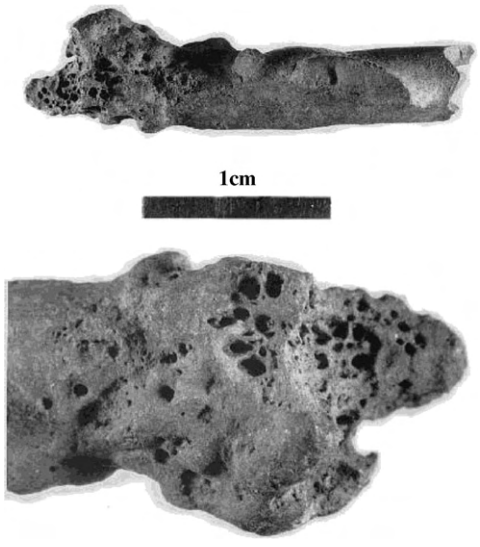


Fig. 3. Left tibia of rock cavy (*Kerodon rupestris*) affected by an osteopathy (osteomyelitis) from Pedra do Alexandre archaeological site. Photo by Claude Ratton (Muséum National d'Histoire Naturelle, Genève).

Table 10
Genera and species quantification by NR and MNI by stratigraphic level and chronology from Afonso Garivaldino Rodrigues (RS-TQ-58) archaeological site (revised and modified from Queiroz, 2001)

Levels (cm)	Surface/from 10 to 50		50–60		130–140		170–180		200–210	
Chronology (years BP)	–		7520±350		8020±150		8290±130		9439±360	
Quantification	NR	MNI	NR	MNI	NR	MNI	NR	MNI	NR	MNI
Blastocerus dichotomus	5	1	6	1	4	1	3	1	2	1
Mazama Americana	9	3	14	5	12	5	9	2	4	1
Tayassu pecari	9	2	11	3	14	3	8	2	4	2
Pecari tajacu	8	2	9	2	10	2	6	1	3	1
Cavia magna	10	3	11	3	8	2	8	2	4	1
Echimys sp.	3	1	4	1	4	1	4	1	3	1
Akodon sp.	21	9	16	4	23	9	13	4	9	2
Holochilus sp.	19	5	15	4	17	5	12	3	11	2
Oryzomys sp.	22	8	14	5	29	11	13	4	10	4
Oxymycterus sp.	21	8	15	6	31	10	16	6	11	4
Scapteromys tumidus	12	4	14	6	15	6	13	5	11	4
Sylvilagus brasiliensis	2	1	2	1	4	1	3	1	1	1
Didelphis sp.	8	3	8	2	9	2	6	2	4	1
Lutreolina crassicaudata	8	4	7	2	7	2	9	3	4	2
Micoureus cinereus	0	0	0	0	1	1	0	0	0	0
Marmosa sp.	9	2	11	0	5	1	5	2	4	1
Monodelphis sp.	31	12	33	12	12	4	10	4	8	3
Philander sp.	8	3	10	3	12	4	8	3	6	2
Cabassous tatouay	2	1	2	1	2	1	2	1	1	1
Dasypus sp.	4	1	2	1	5	2	2	1	2	1
Felis sp.	1	1	2	1	1	1	1	1	1	1
Lutra sp.	0	0	1	1	0	0	0	0	0	0
Alouatta belzebul	0	0	1	1	1	1	0	0	0	0
Cebus sp.	0	0	1	1	1	1	1	1	0	0

(Table 10) and have numerous surface modifications (Queiroz, 2004), many of which were the result of abiotic action and bioturbation (roots and rodents). Others had non-anthropic causes (Table 11). Large animal remains were observed, in particular within combustion contexts.

Cutmarks were mainly observed on cervid bones such as brockets (*Mazama* genus) and peccaries (*Tayassu* and *Pecari* genera). The frequency of burnt elements is significant. Cervid and tayassuidae bones were important, although burnt saurian bones were also observed.

On this site, marks left on thick animal bones seem clearly different from those observed on small fauna, as verified on the "Pedra do Alexandre" and "Alcobaça" sites. Microfauna were previously affected by weathering and bioturbation (roots, insect, and mollusc burrowings).

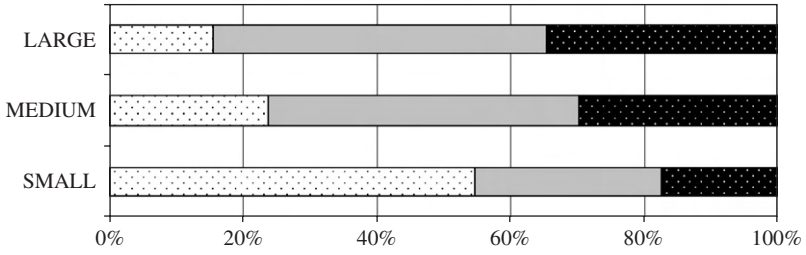
The main characteristic of this faunal assemblage is a high frequency of elaborate artefacts made of wood and from the bones of cervids, as well as from terrestrial gastropod shells (which have been perforated). The pieces have been cut, worked, and polished. Stone awls, scrapers, blades, and adornments also form a part of manufactured artefacts recovered. Zooarchaeological data from these pre-Colombian sites are composed exclusively of wild animals.

Age groups may serve as an additional tool to the understanding of assemblage formation. At Gruta do Gavião, juvenile animals are abundant among small mammals, while the subadults and adults are more frequent among medium and large sized specimens (Fig. 4). At Gruta do Pequiá, juvenile and subadult animals

Table 11
Absolute frequency of bony surface modifications by natural, human, and uncertain causes in major faunal taxa from Afonso Garivaldino Rodrigues (RS-TQ-58) archaeological site (revised and modified from Queiroz, 2004)

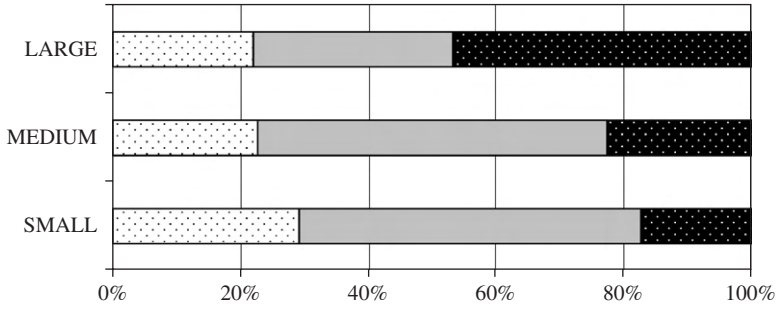
Cause of modification	Taxa			
	Mammals	Birds	Reptiles	Amphibians, fishes
Natural				
Sediment impregnation	112	0	5	0
Weathering	134	0	13	0
Roots	188	0	11	0
Human				
Cutmarks and disarticulation	111	1	0	0
Burnt stage 1 (light)	213	0	9	2
Burnt stage 2 (carbonization)	119	0	11	0
Burnt stage 3 (incinerated)	124	0	8	0
Burnt stage 4 (differential)	112	0	5	0
Uncertain (*natural or human*)				
Gnawing	127	0	4	0
Chewing	15	0	4	0
Digestion	12	0	1	0

are abundant among small sized specimens (Fig. 5). Pedra do Alexandre had a high frequency of juvenile and subadult animals among medium sized specimens, similarly to the Alcobaça archaeological site (Figs. 6 and 7). At Afonso Garivaldino Rodrigues, subadult and adult animals are more abundant in all of variables of body size (Fig. 8).



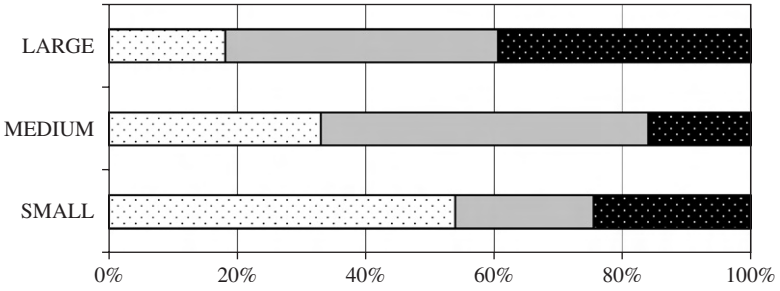
	SMALL	MEDIUM	LARGE
ADULT	75	44	27
SUBADULT	121	69	39
JUVENILE	253	35	12

Fig. 4. Frequencies of body size average and age groups of the mammal remains from Gruta do Gavião archaeological site (modified from Queiroz, 2001).



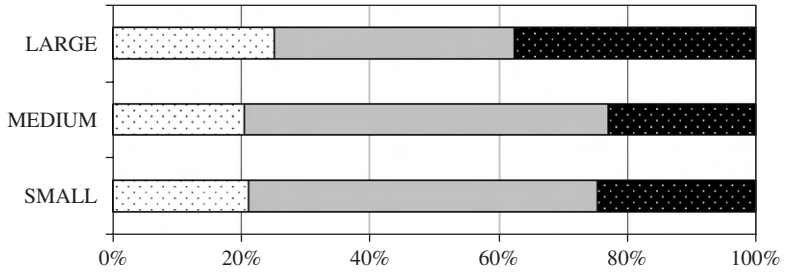
	SMALL	MEDIUM	LARGE
ADULT	15	12	15
SUBADULT	46	29	10
JUVENILE	25	12	7

Fig. 5. Frequencies of body size average and age groups of the mammal remains from Gruta do Pequiá archaeological site (modified from Queiroz, 2001).



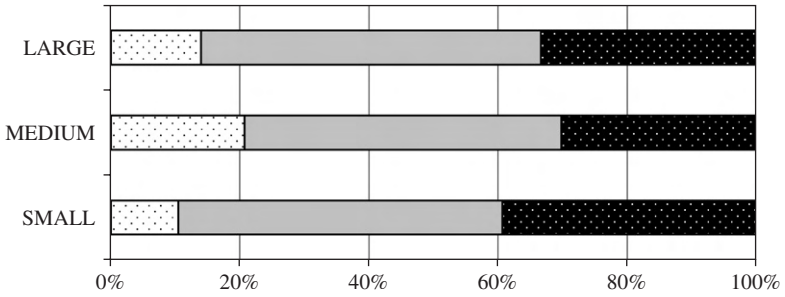
	SMALL	MEDIUM	LARGE
ADULT	25	16	39
SUBADULT	22	51	42
JUVENILE	55	33	18

Fig. 6. Frequencies of body size average and age groups of the mammal remains from Pedra do Alexandre archaeological site (modified from Queiroz, 2001).



	SMALL	MEDIUM	LARGE
ADULT	42	55	3
SUBADULT	92	135	3
JUVENILE	36	49	2

Fig. 7. Frequencies of body size average and age groups of the mammal remains from Alcobaça archaeological site (modified from Queiroz, 2001).



	SMALL	MEDIUM	LARGE
ADULT	87	16	31
SUBADULT	111	26	49
JUVENILE	23	11	13

Fig. 8. Frequencies of body size average and age groups of the mammal remains from Afonso Garivaldino Rodrigues archaeological site (modified from Queiroz, 2001).

These profiles do not seem to be random or due to natural assemblages (by sedimentation, for example): there was certainly a process of prey selection by humans. Taphonomy studies represent the most important instrument to minimize difficulties in determining the origin of faunal accumulations in the country, offering much information on the modification of faunal elements by environments and anthropic actions.

5. Conclusions

The fauna recovered from the five archaeological sites is varied and rich in many faunal groups, mainly in micromammals. Reflecting on the evolution of fauna from a diachronic perspective indicates a certain environmental stability over the last 9000 years in these regions. Many elements are often related to subsistence practices, because some of them carry butchering marks, whereas others are shaped. According to previous taphonomic analyses in some European and North American sites (Blasco Sancho, 1992; Lyman, 1994), microvertebrate concentrations could indicate scavenging activities of natural predators/prey rather than human hunting.

These analyses of Brazilian archaeofauna point to some particular conclusions. The abundance of microvertebrates in several Holocene stratigraphic levels, particularly in the Amazonian and south regions, suggests primarily non-human predation, as they lack evidence of cutmarks, scraping, and disarticulation marks. Anthropic evidence is related to medium and large size specimens (such as an agouti or a peccari) (Figs. 4 and 5).

Evidence of human activity from the small animals is obvious in archaeological sites from the northeast region (Pedra do Alexandre and Alcobaça). These animal bones were abundant in hearths, burnt, often broken in the diaphysis area, and also show cutmarks and butchering evidence.

In summary, the action of non-human predators on microvertebrates is more significant in the Amazonian sites (Gruta do Gavião and Gruta do Pequiá), and in the south (Afonso Garivaldino Rodrigues), because there is no clear evidence of human activity on bone samples (butchering,

cutmarks). Taphonomy is an indispensable tool for a modern zooarchaeological investigation in Brazil.

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