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Perception and use of biodiversity in the vicinity of an urban conservation area, North eastern Brazil

Rômulo Romeu Nóbrega Alves[1,*], Iamara da Silva Policarpo[2], Raynner Rilke Duarte Barboza[1,2] & Helder Farias Pereira de Araújo[3]

[1]Departamento de Biologia, Universidade Estadual da Paraíba (UEPB), Avenida das Baraúnas, 351- Bodocongó, CEP: 58109-753. Campina Grande, Paraíba, Brasil;
[2]Departamento de Sistemática e Ecologia, CCEN, Universidade Federal daParaíba, Laboratório de Termitologia, 58051-900João Pessoa, PB, Brazil;
[3]Departamento de Fitotecnia e Ciências Ambientais (DFCA),Universidade Federal da Paraíba (UFPB), Campus II. Centro de Ciências Agrárias (CCA) Bairro Universitário, CEP: 58.397-000. Areia, Paraíba
E-mail: romulo_nobrega@yahoo.com.br

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The Buraquinho Forest (Mata do Buraquinho) is a remnant of the Atlantic Forest located in the urban area of the city of João Pessoa, PB, Brazil. In this paper, we investigated aspects of environmental perception of the human population living in the surroundings, in order to contribute to future management plans and conservation of this area. A total of 43 questionnaires were applied to residents of neighborhoods adjacent to Buraquinho Forest, the questions sought to assess the social profile, environmental perception, habits, preferences and suggestions regarding natural features and services related to this protected area. Respondents recognize the role and importance of the forest to improve the quality of life as well as point out several aspects which may adversely affect the environment. Urbanization-related problems, such as the dumping of sewage and household garbage in the woods, and the lack of infrastructure, were mentioned by respondents. Data from ecological awareness indicated that respondents recognize the occurrence of 96 species of animals and 63 plants in this forest. Medicinal, edible and ornamental uses were identified in relation to the aforementioned species.

Keywords: Atlantic forest, Ethnoecology, Ethnozoology, Use of biodiversity, Environmental perception.

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The Atlantic forest, although situated in the most urbanized region of Brazil, reduced to only 7.3% of its original dimension, heavily fragmented and still under threat of destruction in various regions, is one of the most important tropical forests on the planet. It has immense scenic, scientific, tourist and cultural value, providing many environmental services such as maintenance of biodiversity, soil protection, water and hillsides, among others, and contributes significantly to the Brazilian economy locally, nationally and internationally[1]. In the state of Paraíba (Brazil), the destruction of the Atlantic forest occurred over time to make way for sugarcane plantations and loggings, reducing the Atlantic forest to small quite vulnerable islands that today, on the whole, do not add more than 0.4% of the state area[2]. Among the main remaining Atlantic forest in the state, the *Mata do Buraquinho* Permanent Preservation Area (forest reserve), located in the city of João Pessoa, capital of Paraíba, has approximately 515 ha and is considered one of the largest green areas in urban environment of the country, which provides numerous benefits to the city of João Pessoa. Urban forests are ecosystems composed by the interaction between natural systems and anthropogenic systems[3]. According to Milano & Dalcin[4], there are several positive aspects to the presence of trees in cities, such as: mesoclimatic stabilization and improvement; reduction of air pollution; reduction of noise pollution; aesthetic improvement of the cities; benefits regarding human health and social, economic and political benefits. One can also cite the absorption of ultraviolet radiation, carbon dioxide and the impact reduction of rainwater and its runoff. The Buraquinho forest is a Permanent Protection Area and is included among the Priority Areas of the Northeast Atlantic Forest Conservation, housing an impressive flora and fauna

*Corresponding author

diversity. However, negative impacts associated with human activities, can be seen in the woods, especially in its immediately marginal areas. Currently, there is an increase of the influence of human activities on nature. With industrial and urban growth, the relationship between human beings and the territory came to have less concern for the natural balance. In addition, many of the conservation and management policies adopted both in Brazil and worldwide are inefficient, largely for ignoring the human communities living in protected areas or in their surroundings. Thus, the ecosystems management should take into consideration the people-environment relationships and perception of human groups involved[5,6]. Considering this background, research on local needs and attitudes of residential communities on the surroundings of parks and reserves can provide subsidies for the re-orientation of the actions and policies taken[7], which has stimulated studies on the subject in recent years[8-11]. Given the above, this study aimed to analyze aspects of the interaction between the Buraquinho forest and human populations living in their vicinity. It sought, through an ethnobiological/ ethnoecological approach, to investigate aspects of environmental awareness and use of fauna and flora resources of the Buraquinho forest also analyzing the conservation implications associated.

Methods

Study area

The survey was conducted in 2005 among residents of adjacent communities to Permanent Preservation Area Forest of Buraquinho forest (7º08'42"S and 34º51'54"W), located South west of the city of João Pessoa, Paraíba state. This remnant of the Atlantic Forest has an area of 515 ha and constitutes a legitimate representative of coastal forests rain in North east Brazil, with typical species recorded in the Atlantic Forest, along with Amazon flora elements and Bahia Hiléia[12].

Data collection

The ethnobiological survey was conducted with residents of the neighborhoods of Christ the Redeemer, Rangel and Jaguaribe who live in the immediate vicinity of the Buraquinho forest. Respondents were chosen at random. Forty three open interviews, directed with semi-structured forms that addressed questions about general knowledge and use of local flora and fauna were carried out. Information on the socio-economic profile was acquired from structured forms[13]. The forms were sent to all respondents in order to confront and compare the result, which refers to the technical information repeated in synchronic situation[13]. To acquire the names of animals and plants known by respondents, it was adopted the technical free list, which assumes that the culturally most important elements appear in many of the lists ordered according to its importance[13]. To address existing limitations to the free list, it was also non-specific induction (Non-specific prompting) and the new reading (Reading back)[14]. An order (Ranking) was made based on the number of times that the species was mentioned, establishing from the free list an array of cultural importance of animals and plants. The lists with the vernacular names of animals and plants were confronted with the specific taxonomy lists to assist identification. In many cases we were able to safely identify the afore mentioned species, or by direct visualization of the same during interviews, or by consulting the zoological work in the area searched[15,16] and the experts registered in the groups, which have developed research in the same area.

Data analysis

We used the Spearman correlation through the Statistica 4.0 software to verify the occurrence of relations between the information of respondents about the frequency of citations of species of animals and plants with socio-economic variables (income, education level, age and residence time on site). For the variable "level of education" was established a ranking 1-9 for the respective categories: 1. illiterate; 2. just write the name; 3. just read; 4. reads and writes; 5. incomplete primary education; 6. complete primary education; 7. incomplete secondary education; 8. complete high school; 9. higher education.

Results and discussion

The profile of the population studied corresponds to people who mostly inhabit the Buraquinho forest vicinity for over 16 yrs. Of the respondents, 25% were female and 75% were men, whose age ranged 16-80 yrs, average of 42 yrs. For positive environmental aspects related to the mentioned forest by the interviewees, the responses were varied. All agreed, however, that the greatest advantages of living close to the forest are associated with improved mesoclimate, since the presence of the forest provides shade, with a cool and pleasant climate and the air is less polluted. In addition, three of the respondents

also highlighted the importance of the forest as a remnant that is home to various animals. The opinions of respondents are corroborated by the authors, as Magalhães & Crispim[17], which point out that urban climate becomes more enjoyable because of the tree cover. According to these authors, the vegetation uses about 60-75% of incident solar energy in the evapo-transpiration process. This "expenditure" in heat evaporation of water results in a reduction in the room temperature.

Concerning the negative aspects, the main problems mentioned by respondents were the accumulation of garbage at the edges of the forest; deforestation that occurs, particularly in times of the June festivities (period that people bonfires in front of their homes to honour Catholic saints); sewage, particularly in the poorest communities; and the fact that the forest represent haven for bandits. Some of these problems are common in urban forest fragments, similar to what occurs in Campinas, São Paulo State, where a large number of human disturbance factors can be perceived, among which stand out the selective logging and deposition of waste and rubble[18]. Twenty five of the respondents indicated that certain animals of the forest are dangerous, like the snakes, especially venomous species (*Micrurus ibiboboca* (Merrem, 1820), *Crotalus durissus* (Linnaeus, 1758) and *Bothrops* sp.), the alligator (*Caiman latirostris* (Daudin, 1802) and *Paleosuchus palpebrosus* (Cuvier, 1807), the tarantulas (*Lasiodora* sp.) and scorpions (*Tityus neglectus* (Mello-Leitão, 1932) and *Tityus stigmurus* (Thorell, 1876).

The assessment of this awareness on the negative aspects is important because it reveals which concentrate the main problems experienced by the population and can serve as a basis for the establishment of conservation measures related to these issues. According to respondents, in addition to deforestation, a major impact on the forest is related to hunting animals for food. Some residents suggest solutions to the problems pointed out; all of them related to social programs and infrastructure such as the construction of the wall around the forest, implementation of environmental education programs for communities and improved supervision.

Buraquinho forest biodiversity in the view of respondents

Mentioned fauna

Respondents mentioned 96 animals (88 vertebrates and 8 invertebrates) occurring in the Buraquinho Forest. Considering the traditional zoos groupings registered species belong to 7 different taxonomic categories. The categories with the highest number of mentioned species were birds (47), reptiles (21) and mammals (19). The other mentioned groups were: mollusks, insects and chelicerate (Table 1). The daily contact of human populations with animal resources enables the recognition of these organisms, especially those resources with utility or even those that represent some risk value[19-22]. Among the mentioned birds, the cock-of-meadow is endemic to the Caatinga and was not raised in fauna inventory held at the Buraquinho Forest. Perhaps this quote is explained due to the hinterland origin of some respondents, or from observation of escaped animals' from cages in private creations, or even of their occurrence on site, since this species can expand their range occupying new areas together with specimens originating from captivity[22]. Dealing specifically with the 4 categories of land vertebrates, amphibians were not even mentioned during the data collection process, although they are common in the region (including the areas inhabited) like some species of frogs, toads and tree frogs[16,5]. A similar situation was observed by Pedroso-Júnior & Sato[23], in a study of human populations Saperagui National Park, Parana State, where no species of frog although of common occurrence, was not mentioned, while nine species in the category "reptiles" were mentioned, especially the *lizard*, *Tupinam bisteguixim*, pointed out as the best animal for use in traditional medicine.

It was observed negative and significant correlations for the variables income and level of education, while the age and residence time variables showed no significant correlation with the frequency of animal quote. It was evident, therefore, that lower social status of people have a more accurate perception of Buraquinho forest wildlife, probably because they commonly use forest resources and possess considerable knowledge of the natural resources they use.

Fauna use

The diversity of interactions that human cultures have with the environment has been the subject of varied works[24-31]. Human populations living inside or around conservation areas generally use natural resources in different ways[8-12,32]. The statements of the respondents reveal that many animals and plants of Buraquinho forest are commonly used for different purposes. Among the respondents' communities,

Table 1- Animal and plant species mentioned by surrounding residents of Buraquinho Forest, João Pessoa - PB

Mammals - *Didelphis albiventris* (Lund, 1840), *Bradypus variegatus* (Schinz, 1825), *Dasyprocta azarae* (Lichtenstein, 1823), *Cuniculus paca* (Linnaeus, 1766), *Tamandua tetradactyla* (Linnaeus, 1758), *Callithrix jacchus* (Linnaeus, 1758), *Euphractus sexcinctus* (Linnaeus, 1758), *Tolypeutes tricinctus* (Linnaeus, 1758), *Dasypus novemcinctus* (Linnaeus, 1758), *Coendouprehensilis* (Linnaeus, 1758), *Leopardus wiedii* (Schinz, 1821), *Cerdocyon thous* (Linnaeus, 1766), *Cavia aperea* (Erxleben, 1777), *Sylvilagus brasiliensis* (Linnaeus, 1758), *Procyon cancrivorus* G. (Baron) Cuvier, 1798

Birds – *Rupornis magnirostris* (Gmelin, 1788), *Falco sparverius* (Linnaeus, 1758), *Geranoaetus albicaudatus* (Vieillot, 1816), *Caracara plancus* (Miller, 1777), *Coragyps atratus* (Bechstein, 1783), *Euphonia chlorotica* (Linnaeus, 1766), *Pitangus sulphuratus* (Linnaeus, 1766), *Coereba flaveola* (Linnaeus, 1758), *Turdus leucomelas* (Vieillot, 1818), *Thraupis palmarum* (Wied, 1821), *Thraupis sayaca* (Linnaeus, 1766), *Ramphocelus bresilius* (Linnaeus, 1766), *Tangara cayana* (Linnaeus, 1758), *Euphonia violacea* (Linnaeus, 1758), *Dacnis cayana* (Linnaeus, 1766), *Sporophila nigricollis* (Vieillot, 1823), *Oryzoborus angolensis* (Linnaeus, 1766), *Paroaria dominicana* (Linnaeus, 1758) – *Sicalis flaveola* (Linnaeus, 1766), *Leptotila rufaxilla* (Richard & Bernard, 1792), *Forpus xanthopterygius* (Taczanowski, 1883), *Gallinula chloropus* (Linnaeus, 1758), *Aramides cajaneus* (Müller, 1776), *Veniliornis passerinus* (Linnaeus, 1766), *Porphyrio Martinica* (Linnaeus, 1766), *Jacana jacana* (Linnaeus, 1766), *Tangaracyano cephala* (Müller, 1776), *Dendrocygna viduata* (Linnaeus, 1766), *Psittacaraleucophthalmus* (Müller, 1776), *Tigrisoma lineatum* (Boddaert, 1783), *Amazona sp., Tapera naevia* (Linnaeus, 1766), *Troglodytes aedon* (Vieillot, 1809), *Columbina squammata* (Lesson, 1831), *Columbina picui* (Temminck, 1813), *Columbina talpacoti* (Temminck, 1809), *Carduelis yarrellii* (Audubon, 1839), *Tyto Alba* (Scopoli, 1769), *Megascops choliba* (Vieillot, 1817), *Turdus rufiventris* (Vieillot, 1818), *Passer domesticus* (Linnaeus, 1758), *Sporophila bouvreuil* (Müller, 1776)

Reptiles - *Caiman latirostris* (Daudin, 1802), *Paleosuchus palpebrosus* (Cuvier, 1807), *Salvator merianae* (Duméril & Bibron, 1839), *Boa constrictor* (Linnaeus, 1758), *Bothrops* sp., *Epicrates cenchria* (Linnaeus, 1758), *Micrurus ibiboboca* (Merrem, 1820), *Oxyrhopus guibei* (Zaher & Caramaschi, 1992), *Oxyrhopus petola* (Linnaeus, 1758), *Philodrya solfersii* (Lichtenstein, 1823), *Spilotes pullatus* (Linnaeus, 1758), *Phrynops geoffroanus* (Schweigger, 1812), *Iguana iguana* (Linnaeus, 1758), *Ameiva ameiva* (Linnaeus, 1758), *Tropidurus hispidus* (Spix, 1825), *Crotalus durissus* (Linnaeus, 1758), *Lachesis muta* (Linnaeus, 1766), *Oxybelis aeneus* (Wagler, 1824)

Chelicerate – *Lasiodora sp, Tityus neglectus* (Mello-Leitão, 1932), *Tityus stigmurus* (Thorell, 1876)

Plants - *Stryphnodendron* sp., *Zizyphus joazeiro* Mart., *Artocarpus jaca* Lam., *Persea americana* Mill., *Elaeis guineensis* Jacq., *Mauritia flexuosa* L.f., *Cocus nucifera* L., *Acrocomia sclerocarpa* Mart., *Musa paradisiaca* L., *Mangifera indica* L., *Anacardium occidentale* L., *Tapirira guianensis* Aubl., *Spondias lutea* L., *Schinusterebinthi folius* Raddi, *Thyrsodiums pruceanum* Benth., *Maytenus* sp., *Lecythi spisonis* Cambess., *Eschweilera ovata* Mart ex Miers, *Byrsonima sericea* DC., *Talisia esculenta* Radlk., *Caesalpinia ferrea* Mart., *Apuleia leiocarpa* Macbride, *Hymenaea courbaril* L., *Manilkara huberi* Standl., *Cecropia* sp., *Lamium album* L., *Cymbopogon citratus* Stapf, *Bambusa vulgaris* Schrad., *Tabebuia* sp., *Tabebuia avellanedae* Lorentz ex Griseb., *Tabebuia chrysotricha* (Mart.ex DC.) Standl., *Terminalia catappa* L., *Struthanthus* sp., *Euphorbia heterophylla* L., *Phyllanthus niruri* L., *Philodendron imbe* Hort. ex Engl., *Hancornia speciosa* B.A.Gomes, *Bowdichia virgilioides* Kunth, *Inga capitata* Desv., *Amburan acearensis* (Allemao) **A.C.Sm.**, *Inga* sp., *Eugenia jambosa* Crantz, *Eugenia olivacea* O.Berg, *Psidium guajava* L., *Psidium guianense* Pers., *Protium heptaphyllum* March., *Smilax brasiliensis* Spreng., *Xylopia frutescens* Aubl., *Didymopanax morototoni* Decne. & Planch., *Lueheao chrophylla* Mart., *Licania octandra* Kuntze, *Hirtella racemosa* Lam.**,** *Cupania revoluta* Radlk**.,** *Solanum* sp., *Passiflora* sp., *Symphonia globulifera* **L.f.**, *Aloe vera* L., *Tetracera breyniana* Schlecht

various forms of human / animal connections can be noted, while most species have just been mentioned, without them having been given a specific value or characteristic. However, from the raised connections, the utility is the most significant and the use as food was the most representative, since 52.6% of the mammal species, 23.8% of the reptiles species and 6.38% of the bird species have been associated with this type of use. Another form of recorded use was medicinal, in this case only 5 species were related, one mammal and four reptiles. The parts quoted for medicinal purposes are lard and leather, which can be used for four different treatment conditions. These raw materials of animal origin have been observed in several studies that addressed the human use of zootherapic resources[33-37]. The number of mentioned medicinal species in this study was small compared to those obtained in the studies above mentioned, which can be explained by the fact that the people living around the Buraquinho forest have easy access to manufactured drugs, thereby restricting the zootherapic use mode. Nevertheless, the use of animals and plants as medicine can be seen as an option in replacement of drugs that the pharmaceutical industry makes available to the population at prices that do not match their socio-economic or cultural reality[38]. Thus, even people who have access to pharmacies can make use of phyto- and zootherapy, either for economic or sociocultural reasons.

Mentioned flora

Every human society accumulates wealth information about the environment that surrounds it, allowing people to interact with it to meet their survival needs.

In this context, it is part of the knowledge concerning the vegetal world with which these societies are in contact[39]. The use of plant resources is strongly present in popular culture that is transmitted from parents to children over the course of human existence. This knowledge is found with and/or contemporary populations, and from what has been observed, tends to decrease or even disappear, when it suffers the inexorable action of modernity. In Brazil, studies on Atlantic forest areas show that its flora has been widely used by human populations for different purposes[39,40]. Respondents of four communities mentioned 63 species vegetables that are present in the Buraquinho forest (Table 1). Of these, 58 were identified, which are members of 36 plant families. Regarding the distribution of the number of ethnospecies for families, it became clear that the 10 most significant were: Anacardiaceae, Fabaceae, Myrtaceae, Arecaceae, Caesalpiniaceae, Bignoniaceae, Gramineae, Euphorbiaceae, Lecythidaceae and Chrysobalanaceae. These families together comprise 55.2% of mentioned species.

It should be noted the case of yellow and violet ipe (*Tabebuia chrysotricha* and *T. avellanedae, respectively*), well appreciated species in an aesthetic context of beauty because of the color during flowering, only occupy eighth place categorically. It is noticed that the plant quotation criteria, similar to what happens to the animals, are closely related to the uses. Some of the above species are introduced, including: avocado, jackfruit, mango, banana and coconut, all of them of recognized use and economic importance. It was not found correlations between the frequency of citations of species plants and socio-economic variables (income, education level, age and residence time on site). There was only a negative and small significant correlation (R=0.037) for the variable income.

Flora use

Many plant species of the Atlantic Forest have been used in different ways by human populations living within or adjacent to protected areas. The situation is no different in the Buraquinho forest, which despite being totally located within the city limits, features a rich floristic biodiversity[2], with many plant species being used in different ways by people living around it. According to the testimonies, 52% of said plant species have utility value. Use categories registered were: medical, food and fuel (for cooking or cooking fires). The category of food use showed a total of 18 species, approximately quantity to medical that showed 17 species. Regarding the use as fuel, most of the respondents did not name any specific type of wood, saying that any "dry wood" lying on the ground can be used for this purpose.

The number of plant species mentioned by surrounding residents of the Buraquinho forest was low compared to other studies conducted with human populations living in areas of Atlantic Forest. In studies conducted in the Atlantic forest of São Paulo, 276 vegetables ethnospecies were mentioned[39]; the Environmental Protection Area of Guaraqueçaba, Paraná State, and Begossi ***et al.***[40] recorded among traditional communities of the South east of Brazil, 227 species used, mainly for food, medicine, handicraft and construction of houses and canoes. The highest number of species mentioned in these studies may be related to the geographical isolation of the areas where they were performed. In the case of the surrounding communities of Buraquinho Forest, direct access to pharmaceutical drugs, gas cylinders, fruits and medicinal plants in fairs, markets and pharmacies may be a factor that can limit the ethnobotanical knowledge. It should be noted that many plant species are taken clandestinely, for the different categories of use. It is important to mention that Buraquinho forest is a full protection area, where extraction of any resources is prohibited.

Conclusion and implications for conservation

The forms of interaction of human populations and the forest are notorious, sometimes appearing to pose risks to biological diversity, sometimes seeming to occur in a sustainable manner[41]. Generally, people have a positive view of the forest, in part influenced by the use of biological resources. The answers of the respondents about the importance of the Buraquinho forest indicate the recognition of ecological aspects and utilities. Respondents recognize the functions of the forest (climate improvement, source of funds, etc.) to improve the quality of life. It appears that this perception is more pronounced, especially among older people, who report the differences experienced in relation to the decrease in the area and the forest quality, including pointing out the disappearance or reduction in natural populations of some species that today do not occur in this environment. It is important to recognize the positive view on the forest among local people, since the dialogue with the community about the environmental problems surrounding the forest, increase the chances to disseminate practices

that can solve them or at least mitigate them[7,42,43]. The positive perception people lay on the forest is an important parameter that can influence the adoption of a conservation behavior. Access to information about the ecological importance of the forest, environmental legislation and enforcement of punishments appear to be factors influencing the view of the environment. The performance of environmental enforcement agencies in the area, according to residents, is shown innocuous, perhaps because of the lack of public awareness programs. Respondents point out several factors that may adversely affect the environment, especially the deposition of garbage at the edges of the forest, the release of sewage, deforestation and hunting. Some even propose measures that can solve such problems. In this sense, such perceptions should be taken into account, although the economic logic can influence people's attitudes, there seems to be a predisposition to conserve the forest, due to both legal requirements (penalties) as the appreciation and enjoyment of ecological benefits. Actions that allow improving the quality of life of families living in the vicinity of the forest, without a doubt, will have positive effects in preserving it. Environmental education programs and better surveillance at important periods such as in times of June Festivals certainly decrease the pressure on vegetation. In this context, the participatory process of environmental implementation management programs embedded in a social dynamics, through activities involving residents, seems to be a viable solution.

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