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COMPOSITION, REPRODUCTION AND ECOLOGICAL ASPECTS OF A CAATINGA ANUROFAUNA IN PARAIBA STATE, BRAZIL

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ABSTRACT

Composition, reproduction and ecological aspects of a Caatinga anurofauna in Paraiba state, Brazil. The study area is located at 7 ° 22 'S and 36 ° 15' W, in the Cariri Paraibano, one of the driest regions of Brazil. It has typical Caatinga vegetation and a diversity of natural and artificial water bodies. Eighteen species of anurans belonging to the families Pipidae, Leptodactylidae, Odontophrynidae, Bufonidae, Hylidae, Phyllomedusidae and Microhylidae were recorded. From each species data on activity, reproduction, behavior and micro-habitat were obtained. Each of the 15 water bodies studied was described and the presence of the different forms of anurans throughout the study period, from 1982 to 1984 was recorded. All species had the reproductive period regulated only by rainfall and did not show any special adaptations or specific reproductive strategies for the semi-arid environment. The differences between species in the occupation of the water bodies and the duration of the reproductive period did not seem to be related to a temporal or spatial partition of the environment. Seven different reproductive modes have been recorded, all of which are also found in more mesic habitats.
Key words: Anurofauna, Caatinga, Composition, Ecology, Reproduction, Paraiba, Brazil.

RESUMO

Composição, reprodução e aspectos ecológicos de uma anurofauna de Caatinga no Estado da Paraíba, Brasil. A área de estudo (7°22' S e 36°15' W), está inserida no Cariri Paraibano, uma das regiões mais secas do Brasil. Ela possui vegetação típica de Caatinga e uma diversidade de corpos de água naturais e artificiais. Foram registradas 18 espécies de anuros pertencentes às famílias Pipidae, Leptodactylidae, Odontophrynidae, Bufonidae, Hylidae, Phyllomedusidae e Microhylidae. De cada espécie foram obtidos dados sobre atividade, reprodução, comportamento e micro-hábitat. Cada um dos 15 corpos de água estudados foi descrito e teve registrada a presença das diversas formas de anuros ao longo do período de estudo, de 1982 a 1984. As espécies registradas tiveram o período reprodutivo regulado apenas pelas chuvas e não apresentaram adaptações especiais ou estratégias reprodutivas específicas para o ambiente semiárido. As diferenças entre as espécies na ocupação das

massas de água e na duração do período reprodutivo não pareceram estar relacionadas com uma repartição temporal ou espacial do ambiente. Sete modos reprodutivos diferentes foram registrados, todos eles também encontrados em formas de habitats mais mésicos.
Palavras chave: Anurofauna, Caatinga, Composição, Ecologia, Reprodução, Paraíba, Brasil.

INTRODUCTION

The domain of the Caatingas (ANDRADE-LIMA, 1981), which occupies a large part of Northeastern Brazil, is characterized by a marked seasonality, with a prolonged dry season that lasts from 6 to 11 months each year, when there is practically no rainfall, and a short and irregular rainy season, in which precipitations are very frequent and intense. The annual total rainfall varies temporally and spatially, but typically is less than 1000 mm, with some areas presenting a historical average of less than 500 mm (MORO *et al.,* 2016). The Caatinga encompasses a variety of environments and phytophysiognomies, but the vegetation present in most of its domain consists of an open, deciduous forest, formed by trees of low or medium height and spiny shrubs (HUECK, 1972).

Despite the prevailing semiarid conditions, Northeastern Brazil presents an interesting anurofauna, which has been the subject of several studies in the last twenty years (ARZABE, 1999; BORGES-NOJOSA and SANTOS, 2005; LEITE-FILHO *et al.* 2015; SANTANA *et al*., 2015; VIEIRA *et al*., 2007). However, most of these studies have been made in the coastal region, in more mesic areas of the Caatinga, or in the so-called "Brejos de Altitude", with few being carried out in the semi-arid region with vegetation of Caatinga *stricto sensu* (SANTANA *et al*., 2015). The dependence of anuran amphibians on the aquatic environment to reproduce and their relative vulnerability to desiccation make it of particular interest to study the diversity and aspects of the ecology and reproduction of these animals in an environment with extreme variations and irregular availability of water, such as the Caatinga. Of special interest is the possibility to identify possible adaptations of anurans to reproduction under these conditions. Other vertebrates, such as mammals, did not show special adaptations to the Caatinga environment (MARES *et al.,* 1985). This would be a consequence of the temporal heterogeneity of the Caatinga, where we see an arid climate at one moment and one intensely pluvial at another moment. Thus the adaptations to one of the two environments would not be useful in the other and the more generalist organisms would be the most successful. Survival strategies in anurans of xeric environments have been described in several studies (BENTLEY, 1966; BLAIR, 1976; LOW, 1976; MAYHEW, 1965 and 1968 and NAVAS *et al*., 2004). In the case of the Caatinga anurofauna, these strategies would work during drought but during the rainy season, the most favorable strategies would be those found in more mesic environments.

During the first visit we made to the Fazenda Bravo in the 1981 rainy season our attention was called by the diversity of anuran species vocalizing simultaneously and the variety of water bodies in the area, including natural and artificial, temporary or permanent. So came the idea of conducting a long-term study on the diversity and reproduction of anurans in this area since our knowledge on the reproductive biology of anurans in the semi-arid Caatinga environment still is scarce (VIEIRA *et al*., 2009). We began fieldwork in 1982 in the context of Paulo Cascon's master thesis with the purpose of studying the local anuran community. Our hypothesis was that the local anuran fauna would present a low richness compared to that of more mesic areas in Northeastern Brazil because of the semi-arid conditions and that the majority of the species would reproduce during the rainy season, competing with each other for reproductive space. Thus, we wished to understand: A) The local composition of the anuran fauna; B) The periods of general activity and reproduction of each species; C) The temporal patterns of use of water bodies by different species; D) The spatial patterns of use of water bodies by different species. Finally, we wished to discuss, for the different species, the degree of adaptation to environmental conditions, both the more xeric found during the dry-season as well as the more mesic found during the rainy season.

THE STUDY AREA

Location

The area where this study was carried out is placed in the rural property called Fazenda Bravo, located 11 km south of the city of Boa Vista, on the border between the Municipalities of Cabaceiras and Boa Vista, in the State of Paraíba (7 ° 22 'S and 36 ° 15' W), between 400 and 500 meters of altitude. The Fazenda is part of the Cariri Paraibano, formed by the microregions of Cariri Occidental and Cariri Oriental, mesorregion of Borborema. This region is one of the xeric poles of Northeastern Brazil. The average annual precipitation does not reach 600 mm, having in Cabaceiras the lowest rainfall indices of Brazil (246 mm). The annual average temperature is 26°C, with minimum averages below 20°C, and the relative humidity does not exceed 75%. In Cariri the soils are shallow and stony and vegetation is considered low and poor in species, but it accompanies a gradient of precipitation and soil depth (ALVES, 2009). In the study area, there are large outcrops of crystalline rocks, more or less flat, characteristic of the Caatinga and locally called "lajedos" or "lajeiros".

This area was chosen because it presented some characteristics that were adequate to the objectives of the present study, such as being placed in one of the driest regions of Brazil, possessing typical Caatinga vegetation, and a diversity of natural and artificial water bodies used by anurans (Fig. 1). The region of Cariris Paraibanos was considered one of the priority areas for the conservation of reptiles and amphibians in the Caatinga (RODRIGUES, 2003).

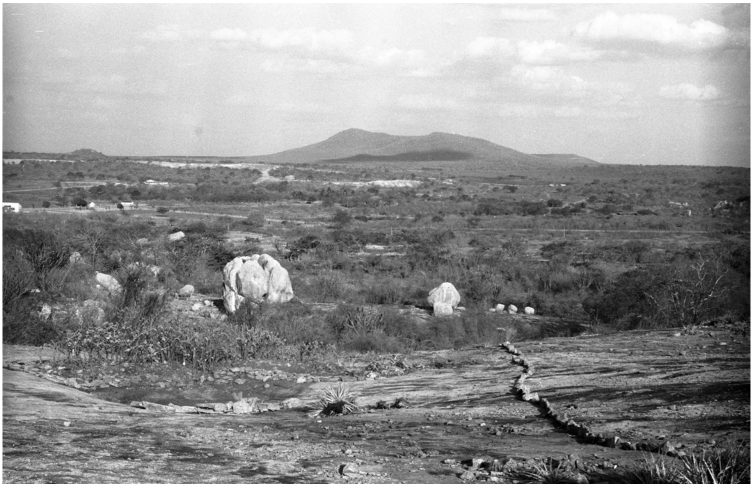

Figure 1. Panoramic view of the study region.

Climate

The region exhibits a concentrated rainfall regime, annual precipitation with very low values, and a lack of transition between the dry and rainy seasons and vice versa, with abrupt changes in precipitation rates from one month to another. The rainy seasons of the three years in which the field work was carried out varied in starting time, duration, precipitation volume and rainfall distribution pattern (Fig. 2).

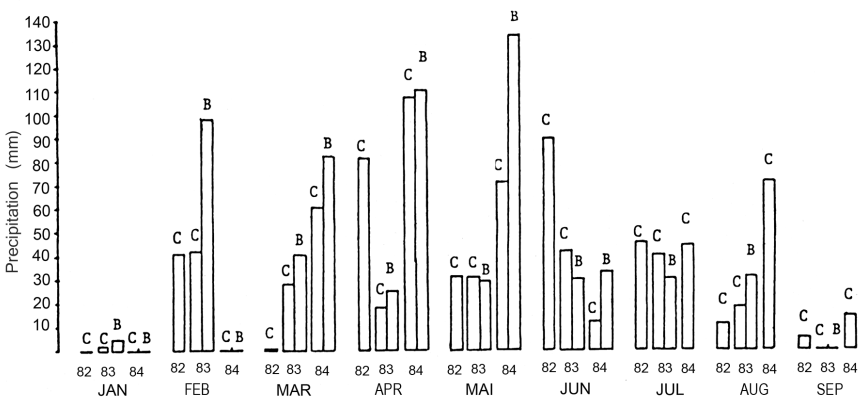

Figure 2. Monthly precipitation (mm) in 1982 (82), 1983 (83) and 1984 (84), in Cabaceiras (C) and Faz. Bravo (B). Data from Cabaceiras provided by SUDENE.

The rainy season of 1982 began in November of the previous year, and extended until September. Monthly records were not available in Faz. Bravo for this year. In 1983 the rains began in January and finished in August, whereas in 1984 they started only in March, and lasted until September. The first two years of the study had lower precipitations than the historical average of the neighboring municipality of Cabaceiras - 336.6 mm from 1926 to 2011 (MEDEIROS *et al*., 2012) - reaching 306.0 mm in 1982 and 321.7 mm in 1983. In 1984 there was an increase in the total volume of precipitation, which reached 379.9 mm. Another significant aspect was the absence of daily rainfall of greater magnitude, with the highest record of only 47 mm in Feb 5, 83 (Fig. 3).

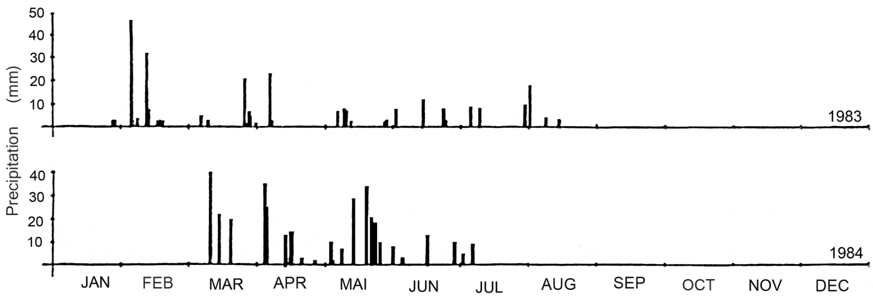

Figure 3. Daily precipitation (mm) in 1983 and 1984 (until July 6), in Faz. Bravo.

The aridity of the study area is accentuated by local topographical situations. The region is located on the leeward side of the mountain ranges bordering Pernambuco state, which causes a decrease in the humidity of the Southeastern trade winds, after producing orographic rains in their windward slopes (CARVALHO, 1982). The rivers of the region have exorreic drainage (AB'SÁBER, 1974), with a torrential regime, characterized by presenting the period of time with null discharge almost always larger than the period in which there is flow. The dry season presents a gradual lowering of the river waters until reaching a minimum, almost always equal to zero, while the floods occur in an abrupt way (NIMER, 1979).

Regarding the temperature regime, the studied area is characterized by a considerable degree of homogeneity, with an elevated frequency of high temperatures throughout the year, insignificant annual thermal amplitudes and remarkable daily amplitudes in every month (NIMER, 1979).

The maximum and minimum values of the air temperature recorded during the excursions to Faz. Bravo are given in figure 4. The highest temperatures were recorded toward the end of the dry season (34°C between Jan 18 and Jan 21, 83 and 33°C between Feb 29 and Mar 3, 84). With the beginning of the rains, there was a drop in the maximum temperatures recorded, which rose again at the end of the rainy seasons of 1982 and 1983.

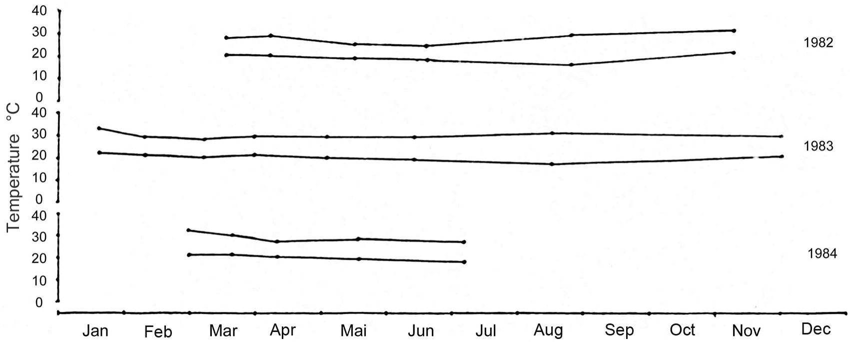

Figure 4. Maximum and minimum air temperatures (°C) recorded during excursions to Faz. Bravo.

The lowest temperatures were recorded at the end of the rainy season (17°C between Aug 24 and Aug 27, 82 and 18°C between Aug 15 and Aug 18, 83). The minimum temperatures recorded did not show significant variations between the dry period and the beginning of the rainy season. Consequently, the highest thermal amplitudes during the excursions were recorded at the end of the rainy season (13°C between Aug 24 and Aug 27, 82 and 12°C between Aug 15 and Aug 18, 83).

Vegetation

The flora recorded in the Cariri Paraibano is composed by 396 species, distributed in 90 families. Some families are characteristic of aquatic environments, such as Cabombaceae, Lemnaceae, Limnocharitaceae, Menyanthaceae, Nymphaeaceae and Pontederiaceae, that show up only during the rainy season, in dams, mud pits and temporary ponds. The scarce vegetation that occurs on the "lajeiros" throughout the Cariri, shows characteristic species of rocky outcrops and a low diversity in relation to the Caatinga that surrounds them (BARBOSA *et al.*, 2007). On the other side, there are arboreal species in places next to rocky walls, very common in the region. The most frequent Cactaceae in the area are the facheiro (*Facheiroa squamosa* (Gürke) PJBraun and Esteves) and the xique-xique (*Pilosocereus gounellei* (FACWeber ex K.Schum.) Byles and GDRowley) being also very common the Bromeliaceae known as macambira (*Bromelia laciniosa* ex Schult. and Schult.f.). The main human activity in the area surrounding the studied water bodies is extensive cattle breeding, mainly goats, and to a lesser extent bovines and sheep.

METHODS

In the area chosen for the field work, a selection of water bodies to be studied was made, according to size, depth, nature of the substrate where they were formed and amount of aquatic vegetation. The excursions for the collection of data were made in the period between March 1982 and July 1984, and were concentrated in the rainy season, when an average of one excursion per month was made (Fig. 5). During the dry season, sparse collections were carried out. The total number of excursions was 19, each of which lasted an average of 3 days.

Every night during the excursions, with help of a flashlight, searches were made in all selected water bodies, in the dry areas among them, in small rain-ponds and in the vegetation located near the water bodies.

We looked for all anuran amphibians that were active, recording for each animal, place, time of observation and activity performed. Concomitantly with the observations, selective collection of voucher specimens belonging to species in activity was made. In each excursion, a collection of tadpoles in each water body was made with a thin mesh net of 43 cm diameter. During these collections it was sought to cover the entire extent of the water body, or when this was not possible, the whole margin. The collected tadpoles were immediately sorted by species. Part of the specimens of each species was fixed in a 5% solution of formaldehyde and preserved in labeled flasks, the other part was placed in plastic containers with water where the larvae were transported alive to the laboratory. Each collection was accompanied by a record of the temperature of the water and air. In every excursion, samples of the plants that were in or around the water masses were also collected.

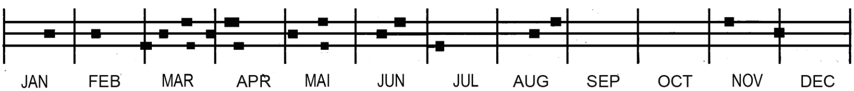

Figure 5. Periods in which the field work was done (bars) in Faz. Bravo (top line = 1982, midline = 1983 and bottom line = 1984)

As of November 1982, a direct reading rain gauge was installed in the working area. A resident of the farm carried out daily readings on the device. It was also considered rain data recorded in the city of Cabaceiras, about 12 km from Faz. Bravo, supplied by SUDENE, to show the irregular distribution of precipitation in the region. During the excursions, the maximum and minimum air temperature were recorded daily. The captured adult animals were transferred alive to the laboratory inside plastic bags arranged in a thermic box. Upon arrival they were photographed and then killed, labeled, fixed in trays until they were stiffened and then placed in vials with a 10% formaldehyde solution. After 10 days the fixative was removed, and the animals, after washing, preserved in a solution of ethyl alcohol at 70 ° GL. The tadpoles transferred alive to the laboratory were kept in plastic containers and fed with commercial food for ornamental fish, being fixed only after the metamorphosis, thus allowing their identification. During the dry season excursions, excavations were carried out with the aid of a sharp spade in the dry beds of water bodies in an attempt to discover buried anurans. The animals were considered active, as long as they were not buried or sheltered in stone holes without vocalizing. Individuals more than 10 m apart were considered to be far from water bodies. The names used here for the water bodies were, in the majority, created for identification purposes. In the figures and tables, the water bodies are arranged in descending order of time in which they remained with water during the study period.

The amphibians collected as voucher specimens were incorporated into the Herpetological Collection of the Department of Systematics and Ecology of the Federal University of Paraíba and cited with catalog number in the treatment of each species. The plants collected were sent to the Lauro Pires Xavier Herbarium of the same institution.

THE WATER BODIES OF THE FAZENDA BRAVO

General features

The water bodies studied in the present work are the result of the accumulation of rainwater in natural basins in the lajeiros, called tanks locally, and in small, flat depressions of the terrain, located on the margins of the lajeiros and at the edge of the road that connects the city of Cabaceiras to the city of Boa Vista. These water bodies varied in the extension of the water surface, depth, bottom type, biotic content and time of duration.

The basins in the lajeiros, although originally natural, were deepened by the inhabitants of the region, who removed the rubble and earth carried by the water over time during torrential rains, with the purpose of increasing the storage capacity, thus minimizing the water supply problem.

Periodic cleaning of the tanks is carried out and, in some cases, the construction of gutters, dams and walls has been made, to increase their capacity to capture and store water.

The masses of water found on the banks of the lajeiros can be considered as natural. On the other hand, those that form on the roadside have their existence conditioned to the presence of the road itself that functions as a dam (Figs. 6, 7 and 8). Figure 9 shows the distances between the groups of water bodies of figures 6, 7 and 8.

The vegetation of the water bodies

The vegetation of the water bodies was rich, with 21 species recorded. The plants and the water bodies in which they were collected are listed in Table 1. The aquatic and swampy forms appeared about 1 month after the onset of rains and disappeared, for the most part, after the end of the rains, even in the water bodies that did not dry out. *Lemna minor* and *Pistia stratiotes*, however, remained as long as water was available.

A

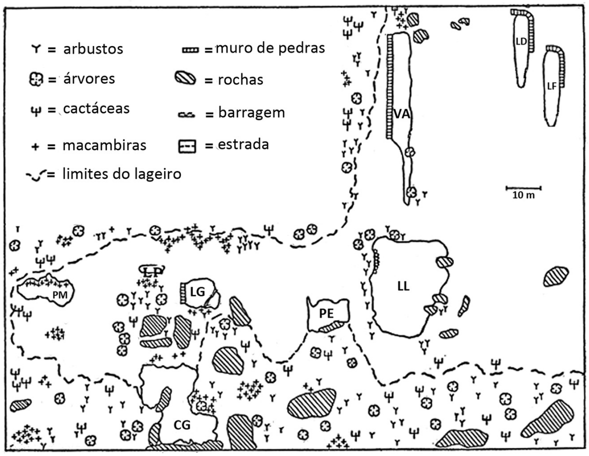

Figure 6. Map of part of the water bodies of Faz. Bravo corresponding to group A of Fig. 9. **LD** = Lagoa de Dentro, **LF** = Lagoa de Fora, **PM** = Poça com Macambiras, **LG** = Lagoa Grande, **PE** = Poça a Esquerda, **LL** = Lagoa da Laje, **CG** = Charco Grande and **VA** = Lagoa da Vala.

B

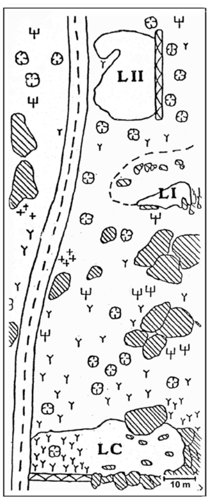

Figure 7. Map of part of the water bodies of Faz. Bravo corresponding to group B of Fig. 9. **LII** = Lagoa II, **LI** = Lagoa I, **LC** = Lagoa da Carroça. Other symbols as in Fig. 6.

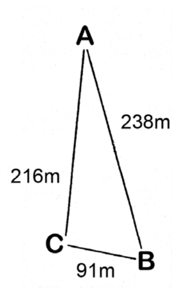

Figure 9. The distance between the three groups of water bodies (A = group shown in Fig.6, B = group shown in Fig. 7, C = group shown in Fig.8)

C

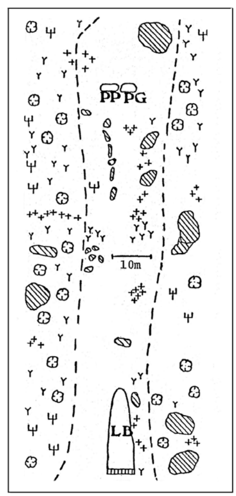

Figure 8. Map of part of the water bodies of Faz. Bravo corresponding to group C of Fig. 9. **PP** = Poça Pequena, **PG** = Poça Grande, **LB** = Lagoa da Bomba. Other symbols as in Fig. 6.

Table 1. Plants and water bodies in which they were collected.

Species / Water bodies	L. Laje	L. Bomba	L. Grande	Lagoa II	Vala	Lagoa I	L. Pequena	P. Grande	P. Esquerda	L. Carroça	P. Macambiras	C. Grande
ALISMATACEAE												
Echinodorus andrieuxii (Hook and Arn) Small	X	-	-	-	X	-	-	-	X	-	X	X
ARACEAE												
Pistia stratiotes L.	X	-	X	-	-	-	-	-	-	-	-	-
BUTOMACEAE												
Butomus sp.	-	-	X	-	X	-	X	-	X	X	-	-
MENYANTHACEAE												
Nymphoides indica (L.) Kuntze	X	-	-	-	-	-	-	-	X	-	-	-
CAPPARACEAE												
Cleome spinosa Jacq.	X	-	-	-	X	-	-	-	X	-	X	-
CONVOLVULACEAE												
Ipomea sp.	-	-	-	-	X	-	X	-	-	-	-	-
Jacquemontia sp.	-	-	X	-	-	-	-	-	-	-	-	-
CYPERACEAE												
Cyperus sp.	X	-	-	-	-	X	-	-	X	-	-	X
ERIOCAULACEAE												
Undetermined species	X	-	-	-	-	X	-	-	-	X	X	X
EUPHORBIACEAE												
Jatropha sp.	-	-	-	-	-	-	X	-	-	-	-	-
FABACEAE												
Rhynchosia minima (L.) DC	-	-	-	-	-	-	-	-	X	-	-	-
LEMNACEAE												
Lemna minor L.	-	X	X	-	-	-	-	X	-	-	-	-
LYTHRACEAE												
Ammannia sp.	-	-	-	-	-	-	-	-	X	-	-	-
NYMPHAECEAE												
Nymphaea lasiophylla Mart. and Zucc.	**X**	-	-	-	-	-	-	-	-	**X**	-	**X**
ONAGRACEAE												
Ludwigia latifolia (Benth) H.Hara	**X**	-	-	-	-	-	-	-	-	-	-	-
Ludwigja sp.	-	-	**X**	-	-	-	-	-	-	-	-	-
POACEAE												
Undetermined species	**X**	-	**X**	-	**X**	**X**	-	-	**X**	-	-	**X**
PONTEDERIACEAE												
Hydrothrix gardneri Hook. f.	-	-	-	**X**	**X**	**X**	-	-	**X**	**X**	-	-
Pontederia sp.	-	-	-	-	-	-	-	-	**X**	-	-	-
SCHROPHULARIACEAE												
Stemodia maritima L.	**X**	-	-	-	-	-	-	-	-	-	-	-
VERBENACEAE												
Stachytarpheta sp.	**X**	-	-	-	-	-	-	-	-	-	-	-

Description of the Water Bodies

LAGOA DA LAJE (LL) Figure 10. - Located on the lajeiro, measured approximately 28m x 22m and 2.5m of maximum depth. The bottom was stony in its deeper half, and sandy in the other half. All along its bank, there were numerous stony hiding places. In this water body tadpoles were found only in 1984, this may be related to the presence in the previous two years of fishes of the genus *Tilapia*, which would predate the anurans' eggs and / or larvae. The existing plants were concentrated along its banks and shallower places. The highest temperature recorded in the water was 29°C (Mar 7, 83 at 15:05; Mar 19, 84 at 16:20 and Apr 10, 84 at 13:15).

LAGOA DA VALA (VA). - Located on the lajeiro, next to an elevation of the same, measured about 50m x 5m and 1.5m of maximum depth. The rocky bottom was covered by a thin layer of earth and vegetable debris. Along one of its banks was a stone wall about 0.3m high to increase its water storage capacity. The plants were concentrated in the extremities of this body of water, being few in number. The highest temperature recorded in the water was 29°C (Apr 10, 84 at 14:35).

LAGOA DE FORA (LF) Figure 11.- It was a deep, elongated depression of the lajeiro, measuring about 22m x 4.5m and a maximum depth of 3m. The rocky bed had small amount of sediment only at its deepest parts. A stone wall about 0.4 m high was built along part of its banks in order to increase its water storage capacity. Gutters were constructed in its proximities to drive the rain water into this depression. In this water body no vegetation was observed during the study period. The highest temperature recorded in the water was 29°C (Jan 19, 83 at 14:00).

LAGOA DE DENTRO (LD) Figure 12. - Quite similar to the Lagoa de Fora, being, however, a little smaller, with about 21m x 4m and 3m of maximum depth. Like the previous water body, there was sediment deposited only in some of its deeper places, in addition to a wall of stones along part of its margin and gutters in nearby areas. Also in this water body no plants were found. The highest temperature recorded in the water was 28°C (Mar 20, 84 at 13:50, Apr 10, 84 at 15:10).

POÇA A ESQUERDA (PE). - Located next to the margin of the lajeiro, measuring about 11m x 9m and 0.4m of maximum depth. It has a sandy bottom. The several plants found therein occupied the entire bed. The highest temperature recorded in the water was 29°C (Mar 7, 83 at 16:20, Mar 19, 84 at 17:36 and Apr 10, 84 at 13:45).

POÇA COM MACAMBIRAS (PM) Figure 13. - Located in the lajeiro near its border, it had irregular shape, measuring approximately 16m x 7m and 0.3m of maximum depth. Its bed was covered by a thin layer of sand where about 20 macambiras (*Bromelia laciniosa*), were growing. In addition to these plants, its bed was also covered by Eriocaulaceae, as well as sparse *Echinodorus andrieuxii*. The highest temperature recorded in the water was 31°C (Mar 29, 83 at 10:45).

Figure 10. View of Lagoa da Laje

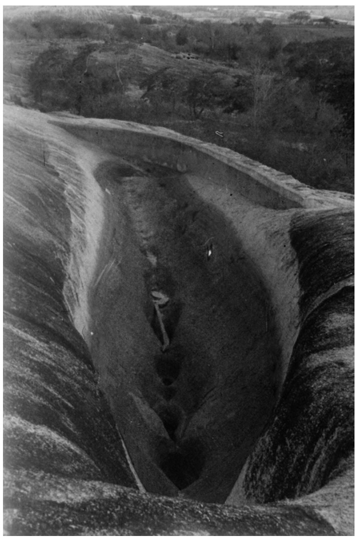

Figure 11. View of Lagoa de Fora

LAGOA GRANDE (LG). - It was a depression in the lajeiro, approximately circular in shape, about 8m in diameter and 3m deep. Around 1/5 of this water body was shallow, forming a “step”, with a depth of only 1m. One of the walls of this depression was an artificial stone wall. The bed was formed by loose stones in its deepest part and

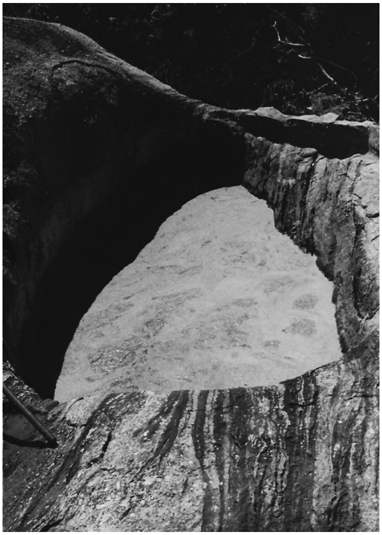

Figure 12.View of Lagoa de Dentro.

Figure 13. View of Poça com Macambiras.

by rocks in the “step”. Its water surface was constantly covered by *Pistia stratiotes*, among which some *Lemna minor* could be found. The highest temperature recorded in the water was 29°C (Mar 8, 83 at 11: 05 and Mar 20, 84 at 15:00).

LAGOA PEQUENA (LP). It was located on the lajeiro, measuring 7m x 3m with a maximum depth of 1.3m and a rocky bed. This water body did not present aquatic vegetation, however, there are shrubs in some places near its margin. The highest temperature recorded in the water was 29°C (Mar 8, 83 at 12:00 and Mar 29, 83 at 10:20).

CHARCO GRANDE (CG) Figure 14.- Located next to the margin of the lajeiro, of irregular shape, something like a "Z", measuring about 22m x 16m and 1.5m of maximum depth. The accumulation of water was favored because its bed, covered with sand, was on a lower plane than the neighboring areas. Part of its banks was limited by rocks about 3m high, and another part was next to a clump of macambiras. Almost all of its bed was covered by Eriocaulaceae, besides sparse plants of other groups. The highest temperature recorded in the water was 29°C (Feb 9, 83 at 15:45 and Mar 29, 83 at 23:20).

LAGOA DA CARROÇA (LC) Figure 15. - Located besides the road, with about 50m x 18m and 1.5m of maximum depth. It had a clay bottom and was bordered partly by the road, partly by an artificial dam and in a larger part by rocks 2.5m height in average. The plants found there were concentrated along its banks. The highest temperature recorded in the water was 34°C (Mar 21, 84 at 14:30).

LAGOA I (LI) Figure 16. – Formed by a depression of irregular shape in a small lajeiro. It measured 18m x 8m and 1.5m of maximum depth and presented a rocky bed. The most abundant species of plant found was *Hydrothrix gardneri*, which on some occasions occupied about half the surface of this pond. The highest temperature recorded in the water was 30°C (Mar 21, 84 at 15:12).

LAGOA II (LII) Figure 17. - Located besides the road, it had approximately 30m x 20m and 2m of maximum depth. It was bounded on one side by the road and on the other by an artificial dam. The bottom was sandy. This water body always presented scarce vegetation, being covered with few *Hydrothrix gardneri* along part of its banks. The highest temperature recorded in the water was 31°C (Mar 9, 83 at 14:17).

LAGOA DA BOMBA (LB) Figure 18. – It was an elongated and deep depression in the lajeiro, measuring about 21m x 7.5m and 5.5m of maximum depth. At one end there was a wall and a stone staircase and the bottom was rocky. This pond had its water surface always covered by *Lemna minor*, exhibiting also shrubs near its banks, out of the water. The highest temperature recorded in the water was 31°C (Mar 19, 84 at 13:40).

POÇA PEQUENA (PP) Figure 19. – It was a small depression in the rock of the lajeiro, measuring 4.5m x 1.5m and 0.1m of maximum depth. It did not have vegetation during the period of study. The highest temperature recorded in the water was 34°C (Mar 19, 84 at 14:30).

Figure 14. View of Charco Grande.

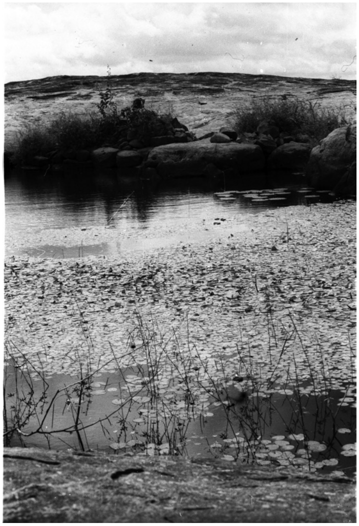

Figure 15. View of Lagoa da Carroça.

POÇA GRANDE (PG). – Formed by a depression in the rock of the lajeiro, close and similar to the Poça Pequena, being, however, deeper. Its measurements were 4m x 2m and 0.9m deep. The bottom was rocky. This water body had, initially, no vegetation, but from May 1983, its water surface was covered by *Lemna minor*. The

Figure 16. View of Lagoa I.

Figure 17. View of Lagoa II.

highest temperature recorded in the water was 33°C (Apr 9, 84 at 16:10).

Observations were also made in ponds or pools that formed during the rainy seasons near the water bodies listed above. These ponds varied in size, with a length between 5m and 2m, width between 2m and 0.5m and depth between 0.1 and 0.05m, and did not have vegetation. The highest temperatures recorded in the water were 32ºC (Mar 25, 83 at 11:00) and 33ºC (Feb 9, 83 at 14:00, Mar 8, 83 at 14:30 and Mar 20, 84 at 16:18).

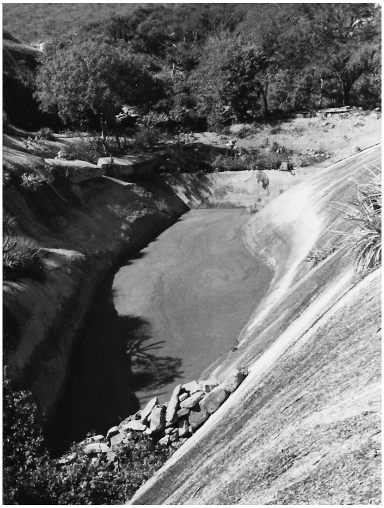

Figure 18. View of Lagoa da Bomba.

Figure 19. View of Poça Pequena.

As could be observed, L. Laje and P. Esquerda were the water bodies that showed the greatest diversity of plants, while the water bodies with smaller surface, formed in excavations in the rocks of the lajeiro, such as L. Dentro, L. Fora, L. Vala, Lagoa I, L. Pequena, P. Grande and P. Pequena, and the collections of water accumulated along the road (L. Carroça and Lagoa II) were characterized by having few or no vegetation. On the other hand, the water bodies formed along the margins of the lajeiros such as P. Esquerda, P. Macambiras and C. Grande, had their beds always covered by vegetation, while L. Bomba and L. Grande had their water surfaces always covered by plants of a single species. The time intervals in which the studied water bodies remained with water during the study period are shown in figure 20. It can be noted that all of them had a temporary character. In the dry period between the rains of 1982 and 1983, only 6 of them remained with water: L. Dentro, L. Fora, L. Laje, L. Bomba, L. Grande and Lagoa II, the others dried for various periods. In the dry season between the rainy seasons of 1983 and 1984, all water bodies dried up completely. The L. Dentro remained dry, according to local residents, for approximately one week before the rainy season resumed, while the most ephemeral water bodies (P. Macambiras and C. Grande) remained dry for 11 consecutive months. It is interesting to note also that in 1983, P. Pequena and P. Esquerda dried in the middle of the rainy season, refilling at the end of the season.

ANURAN SPECIES RECORDED, THEIR ECOLOGY AND REPRODUCTION

Figures 21, 22 and 23 show the periods in which the different species of anurans were found, respectively, in general activity, specifically in vocalization, and in the larval stage, at the study site. Tables 2, 3 and 4 record the number of days in which the different species of anurans were observed in, respectively, general activity, in vocalization and in the larval stage, in the various water bodies of Fazenda Bravo.

Family Pipidae

Pipa carvalhoi (Miranda Ribeiro, 1937)

This species occurred in all water bodies, with the exception of P. Macambiras. It was also found in small ponds formed on the lajeiro near L. Laje on Aug 25, 82 and Feb 9, 83 thus showing to be able to use any kind of body water. Although CARVALHO (1937 and 1939) affirmed that *P. carvalhoi* prefers the shallow banks and places covered by vegetation, the occupation of the water bodies at Faz. Bravo by this species was not related to the depth of the water or to the vegetation. Its lower frequency in the most ephemeral water bodies is directly related to its almost strictly aquatic habits, making the occupation of water bodies often subject to desiccation a drawback. If there was accumulated water, *P. carvalhoi* would be observed during both the rainy and the dry seasons. The anurans of this species remained in the water bodies even when it was left just little water mixed with mud and decomposing organic matter (L. Dentro and L. Fora, Nov 8, 82 and Jan 19, 83; L. Bomba, Jan 18, 83 and Lagoa II, Jan 20, 83). On a single occasion (Mar 21, 84, on the banks of the L. Grande) an individual was found out of the water. DUNN (1948) considered that *P. carvalhoi* is not a completely aquatic species, based on observations of animals (MYERS and CARVALHO, 1945 in the state of Espírito Santo) in the courtyard of a house, about 20 or 30 meters away from water, apparently feeding on insects. In the rainy season of 1984, after a severe dry period, the frequency of this species

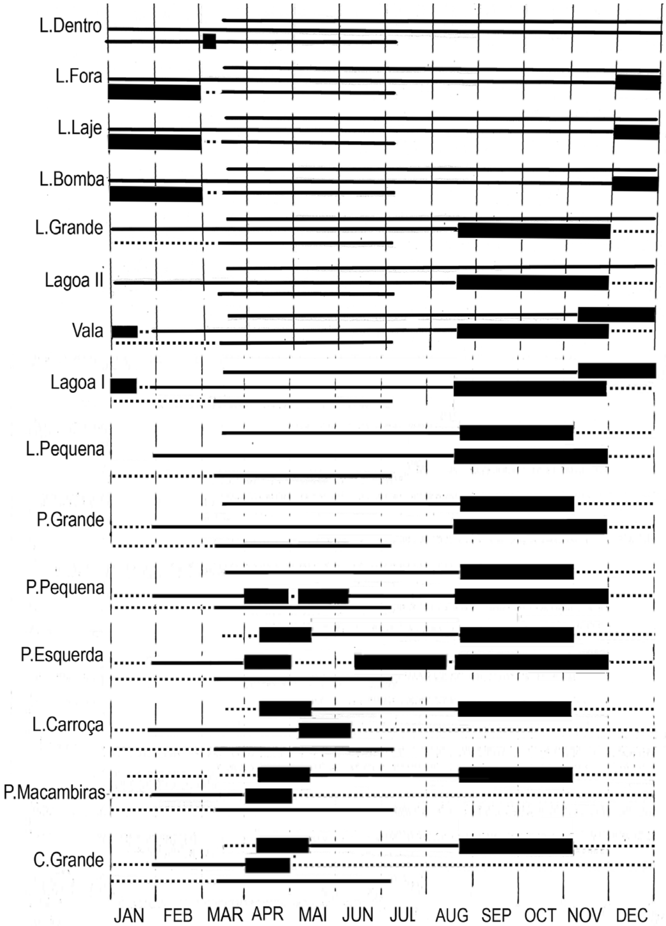

Figure 20. Presence of water in the ponds during the study period. Continuous line = presence of water, broken line = absence of water, horizontal bar = intervals in which drought occurred or water bodies were forming; upper line = 1982, midline = 1983, bottom line = 1984).

was very low when compared to the previous two years, which suggests that it does not have effective protection mechanisms against desiccation.

Pipa carvalhoi tadpoles were collected in all water bodies, except for P. Pequena and P. Macambiras, and were also found in the small ponds formed on the lajeiro near L. Laje on Aug 25, 82, Fev 9 and Mar 8, 83, showing that this species reproduced in practically all the water masses that the adults inhabited. In 1984,

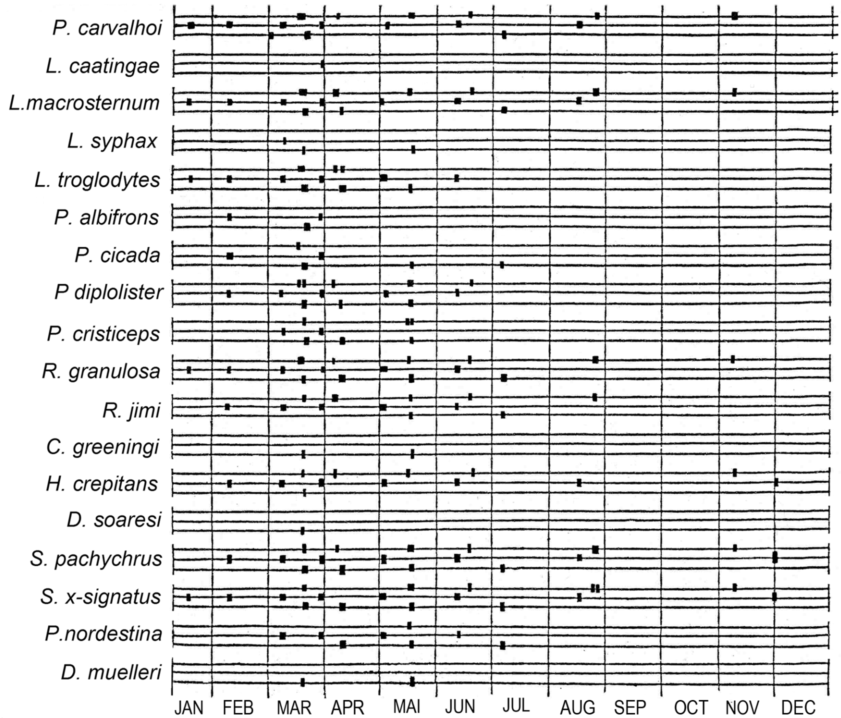

Figure 21. Days in which the different species of anurans were observed in activity in Faz. Bravo. Top line = 1982, midline = 1983, bottom line = 1984.

the larvae were found only in L. Vala and, for the first time, in L. Laje. The samples of tadpoles were collected during the entire rainy season and generally showed specimens in different stages of development, suggesting that this species reproduced several times during this period. WEYGOLDT (1976) states that *P.carvalhoi* in captivity reproduces every 4 or every 8 weeks, if well fed. Larvae collected at L. Carroça on Mar 29, 83 were lighter than usual, with coloration similar to that of the muddy water of this pond. Anurans in the final phases of metamorphosis were collected on Mar 7, 8 and 9, 83 in P. Grande, L. Pequena and L. Carroça, respectively, that is about 40 days after the formation of these water bodies by the first rains of the year. This shows that under natural conditions the pre-metamorphic development may take a shorter time than that reported for animals kept in the laboratory by CARVALHO (1939). According to this author, incubation of the eggs carried out in the epidermis of the back of the female takes from 19 to 29 days, being born, then, the tadpoles, that complete the metamorphosis in the water "in a longer time". Voucher specimens: UFPB 1716, 1717, 1725, 1730.

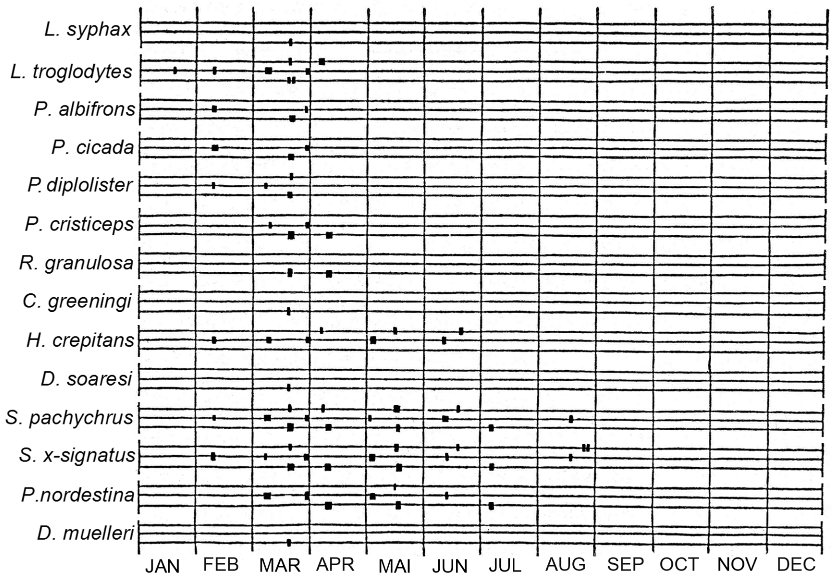

Figure 22. Days in which the different species of anurans were observed vocalizing in Faz. Bravo. Top line = 1982, midline = 1983, bottom line = 1984.

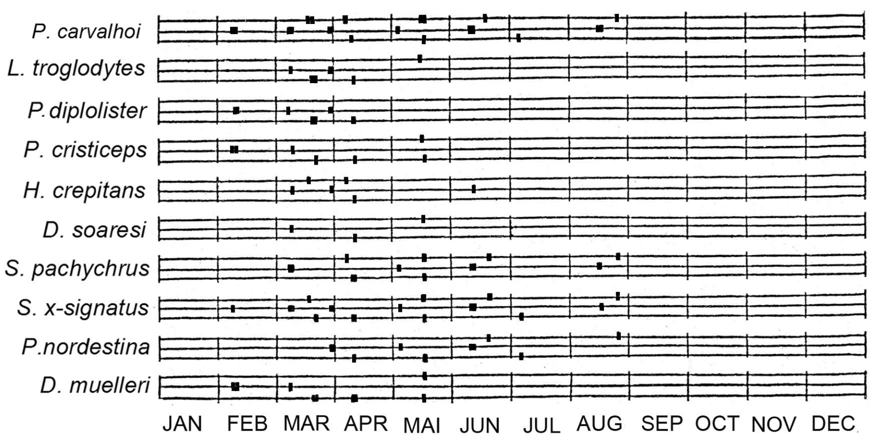

Figure 23. Days in which tadpoles of different species of anurans were found in Faz. Bravo. Top line = 1982, midline = 1983 and bottom line = 1984.

Table 2. Number of days in which the different species of anurans were observed in activity in the water bodies and also in activity away from the water bodies.

Species / Water bodies and away from them	L. Dentro	L. Fora	L. Laje	L. Bomba	L. Grande	Lagoa II	Vala	Lagoa I	L. Pequena	P grande	P pequena	P. Esquerda	L Carroça	P. Macambiras	C. Grande	Away from water bodies	Totals
P. carvalhoi	14	6	4	5	8	7	12	4	7	6	1	3	1	-	1	-	79
L. caatingae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
L.macrosternum	2	3	29	2	12	9	12	11	3	5	1	4	15	-	3	-	111
L. syphax	-	-	-	1	1	-	-	-	-	-	-	-	-	-	2	1	5
L. troglodytes	-	-	6	-	2	3	8	1	1	1	-	5	11	2	12	1	53
P. albifrons	1	-	2	-	-	2	1	1	-	-	-	3	5	-	-	-	15
P. cicada	-	-	-	-	-	3	-	2	1	-	-	3	3	-	3	1	16
P diplolister	1	-	-	1	-	6	1	1	-	-	2	-	2	1	2	13	30
P. cristiceps	-	-	-	-	-	2	-	-	-	-	-	4	-	1	9	5	21
R. granulosa	2	1	6	2	-	4	4	8	-	-	3	-	7	--	1	15	53
R. jimi	5	1	11	4	1	3	2	6	3	7	2	-	3	-	-	3	51
C. greeningi	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1	4
H. crepitans	3	2	13	-	-	7	6	5	-	1	-	-	8	1	-	1	47
D. soaresi		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
S. pachychrus	6	4	9	13	8	4	8	6	8	1	-	10	6	20	6	-	109
S. x-signatus	8	7	19	19	7	5	8	9	4	4	-	6	6	3	5	1	111
P.nordestinus	-	-	12	6	4	12	7	11	5	-	-	5	9	2	9	-	82
D. muelleri	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	3

Table 3. Number of days in which different species of anurans were observed vocalizing in the water bodies

species / water bodies	L. Dentro	L. Fora	L. Laje	L. Bomba	L. Grande	Lagoa II	Vala	Lagoa I	L. Pequena	P. Esquerda	L. Carroça	P. Macambiras	C. Grande	Totais
L. syphax	-	-	-	-	-	-	-	-	-	-	-	-	1	1
L.troglodytes	-	-	2	-	2	1	5	-	-	5	7	1	8	31
P. albifrons	1	-	2	-	-	2	1	-	-	3	5	-	-	14
P. cicada	-	-	-	-	-	2	-	2	1	3	3	-	3	144
P. diplolister	-	-	-	-	-	-	-	-	-	-	-	-	2	2
P. cristiceps	-	-	-	-	-	2	-	-	-	4	-	-	9	15
R. granulosa	-	-	1	-	-	1	-	1	-	-	4	-	1	8
C. greeningi	-	-	1	1	-	-	-	-	-	-	-	-	-	2
D. soaresi	-	-	-	-	-	-	-	-	-	-	-	-	1	1
H. crepitans	2	1	12	-	-	6	2	1	-	-	8	-	-	21
S.pachychrus	6	6	9	13	8	2	7	6	6	9	7	4	6	77
S. x-signatus	3	4	15	17	6	5	7	7	3	6	6	2	5	56
P.nordestinus	-	-	10	5	3	12	6	11	3	5	9	1	8	43
D. muelleri	-	-	-	-	-	-	-	-	-	-	-	-	1	1

Family Leptodactylidae

Leptodactylus caatingae Heyer and Juncá, 2003

During the study period, only one specimen of this species was recorded. This was at C. Grande. It was observed in a shady spot by a tree, about 3 meters from water, on Mar 30, 83, at 21:10 h. Voucher specimens: UFPB 1966, 2221.

Leptodactylus macrosternum Miranda-Ribeiro, 1926

Leptodactylus macrosternum occurred in all water bodies, except P. Macambiras. Although they concentrated their activities during the rainy season, anurans of this species were also observed during the dry season, but always near accumulations of water, indicating that their activity was linked to the existence of available water masses. GALLARDO (1964), commenting on *Leptodactylus latrans*, that belongs to the same group of *L. macrosternum* (de SÁ *et al*., 2014), observed that tagged animals remained for more than 30 days in the same place, next to the water, sustaining the existence of a definite “homing” behavior in this species. In Faz. Bravo, the specimens stood out of the water, facing it, or semi-submerged,

Table 4. Number of days in which tadpoles of the different species of anurans were observed in the water bodies

Species / water bodies	L. Dentro	L. Fora	L. Laje	L. Bomba	L. Grande	Lagoa II	Vala	Lagoa I	L. Pequena	P. Grande	P. Pequena	P. Esquerda	L Carroça	P. Macambiras	C. Grande	Totals
P. carvalhoi	6	1	1	7	4	4	10	7	6	8	-	3	4	-	2	63
L. troglodytes	-	-	-	-	-	1	-	-	-	-	-	2	2	-	4	9
P diplolister	-	-	1	-	-	1	3	2	1	1	1	2	1	3	-	16
P. cristiceps	-	-	-	-	-	3	-	1	-	-	-	2	2	-	3	11
D. soaresi	-	-	-	-	-	-	-	-	1	-	-	1	-	-		2
H. crepitans	-	-	-	-	-	3	2	3	2	-	-	-	1	-	-	11
S. pachychrus	1	1	2	2	3	4	6	4	1	4	1	6	3	3	4	45
S. x-signatus	1	2	4	3	2	8	7	8	6	-	-	9	6	1	3	60
P. nordestinus	-	-	1	1	5	1	3	3	1	-	-	2	2	2		21
D. muelleri	-	-	2	3	2	-	3	-	-	-	-	3	1	-	1	15

and when they detected the presence of the observer, they fled submerging. The only exception to the occurrence close to the water was the presence of individuals on blocks of clay in the dry bed of L. Carroça on Jun 10, 11 and 12, 83. On this last day, daytime observations were made at the same site, and three more specimens were found sheltered in the cracks that separated the clay blocks, which remained moist from a depth of 3 cm. Individuals of *L. macrosternum* were observed under similar conditions, also in Lagoa II (Nov 30, 83). The shelter in clay cracks was also observed by GALLARDO (1970) for *Leptodactylus latrans* in dry streams in the southwest of the Province of Buenos Aires. At Faz. Bravo, this seemed to have a relative importance as a strategy of survival during the dry period, since the moisture contained in the crevices disappeared before the resumption of rains.
GALLARDO (1970) also recorded the hibernation of *L. latrans* in otter dens. During the sunset of Nov 9, 82, individuals of *L. macrosternum* were observed coming out of stone holes along the margins of the L. Laje, and it is possible that, in Faz. Bravo, this species uses these places as shelter not only during the day, but also throughout the dry season. The presence of *L. macrosternum* was recorded in the three years in which observations were made, however, there was a decrease in the frequency in 1984, a fact that, as in the case of *P. carvalhoi,* may be related to a certain vulnerability to severe periods of drought, such as that which separated the rains of 1983 and 1984.

Although they have practically frequented all water bodies, we have never seen animals in amplexus, vocalizing, in the larval stage or their conspicuous foam nests, suggesting that, during the period of observations, *L. macrosternum* did not reproduce in the water bodies studied. Species of this group, construct their foam nests generally in shallow or in temporary ponds (CEI,1980; GALLARDO, 1964 and 1970; VAZ-FERREIRA and GERHAU, 1975; DE SÁ *et al.,* 2014), similar to those found in the study area. It may be hypothesized that the absence of reproductive activities is related to the lack of stronger rains during the observation period. GALLARDO (1964) stated that on the outskirts of Buenos Aires and São Paulo, reproduction is triggered by the strong rains of spring and summer. BRAGG (1945) and MAYHEW (1965) also observed that *Scaphiopus couchii*, a frog inhabiting xeric zones of North America, may not reproduce for a year or several years if climatic conditions are not adequate. The *L. macrosternum* female, as that of all species of the *L. latrans* group (DE SÁ *et al*., 2014) remains in the middle or below the foam nest during the development of the embryos. As tadpoles are gregarious, she can continue her offspring protection behavior until the metamorphosis, following and watching over the group of tadpoles and attacking predators, such as birds, that approach (VAZ-FERREIRA and GEHRAU, 1974 and 1975; DE SÁ *et al*., 2014). The fact that this species exhibits high parental investment determines that reproduction only occurs when environmental conditions are clearly favorable. Voucher specimens: UFPB 1842, 1874, 1875, 1876.

Leptodactylus syphax Bokermann, 1969

An individual was observed on Mar 9, 83 at C. Grande, and five on Mai 17, 84 at L. Bomba, L. Grande and at other sites on the lajeiro away from water bodies. On Mar 19, 84, an individual was observed vocalizing from inside rocky holes in C. Grande. The record of this species agrees with the statement made by DE SÁ *et al.* (2014), that the distribution of *L. syphax* is almost always associated with areas with rocky outcrops. BOKERMANN (1969) reported that all specimens of this species collected by him were calling inside termitaries or in rocky holes, such as we observed in the present study in C. Grande. The concentration of occurrences in 1984 may be related to increased rainfall this year. Voucher specimens: UFPB 2228, 2229, 2230, 2234.

Leptodactylus troglodytes A. Lutz, 1926

Leptodactylus troglodytes was recorded in 11 water bodies along the three years of studies. It did not occur only in water bodies without vegetation and in L. Bomba, which had only *Lemna minor* covering its water surface. This indicates the preference of the species for water bodies with plants. The seasonal character of *L. troglodytes* was revealed by the fact that, with one exception, all records were made during rainy seasons, although on some occasions in ponds that have dried. In a single opportunity (Feb 9, 83), a specimen was observed far from water. Considering that the record of vocalizations, in 8 water bodies, was limited to 2 months from the onset of rains and that tadpoles were collected in 4 water bodies at the beginning of the rainy season (CASCON and PEIXOTO, 1985), and presented similar stages of development, it can be suggested that *L. troglodytes* in Faz. Bravo reproduced only at the beginning of the rainy season. Vocalizing animals were found in dry ponds in the rainy season (P. Esquerda, Apr 6, 82) and dry season (L. Vala, Jan 19, 83). On Mar 1, 84, we observed an individual buried in the dry bed of L. Vala. HEYER (1978) states that the members of the *fuscus* group, to which *L. troglodytes* belongs, deposit their eggs in underground chambers, and also that, based on the snout morphology, it can be assumed that males are responsible for digging these chambers in wet soil. HEYER (1978) also registered for *L. troglodytes* a sexual dimorphism in limb proportions, and considers that the longer legs of males result from selective pressures exerted by predatory vertebrates. He states that "this pattern suggests that most of the life activities of the species takes place under ground and the nest construction and/or calling activity of the male are the longest above ground activities in the adult life history". The fact, observed in the present work, of males of this species almost always calling sheltered in stones holes, may also be the result of selective pressure exerted by predatory vertebrates. Voucher specimens: UFPB 1976, 1994, 2004, 2083.

Physalaemus albifrons (Spix, 1824)

Anurans of this species were found in 7 water bodies of different characteristics, always in the first two months of the rainy seasons of 1983 and 1984 and all vocalizing, except the animals observed in Lagoa I. Couples in axillary amplexus were observed in L. Vala (Feb 9, 83), L. Laje and L. Dentro (Mar 20, 84). These records suggest that *P. albifrons* had its reproductive period restricted to the beginning of the rainy season. The absence of larvae, although there was reproductive activity, could not be explained. Voucher specimens: UFPB 1930, 1931, 1932, 1933.

Physalaemus cicada Bokermann, 1966

This species, like the previous one, showed a period of seasonal reproduction restricted to the beginning of the rainy season. It has been observed, almost always vocalizing, during a short period (approximately 2 months), after the rains began. The only individuals that were not calling were those observed far from water bodies and the one found in Lagoa II on Mar 17, 82. We have seen couples in axillary amplexus in L. Pequena (Feb 9, 83), L. Carroça (Mar 28, 83) and in C. Grande (Mar 21, 84). One of the two pairs observed in amplexus at L. Pequena was, at the time, forming a nest of white foam in a manner identical to that described for *Physalaemus cuvieri* by BOKERMANN (1962). As in the case of *P. albifrons*, it was not possible to explain why we did not find tadpoles of this species. *Physalaemus albifrons* and *P. cicada* were, on several occasions, observed calling together in the same water bodies, and even standing in the same kind of substrate during vocalization. BOKERMANN (1966) observed the same species vocalizing together in a large rainwater pond in Chapada de Maracás, State of Bahia, and pointed out that the difference in size and call between them is quite pronounced, avoiding eventual hybridization. Voucher specimens: UFPB 1726, 1926, 1927, 1928.

Pleurodema diplolister (Peters, 1870)

This species was recorded in 9 water bodies of different characteristics, during the three years in which observations were made. It presented seasonal activity, with observations being restricted to the initial 2/3 of the rainy season. Anurans of this species were found vocalizing in C. Grande (Mar 19 and 20, 84), and in small ponds formed on the lajeiro in the vicinity of L. Laje (Mar 20, 82; Feb 9 and Mar 7, 83; Mar 19, 84) and on sandy soil near L. Carroça (Mar 19, 84). On almost all these occasions, they vocalized forming choruses. Couples in amplexus were observed in the ponds formed on the lajeiro, mentioned above (Mar 7, 83) and in Lagoa I (Mar 19, 84). The tadpoles were collected in 10 water bodies in 1983 and 1984, and in a small pond formed next to P. Macambiras on Mar 29, 83, always during the first two months of the rainy season. The samples of tadpoles collected showed specimens in close stages of development. A white foam nest was collected in a pond located far from the water bodies on Apr 10, 84 and transferred to the laboratory, where larvae of this species developed. Judging from the vocalizations, records of couples in amplexus, and the presence of tadpoles, mating occurred only in short periods after the strongest precipitations, at the beginning of the rainy season. The use for breeding of small pools subject to rapid drying in case of interruption of rainfall is being possible due to the rapid embryonic and larval development of *P. diplolister*. PEIXOTO (1982) reported the occurrence of metamorphosis from 16 to 19 days after egg deposition, under laboratory conditions. CARVALHO and BAILEY (1948) observed, in the region of the São Francisco River, anurans of *P. diplolister* buried in the sand during the day, at a depth probably determined by the level of soil moisture. In the present work, no buried specimens were found in the beds of water bodies. A few months after desiccation the bed had lost completely the moisture content, even in deeper layers. *Pleurodema diplolister* should remain buried in the rainy months during the day, and throughout the dry season, similarly to *Pleurodema nebulosa*, inhabitant of the arid zones of northeastern Argentina which is, also, seasonal and remains buried in the ground during the dry months (GALLARDO, 1965). Other species of the genus also present digging habits such as *Pleurodema borelli*, which according to GALLARDO (1968) remains buried during the winter. Voucher specimens: UFPB 1781, 1782, 1783, 1784.

Family Odontophrynidae

Proceratophrys cristiceps (Muller, 1883)

The activity of *P.cristiceps* was recorded in only four water bodies during the three years of study and was restricted to the initial period of the rainy season, indicating the seasonal character of this species. With the only exception of the young individual observed in P. Macambiras on Mar 20, 84, all the individuals observed in the water bodies were vocalizing, whereas none of those found away from water bodies were vocalizing. *P. cristiceps* called, almost always, in places shaded by trees or large rocks, or hidden under shrub vegetation, at a distance of not more than 4 m from the water. This cryptic behavior is common to other *Proceratophrys* species (IZECKSOHN and PEIXOTO, 1981), and explains that half of the occurrences of the species was recorded in C. Grande on whose margins there is relatively dense vegetation and high rocks. When vocalizing, anurans of this species inflated the whole body, especially the gular region. There were couples in amplexus in C. Grande, on Mar 19 and 21, 84. In the three years of study, samples of tadpoles of *P. cristiceps* were collected in five water bodies. Each sample had specimens at similar stages of development. This reproduction in lentic waters differentiates this species from others of the same genus, which use small watercourses within the forest to develop their larvae, such as *P. boiei, P. appendiculata* and *P. laticeps* (IZECKSOHN and PEIXOTO, 1981). The presence of a large tarsal callus and the record of a specimen buried about 5 cm deep in sand between rocks in the dry bed of L. Laje on March 1, 84 indicate that this species probably remains buried in the soil during the dry season, and in the hot hours of the day, during the rainy season. NAVAS *et al*. (2004) state that *P.cristiceps*, in a state of dormancy, remains buried in the soil up to 1 m deep during the dry season, when it presents a modified skin. The observation, in several occasions, of individuals moving far from water bodies indicates that *P. cristiceps*, like *P. diplolister*, seeks soils more protected against the loss of moisture to bury. Voucher specimens: UFPB 2135, 2164, 2165, 2166.

Family Bufonidae

Rhinella granulosa (Spix, 1824)

Rhinella granulosa occurred in 10 water bodies of varied characteristics and its activity period seems to be related to the availability of water masses and independent of the rains. This species, observed most of the time throughout the rainy season, continued to be recorded during the dry season, as long as there were water bodies. The fact that vocalization, observed in 5 water bodies, was recorded in the initial period of the rainy season of 1984, when rainfall was significantly higher than in the previous 2 years, suggests that *R. granulosa*, in order to initiate reproductive activity, needs the stimulus provided by rains of relative magnitude. The anurans observed in vocalization were found in the shallow places of the water bodies, or on stones in the water. When they were not calling, the anurans were resting on the dry margin facing the water. During the day, individuals were found sheltered in crevices that remained moisty in the dry bed of L. Carroça (Jun 12, 83) and buried, about 5 cm deep, in the dry bed of L. Vala and L. Bomba (Mar 1, 84). On 15 different occasions, individuals of *R. granulosa* were observed far from water bodies. This fact may be related to movements between water bodies or to seeking for adequate soil to bury during the hot hours of the day and during the dry season. Although there was vocalization in 1984, no tadpole of this species was found, which, as in the case of *P. albifrons* and *P. cicada*, could not be explained. *Rhinella granulosa* was frequently seen, during the dry period, near human constructions, in places that remained moist like cisterns and drinking fountains for animals. Voucher specimens: UFPB 720, 1721, 1723, 1758.

Rhinella jimi (Stevaux, 2002)

This species was observed in 12 water bodies, being found far from water only on three occasions in 1984. Its activity was only observed during the rainy season, which indicates its seasonal character. CASCON *et al.* (2014) report that, in the state of Ceará, the reproductive period of this species begins with the first rains, lasting from 1 to 2 months. In the water bodies the anurans remained as much outside the water, near the banks, as in the water, in shallow places or floating. The absence of reproductive activities is probably related, as in the case of *L. macrosternum*, to the lack of precipitation of greater intensity during the study period. Animals were found sheltered within rock hollows and crevices, located in the banks of the L. Laje during the dry period (Nov 9, 82 and Mar 2, 84) or near the L. Pequena in the rainy season (Feb 9, 83). They were also frequently observed under light poles, feeding on insects that were attracted to the light, both during the rainy season and during the dry season. Voucher specimens: UFPB 1962, 1996, 1998, 2071.

Family Hylidae

Corythomantis greeningi Boulenger, 1896

This species was only found in two days of 1984, Mar 19 in L. Bomba, L. Laje and C. Grande, and Mai 17, far from water bodies. The individual observed in L. Bomba was calling on a rock in almost vertical position, and the one recorded in L. Laje vocalized under a stone. In both cases, the individual´s body was partially emergent from the water. Specimens of *C. greeningi* had been collected by A. Langguth at the study site during the rainy season of 1981 and were also found on Feb 8, 83 at the edge of the Taperoá River, about 12 km from Faz. Bravo. This species is found in narrow shelters such as stone crevices or certain Bromeliaceae species, which were not found in the study area, obstructing the entrance of the shelter with the top of the head, which is ossified (JARED *et al*., 1999). In Faz. Bravo, *C. greeningi* was only found in rainier years, as 1981 and 1984, when rainfall totaled 480 mm and 379 mm, respectively. Voucher specimens: UFPB 2120, 2215, 1913, 1914.

Hypsiboas crepitans (Wied-Neuwied, 1824)

Hypsiboas crepitans was found in 9 water bodies of different characteristics in the three years of studies. It was only on one occasion far from water bodies, and in only two occasions outside the rainy season. This indicates the seasonality of this species, already observed by DUELLMAN (1970) who also reports that in Panama, it reproduces in shallow rain pools with grasses as well as in shallow areas of flooded water bodies. At Faz. Bravo, *H. crepitans* did not show preferences for specific types of water bodies for reproduction, and even used water bodies without vegetation. The vocalization was observed in 7 water bodies on Jun 10 and 11, 83, in vegetation clumps near small pools that had formed in the lajeiro between L. Laje and L. Pequena. In 1982 and 1983 this species ceased to vocalize in the last months of the rainy season. The specimens usually called on rocks up to 1.5 m high from the water surface, or in the water in shallow places. Tadpoles were found in the first two months of the rainy season, in 4 of the 7 water bodies in which they were seen vocalizing in L. Pequena, and also in Jun 12, 83, in pools near the bushes, in which adults of this species vocalized in the previous two days. The larvae samples collected were composed of few specimens in various stages of development. Vocalization and tadpole samples obtained in 1982 and 1983, indicate that in these years this species only reproduced during the initial 2/3 of the rainy season. Considering that only one specimen was recorded in 1984, a year preceded by a severe drought, it is possible to hypothesize that *H. crepitans*, like *P.carvalhoi* and *L. macrosternum*, does not have effective protection mechanisms against desiccation. Newly metamorphosed individuals showed a green coloration very different from that of adults. This was also reported by LUTZ (1973) for *Hypsiboas pardalis* and by CASCON *et al.* (2014) for *Hypsiboas raniceps*. Voucher specimens: UFPB 1753, 1792, 1813, 1825.

Dendropsophus soaresi (Caramaschi and Jim, 1983)

This species was observed only at C. Grande on Mar 19, 1984. A calling animal and a couple in amplexus, were on branches of shrub vegetation about 1.5 m above the ground. These individuals exhibited habits similar to those that make the *D. soaresi* type series which, according to CARAMASCHI and JIM (1983), “emitted rough corners, climbed on fences made with branches of plants of the Caatinga, at heights that varied between 1 and 3 m, but preferably in the range of 1.5 m”. These fences were found on the banks of small bodies of standing water, formed by recent rains. Tadpoles were collected in P. Esquerda (Mai 16, 82), C. Grande (Mar 8, 83) and in L. Pequena (Apr 11, 1984), in years in which the adults were not observed, indicating, perhaps, that this species has short periods of reproduction arranged next to strong precipitation at the beginning of the rainy season. Voucher specimens: UFPB 2110, 2111, 2112, 2238.

Scinax pachychrus (Miranda Ribeiro, 1937)

This species occurred, in all water bodies, with the exception of P. Pequena. Except for records in P. Macambiras, *Scinax pachychrus* was only observed during the rainy season. It uses the macambiras as a place of temporary shelter. This is evidenced by the greater number of records in P. Macambiras and the observation of individuals on the Bromeliacea leaves of this pool even in the early months of the dry season, when this water body was already dry. The microclimate within these bromeliads probably remains moist only in the first few months after the end of the rains. This would explain the absence of *S. pachychrus* in the late dry season. LUTZ (1973) records the habit of using bromeliads as shelter in *S. pachychrus* and other species of the same “Complex”. *Sinax pachychrus* was not found vocalizing in P. Grande and P. Pequena. Although frequently present, the number of individuals observed calling in P. Macambiras was small in relation to the other water bodies. Vocalization occurred only during the rainy season. The animals called on the top of aquatic plants or in the water, in shallow areas. Couples in amplexus were observed in the following water bodies: L. Bomba (Mar 20, 84); Lagoa II (Mar 19, 84); L. Vala (Mar 19, 84); Lagoa I (Mar 20, 84); P. Esquerda (May 16, 82 and Mar 7, 83); C.

Grande (Abr 10, 84). Samples of tadpoles were collected in all water bodies during the rainy season of the three years of study. The samples usually had specimens in various stages of development. Vocalization was also observed in bushes near shallow pools formed on the lajeiro, between L. Laje and L. Pequena (March 29, 83 and June 10 and11, 83), where couples in amplexus (Mar 24, 82, Jun 11, 83 and Mar 19, 84) and tadpoles (Ago 25, 82, Mar 8, Mai 4 and Ago 16, 83 and Apr 11, 84) were recorded. LUTZ (1973) points out that the species belonging to the "*Hyla rubra - Hyla x-signata*" complex, that includes *S. pachychrus*, "are all very adaptable and seem to be satisfied with minimum requirements for reproduction and spawning." LUTZ (1973) further states that the species of this group "belong to the large number of tree frogs that reproduce in still waters." In the present study, *S. pachychrus* reproduced in all studied water bodies, including shallow and ephemeral ponds formed on the lajeiro, thus confirming the plasticity of this species in terms of the choice of breeding sites and suggesting a rapid ontogenetic development. The record of vocalization throughout the rainy season, and the fact that the samples of tadpoles are composed of specimens in various stages of development indicate that reproductive activity in this species, although concentrated in the initial period, extended throughout the rainy season. Voucher specimens: UFPB 1786, 1787, 1821, 1824.

Scinax x-signatus (Spix, 1824)

Like *S. pachychrus, S. x-signatus* occurred in all water bodies, except in P. Pequena. However, it appeared to have a longer activity period than *S. pachychrus*, being observed not only in the rainy season, but also at the beginning of the dry season, so far water was still available. *Scinax x-signatus* was observed vocalizing and in the larval stage, in all water bodies except for P. Grande, showing to be, also, a species with few demands in respect to the place of reproduction. However, *S. x-signatus* needs a certain size of the water masses, failing to reproduce precisely in the smaller P. Pequena and the shallow ponds in the lajeiro where tadpoles of *S. pachychrus* developed. The reproduction of *S. x-signatus* extended throughout the rainy season, as demonstrated by the dates in which vocalization was recorded and the tadpoles were collected, and also because the last were in different stages of development. Vocalizing individuals were observed on nearby plants or on stones emerging from water or also, in the water in shallow areas. Couples in amplexus were observed in L. Laje (Mai 16, 82), L. Pequena (Feb 9, 83) and L. Bomba (Mar 19, 84). The here recorded presence of *S. x-signatus* in human environments, was considered by LUTZ (1973) to be typical of species of the "*Hyla rubra - Hyla x-signata*" Complex. Voucher specimens: UFPB 1836, 1838, 1839, 1849.

Family Phyllomedusidae

Pithecopus nordestinus (Caramaschi, 2006)

P. nordestinus occurred exclusively during the rainy seasons of the three years of studies and was almost always vocalizing. It was observed in 11 water bodies and was absent, just in the four water bodies without plants in their beds or banks. This shows a preference for water bodies with vegetation, a fact that can be explained by the type of oviposition found in this genus. *Pithecopus* species make a saciform nest above water by folding a leaf around their egg mass (PYBURN, 1980; FAIVOVICH *et al*., 2005). With the hatching of eggs, the tadpoles fall into the water, where they develop. This mode of reproduction, depending on the existence of plants in or near water bodies, would also explain the delay observed in the resumption of reproductive activity, made only 30 to 40 days after the arrival of the rains. This interval would be the time necessary for the development of the vegetation used in the nests. The individuals observed in vocalization were on plants located in or near water bodies. Couples in amplexus were recorded in the following water bodies: Lagoa II (Apr 10, 84), Lagoa I (Mar 8, 83), L. Pequena (Mar 7, 83) and L. Carroça (Mar 8, 83). The tadpoles of *P. nordestinus* appeared in the same water bodies in which the adults were observed. In each sample of larvae collected during the three years of studies, specimens came in different stages of development. This indicates that the reproductive activity occurred on more than one occasion, although the vocalization did not extend until the end of the rainy season. The finding of *P. nordestinus* individuals in macambiras clumps, located far from water bodies, which were burned during the dry season (Mar 2, 84) indicates the use of these plants as shelter during the dry season. At the study site, Maria Nazareth Stevaux (personal communication) found, during the rainy season of 1985, *Pithecopus* nests on leaves of *Echinodorus andrieuxii* growing inside the water. She also observed adult individuals sheltered in clumps of macambiras during the dry season. Voucher specimens: UFPB 1837, 1937, 1938, 1960.

Family Microhylidae

Dermatonotus muelleri (Boettger, 1885)

The fact that adults of this species were observed only 2 days in 1984, March 19 in C.Grande and L.Laje, and May 17, away from water bodies, while tadpoles were collected in the two first months of the rainy season of the three years in 7 water bodies of diverse characteristics, suggests that the reproductive activities of *D. muelleri* were restricted to short periods after the more intense precipitations of the beginning of the rainy seasons. The specimen observed in L. Laje was under a stone near the water, and those recorded in the C. Grande vocalized sheltered under rocks or on the ground between macambiras. This cryptic behavior as well as its fossorial habits, it constructs underground chambers for estivation during the dry period (NOMURA *et al*., 2009), may have contributed to the low number of adult records. Voucher specimens: UFPB 2094, 2101, 2227.

DISCUSSION

Species richness

The Faz. Bravo anurofauna was composed by 18 species. The anuran species richness of the study site was higher than that recorded for other Caatinga areas in Paraíba, such as Cabaceiras, with 8 spp. (PESSOA *et al*., 2012), São João do Cariri, with 16 spp., Boa Vista, with 8 spp. (VIEIRA *et al*., 2007), Maturéia, with 16 spp., São José do Bonfim, with 12 spp. (ARZABE, 1999) and the shrub-arboreal Caatinga, studied by ARZABE *et al.* (2005) that showed 8 spp. The dry forest of the Curimataú river valley presented, however, 20 spp (ARZABE *et al*., 2005).

The anurofauna of Faz. Bravo has a richness similar to that found in two Atlantic Forest fragments in Paraíba State, by SANTANA *et. al*. (2008), 14 spp., and BARBOSA and ALVES (2014), 21 spp.

On the other hand, more extensive and diverse mesic areas in Northeast Brazil, like two high altitude brejos in Ceará State that harbor several phytophysiognomies and include remnants of Atlantic Forest, the Chapada do Araripe and the Complex of Planalto da Ibiapaba, presented, respectively, 31 (RIBEIRO *et al*., 2012) and 38 (LOEBMANN and HADDAD, 2010) anuran species.

Thus our results did not support the hypothesis advanced above that the semi-arid environment of Fazenda Bravo would show a low species richness. This may be explained by the fact that although the period of drought is very dry and long, during the rainy season water is abundant and sufficient to guarantee anuran reproduction. The diversity observed in Faz. Bravo may be the result of still unrevealed historical factors.

None of the forms of anurans recorded for Faz. Bravo is endemic to the Caatinga. Some have a wide geographical distribution in South America, such as *L. macrosternum, H. crepitans, S. x-signatus* and *D. muelleri.* The remaining species have most of their distribution areas within the Caatinga, but also occur in adjacent areas of the Cerrado and / or Atlantic Forest (FROST, 2016). The results obtained for birds (SICK, 1965), reptiles (VANZOLINI, 1974 and 1976; VANZOLINI *et al*., 1980) and mammals (MARES *et al*., 1985; CARMIGNOTTO *et al.,* 2012) show that, contrasting with the high degree of endemism of the Caatinga flora (ANDRADE-LIMA, 1982), the fauna of vertebrates is, for the most part, a subset of the fauna of the neighboring biomes, Cerrado and Atlantic Forest (MARES *et al*., 1985).

Anurans and xeric environments

The occupation of an environment such as the Caatinga, with intense and irregular rains, prolonged dry period, high temperatures during the day and low at night, requires of a fauna of anurans, features that allow their survival under these particular conditions. Several authors (BENTLEY, 1966, BLAIR, 1976, LOW, 1976, MAYHEW, 1965 and 1968 and NAVAS *et al.,* 2004) mentioned the following characteristics of anurans associated with xeric environments: **1)** Time of reproduction not defined, due to irregular rainfall; **2)** Use of temporary water bodies for reproduction; **3)** Start of reproductive behavior induced by rainfall; **4)** High vocalization in males, with a strong attraction of both males and females, quickly forming large chorus. In this way, reproductive males and females are attracted from long distances to the available water masses; **5)** Egg laying in foam nests, which may represent a protection against drying; **6)** Rapid development of eggs and larvae in order to allow metamorphosis before the drying of temporary water bodies; **7)** Tadpoles' ability to use both plant and animal foods; **8)** Cannibalism in tadpoles; **9)** Tarsal callus to dig holes; **10)** Ability to withstand considerable dehydration compared to anurans from other environments; **11)** Nocturnal activity, avoiding the driest and hottest periods of the day.

It is interesting to note that most of these characteristics are not exclusive to xeric forms, but are also present in anurans of mesic habitats. From the above listing characteristics Nrs. 1, 2, 3, and 11 are found in all species in the present study. Other listed characteristics are found only in some species at Faz. Bravo. Egg laying in foam nests is found in the genera *Leptodactylus, Physalaemus* and *Pleurodema* (LYNCH, 1971; FAIVOVICH *et al*., 2012). *Pleurodema diplolister* has a rapid ontogenetic development (PEIXOTO, 1982), and also forms chores. The habit of burying was recorded for *L. troglodytes, P. cristiceps R. granulosa*, *P. diplolister* (CARVALHO and BAILEY, 1948), *D. muelleri* (CEI, 1980; VIZOTTO, 1967 and NOMURA *et al*., 2009) and probably also in *P. albifrons* and *P. cicada*, considering the great development of tubercles in the hind limbs of these species. GALLARDO (1979) points out that *D. muelleri* in the Chaco is a commensal form inhabiting termite mounds and considers this habit an adaptation to local xeric conditions. Along with the habit of burying, the main survival strategies for the dry season at the study area are the use as refuge of rock shelters (registered for *L. macrosternum* and *R. jimi*) and macambira clumps (observed for *S. pachychrus* and *P. nordestinus*). An adaptation against dryness found *in P. nordestinus* is the ability to cover the entire body with a lipid secretion of the alveolar cutaneous glands. This secretion is distributed by hands and feet (BLAYLOCK *et al*., 1976), and is a characteristic also recorded for other species of the same family living in semi-arid environments (WELLS, 2007). Uricotelism and the ability to ingest rainwater were also described for the Phyllomedusidae *Phyllomedusa sauvagii* as adaptations to water scarcity (WELLS, 2007). On the other hand, species of *Pithecopus*, including *P*. *nordestinus*, present a territorial behavior (VILAÇA *et al*., 2011), a characteristic more common in anurans with prolonged reproductive period and not in those with explosive reproduction as seen in semi-arid habitats. Reduced permeability in the skin, fragmotic behavior (gathering to narrow shelters, using the head to block the entrance) and ability to locate the wettest refuges available are features presented by *Corythomantis greeningi* that would explain, according to NAVAS *et al.* (2002), the success of this species in a semi-arid environment such as the Caatinga. Among the species studied, *P. diplolister* presented the highest number of characteristics considered as typical for xeric environments. The ability of this species to reproduce in relatively small bodies of water and to complete its larval development in a relatively short period of time has already been mentioned.

Tolerance to heat

Some of the samples of tadpoles were collected in waters with relatively high temperatures. Tadpoles of *L. troglodytes* from L. Carroça were collected in water with 34°C, *S. pachychrus* from P. Grande were collected in water with 33°C, *S. x-signatus* and *D. muelleri* from L. Bomba, *P. cristiceps, H.crepitans. S. pachychrus S. x-signatus* from Lagoa II and *P. diplodister* from P. Macambiras were collected in water with 31°C. ZWEIFEL (1968) carried out experiments with tadpoles of 8 species of anurans inhabiting North American xeric environments to determine the upper temperature limits under which, with continuous exposure, development could be considered as normal. He found values between 31°C and 34°C. However, the same author, in later work with some of these species (ZWEIFEL, 1977) observed that the embryos of *Bufo cornathus* survive for about six hours at 40.5°C, and that the species *Scaphiopus bombifrons* and *S. couchii* showed a heat resistance nearly equivalent. ZWEIFEL, in both studies, found that the tolerance of embryos to temperature increases with their degree of development and presumed that this occurs in all species of anurans. Due to this, a rapid development can be considered as an adaptation to the high temperature of the water (ZWEIFEL, 1977), besides being an adaptation to the reproduction in temporary water bodies and in those where the predation is high (BRATTSTROM, 1962). On the other hand, tolerance to high temperatures could be considered as an adaptation to reproduction in temporary water bodies, since the rates of growth and development are temperature dependent. Further, the maximization of temperature tolerance, in this case, would be advantageous, since it would increase the probability of tadpoles that live in temporary ponds, complete the metamorphosis before the pons dry out (HEATWOLE *et al*., 1968).

In experimental work, juveniles of *Rhinella granulosa* showed great tolerance to high temperatures and high capacity to absorb water, due to specializations of the skin in the inguinal region (NAVAS *et al*., 2007). Adults of this species also had their capacity of locomotion something affected by desiccation, when compared to other species (PRATES *et al*., 2013). On the other hand, PRATES and NAVAS (2009) reported that individuals of a population of *R. granulosa* of the Caatinga did not present a higher cutaneous resistance to water loss due to evaporation than co-specific anurans in an area of Atlantic Forest. They considered that high cutaneous resistance to water loss is not part of the features that allow survival of this species in the Caatinga.

The increase in air temperature during the dry season (Fig. 4) certainly worsens the problem of maintaining water balance by anurans, and perhaps contributed to the decrease in activity observed during this period. The low nocturnal temperatures recorded at the end of the rainy season may have also influenced the decrease of activity of these animals.

Parental investment

LOW (1976), analyzing the evolution of biological cycles in arid zone amphibians, considered that environments, such as the Caatinga, where the location of rains, the period of the rainy season and the amount of rain are unforeseeable, favor the prolongation of adult life, iteroparity and the reduction of parental investment, so that the cost of progeny loss at any time before the end of parental care, would be minimal.

In the present study, among the 18 species found, only *L. macrosternum* showed parental care. Among the species that were frequently observed, *L. macrosternum* and *R. jimi* did not reproduce in any of the three years, and *R. granulosa* failed to do so in the first two years. This is probably due to the lack of sufficient total amount or daily intensity of rain. *Pipa carvalhoi*, *L. macrosternum* and *H. crepitans*, apparently suffered a considerable reduction in their populations after the severe dry season of 1983.

Spatial distribution patterns

Although CRUMP (1982) stated that oviposition sites within a given area are generally distributed over time and space, most of the species found in this work did not exhibit preferences for certain types of water bodies. On the other hand, *L. troglodytes* and *P. nordestinus* seemed to prefer water bodies with vegetation, whereas *P. carvalhoi*, *P. diplolister* and *S. pachychrus* were the species that presented greater plasticity in the occupation of water bodies, occurring and reproducing, also in the smaller ones.

The lack of a species distribution pattern in the water bodies may be related to the physical characteristics of the region, which allow the formation of a large number of water bodies that are available for anuran breeding. In groups of tropical anurans in oviposition, vocalization was established as the primary factor of species isolation for 10 species of Costa Rican Hylidae (DUELLMAN, 1967) and 3 species of Brazilian Hylidae (CARDOSO, 1981).

Temporal distribution patterns

All species observed were seasonal, with activity only in the rainy season except *P. carvalhoi*, *L. macrosternum*, *R. granulosa* and *S. x-signatus* that had their activities linked to the existence of water bodies, in the rainy as well as in the dry season, and *S. pachychrus* that remained in activity in the macambiras during the initial months of the drought period. All reproductive activities recorded occurred only in the rainy season. This is in support of HEYER's (1973) statement that in tropical areas characterized by a pronounced dry season, such as Faz. Bravo, the only physical factor that regulates the reproductive pattern of anurans is the distribution of rainfall. During the rainy season, the duration of the reproductive activity varied among species, and the following five temporal patterns were observed: 1) *P. carvalhoi*, *S. pachychrus* and *S. x-signatus* reproduced throughout the rainy season; 2) *L. troglodytes*, *P. albifrons*, *P. cicada*, *P. cristiceps* and *R. granulosa* had only reproductive activity in the first third of the rainy season; 3) *H. crepitans* reproduced in the initial 2/3 of the rainy season; 4) *P. diplolister*, *D. soaresi* and *D. muelleri* apparently had reproductive activity limited to short periods after the most intense initial rains; 5) *P.nordestinus* started the reproductive activities about 30 to 40 days after the arrival of the rains, a period necessary for the development of the plants used by this species in the construction of nests.

Reproductive Modes

The reproductive modes of the anurans are characterized by a combination of several factors, particularly the place of oviposition and development of the larvae and the source of food for the latter (DUELLMAN and TRUEB, 1986). HADDAD and PRADO (2005) classified the reproductive modes of anurans in 39 different types. Among these, seven are found among the 18 species of Faz. Bravo. Numbers are from HADDAD and PRADO (2005): **Type 1**: exotrophic eggs and tadpoles in lentic water bodies, observed in *Rhinella granulosa*, *R. jimi, Corythomantis greeningi, Dendropsophus soaresi, Scinax pachychrus, S.x-signatus, Dermatonotus muelleri* and *Proceratophrys cristiceps*. **Type 4**: eggs and initial larval stages in natural or artificial ponds; subsequent to flooding, carry exotrophic tadpoles in lentic or lotic water bodies, as shown by *Hypsiboas crepitans*. **Type 11**: eggs in floating foam nests on lentic water bodies, the eggs hatch in exotrophic aquatic tadpoles, as found in *Leptodactylus macrosternum, Physalaemus albifrons, P.cicada* and *Pleurodema diplolister*. **Type 15**: Eggs embedded in the back of the aquatic females, later hatching in exotrophic tadpoles, as observed in *Pipa carvalhoi*. **Type 17**: eggs and initial larval stages in excavated nests; After flood, exotrophic tadpoles in lentic or lotic water bodies, as found in *Leptodactylus syphax*. **Type 24**: Egg laying fixed in the vegetation above lentic water bodies, eggs hatch in exotrophic tadpoles that fall and develop in these waters, as found in *Pithecopus nordestinus*. **Type 30**: Foam nests, with eggs and tadpoles in early stages of development, in subterranean chambers constructed by the male near the margins of lentic water bodies. The subsequent flooding of the chambers by rainwater or by water overflow transports the exotrophic tadpoles, to the water bodies, where they complete the development, as observed in *Leptodactylus caatingae* and *L. troglodytes*.

The seven reproductive modes found in Faz. Bravo species are among the nine modes related by VIEIRA *et al.* (2009) for Caatinga species of anurans. The most frequent reproductive mode among the anurans of Faz. Bravo (Type 1), presented by 8 species, is considered the most generalized and basal. On the other hand, six species presented reproductive modes that involve the construction of foam nests, which are useful in the protection of eggs against the desiccation. Other functions attributed to anuran foam nests are: protection against predation, pathogens or thermal damage; acceleration or inhibition of development; improvement in oxygenation and a source of food for larvae (WELLS, 2007).

Conclusions

The anuran community of Fazenda Bravo is formed by species with wide geographic distribution, occurring also in other domains that present more mesic characteristics. The species recorded do not seem to show special adaptations to the semi-arid environment and have a reproductive period regulated only by rainfall. The differences between the species in the occupation of water bodies and in the duration of the reproductive period did not appear to be related to a temporal or spatial repartition of the water bodies. Most species (8) presented a generalized reproductive mode, others (6) produced foam nests which are advantageous in Caatinga environment. In general, the anurofauna of Faz. Bravo seems to agree with the hypothesis of STRONG *et al*. (1979) and SIMBERLOFF (1983) who suggested that much of the proposed structural patterns for vertebrate communities simply reflect an interspecific variation in the ecological attributes usually associated with the use of resources rather than a systematic partition of them.

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