Diversity and abundance variations of anurans at a permanent pond in Suruaca's Valley, Linhares, Espírito Santo, southeastern Brazil

Rogério L. Teixeira, Rodrigo Barbosa Ferreira & Dennis Rödder

Abstract

The anuran fauna inhabiting a permanent pond in Suruaca's Valley, Espírito Santo, southeastern Brazil, was studied between November 2001 and March 2002. A total amount of 26 species were found. Herein we discuss about the diversity at the pond, monthly abundance patterns of the frogs, their habitat requirements and distribution patterns in the context of man-made habitat modifications within the Atlantic Forest of southeastern Brazil.

Zusammenfassung

Die Froschgemeinschaft an einem permanenten Gewässer im Suruaca Tal, Espírito Santo, Südost Brasilien, wurde zwischen November 2001 und März 2002 untersucht. Insgesamt wurden 26 Arten nachgewiesen. In dieser Arbeit diskutieren wir über die Diversität an dem Gewässer, die monatlichen Abundanzmuster der Frösche, ihre bevorzugten Habitate und ihre Verbreitungsmuster im Kontext von künstlichen Veränderungen der Habitate innerhalb des Atlantischen Regenwalds in Südost Brasilien.

Introduction

The distribution of anurans depends upon a series of ecological variables, such us microclimatic conditions, altitudinal variations, type of habitats, period of rainy season, human influences, and the availability of special kinds of vegetation necessary for the specific reproductive strategies of each species. Due to the necessity of an aquatic place for tadpole survival of the most species, the anuran tend to occur in restricted periods of the year, what is conditioned mainly to the rainy periods and increase of temperatures (Cardoso & Martins 1987).

The coexistence of similar species in ecological communities is one of the most perplexing problems in ecology (Gordon 2000). Anuran communities are especially complex because the relationship among the species abundances can change from one day to another. One species can spawn at the start of the rainy season, and soon leave the area whereas others may stay during the whole year. Also, a rainy night can show different abundance patterns compared to a dry night. Then, the results normally are interpreted as the "momentum" what makes comparisons between different communities difficult.

Studies dealing with anuran communities within the Atlantic Rainforest in Espírito Santo are rare and these available focus on assemblages in (nearly) undisturbed areas (Prado & Pombal 2005, Rödder et al. 2006), what make sense because the biology of most species is poorly known and even data about wide distributed common species are rare. On the other hand the native Rainforest vegetation in Espírito Santo is reduced to 7-8 % due to human settlings and extensive agriculture (Morellato & Haddad 2000), so the question arise how the fauna, and especially many anurans depending on forest climate, cope with these habitat modifications. One of the first papers describing communities inhabiting such modified environments is Teixeira et al. (2007).

Herein, we present data on the anuran community inhabiting a permanent pond in a human modified area during the rainy period at Suruaca's Valley, county of Pontal do Ipiranga, Municipality of Linhares, Espírito Santo state, southeastern Brazil. We assessed the dominant species, the degree of structural monthly patterns, the diversity index, and the degree of similarities among dominant species.

s of anurans
lley, Linhares,
Brazil

& Dennis Rödder

ence of similar species in ecolo-
ities is one of the most perple-
s in ecology (Gordon 2000).
nunities are especially complex
ationship among the species ab-
change from one day to another.
n spawn at the start of the rainy
on leave the area whereas others
ng the whole year. Also, a rainy
w different abundance patterns
dry night. Then, the results nor-
preted as the "momentum" what
risons between different com-
ult.
ling with anuran communities
antic Rainforest in Espírito San-
l these available focus on assem-
rly) undisturbed areas (Prado
05, Rödder et al. 2006), what
ecause the biology of most spe-
known and even data about wide
mmon species are rare. On the
e native Rainforest vegetation in
is reduced to 7-8 % due to hu-
and extensive agriculture (Mo-
laddad 2000), so the question
fauna, and especially many an-
ing on forest climate, cope with
modifications. One of the first
ibing communities inhabiting
l environments is Teixeira et al.

present data on the anuran com-
iting a permanent pond in a hu-
l area during the rainy period at
ey, county of Pontal do Ipiranga,
of Linhares, Espírito Santo state,
Brazil. We assessed the dominant
egree of structural monthly pat-
rsity index, and the degree of si-
ng dominant species.

Materials and Methods

Study Site – Fieldwork was conducted in the lowlands of Pontal do Ipiranga (Suruaca's Lagoon Farm, 19°07' S, 39°46' W), municipality of Linhares, Espírito Santo State, southeastern Brazil. The vegetation of the analyzed pond was dominated by dense and high plants of *Typha* aff. *dominguensis* (Typhaceae). Other common plants were *Fuirena* sp. (Cyperaceae), *Nymphaea* sp. (Nymphaeaceae), *Cabomba* sp. (Nymphaeaceae), *Utricularia* aff. *neglecta* (Lentibularianaceae), *Eichornia* sp. (Pontederiaceae), and *Salvinia natans* (Salviniaceae). The pond covered an area estimated in 750 m^2 and most parts were shallow, but reached up to 3 m depth at the middle during the dry season (winter). The lack of rain for a long period during the winter, certainly affected the water volume in the pond during the study time.

Thirty years ago, the entire Suruaca's valley was a permanent marsh. After much drainage was build by government agencies in order to increase pasture areas, the entire region was transformed in several isolated permanent ponds closely near each other forming the Suruaca's lagoon. During the peak of the rainy season (December, January; summer), the ponds may link to each other. During the field work, it was observed the increase of the drainaged areas, and the vegetation surrounding the studied pond was devastated in order to plant coconuts. Today, the whole area is a coconut plantation.

Samples – The community was sampled by RLT using visual encounter surveys between 19:00 and 23:00 h from November 2001 to March 2002. The Shannon-Weaver diversity index was applied to compare the diversity between the months. We performed a cluster analysis to detect the degree of similarities in the monthly abundances among the main species (n>12). For the cluster analysis, the percentage of specimens found per month was used. We divided all species found according to their distributions and habitat preferences into specialists inhabiting exclusively the Atlantic Rainforest Biom and areas rich in forest and generalists occurring within the Atlantic Rainforest as well as in the Caatinga-Cerrado Biom and in open and forest rich habitats. Information about habitats and distributions were taken from IUCN (2006).

Results

During the surveys, 26 anuran species belonging to seven families were identified at the pond (Table 1). The family Hylidae was clearly dominating with sixteen species. *Scinax argyreornatus* was numerically the dominant species, representing 12.3% of all anurans sampled. *Hypsiboas semilineatus* and *S. alter* represented 11.5% being the two anurans secondarily important in the community. The anuran fauna inhabiting the lagoon was dominated by generalists characterized by a wide distribution within the Atlantic Rainforest and the Cerrado-Caatinga Biom and inhabiting open as well as forested areas (Table 1).

The total number of species varied from 15 to 22 between the months, increased from November 2001 until January 2002 but showed a tendency to decrease in the last month (Fig. 1a). The number of counted individuals varied from 35 to 224, and followed the same pattern as the number of species (Fig. 1b). The Shannon-Weaver diversity index showed a similar pattern, with differences in November 2001 associated to the number of individuals obtained for different species (Fig. 1c). During the vocalizations' peak season (January, February) the roads near the study site were over flooded evidencing strong rain falls.

The cluster analysis based on the percentage of individuals per month showed two main groups (Fig. 2). One group was composed by the most abundant hylid frogs, such as *D. minutus*, *D. branneri*, *H. albopunctatus*, *H. faber*, *S. alter*, *S. fuscovarius*, *H. semilineatus* and *S. argyreornatus*. All of them occurred in high number throughout the study and most of them showed a peak in January. The second group was formed by the other species that generally occurred in lower abundance more evenly distributed from December through March.

Table 1. List of species, monthly abundance patterns, distribution and habitat requirements of frogs found. Abbreviations: A= Atlantic Forest; C = Cerrado-Caatinga Biom; F = forest; O = open landascapes; x = species present but in low abundance; preliminary habitat / distribution in bold.

	N	%	Monthly Abundance %					Distribution	Habitat
			Nov	Dez	Jan	Feb	Mrz		
Bufonidae									
Chaunus crucifer	18	3,6	11,1	5,6	50,0	22,2	11,1	A	F / O
Chaunus granulosus	3	0,6		×	×			A / **C**	F / **O**
Chaunus schneideri	1	0,2		×				A / **C**	F / **O**
Hylidae									
Bokermannohyla caramaschii	1	0,2					×	A	F
Dendropsophus anceps	1	0,2		×				A	**F** / O
Dendropsophus bipunctatus	23	4,7	21,7	17,4	30,4	30,4	0,0	**A** / C	**F** / O
Dendropsophus branneri	37	7,5	2,7	0,0	59,5	37,8	0,0	A / C	F / O
Dendropsophus decipiens	7	1,4	×				×	**A** / C	F / O
Dendropsophus elegans	28	5,7	3,6	10,7	35,7	25,0	25,0	**A** / C	**F** / O
Dendropsophus minutus	43	8,7	4,7	20,9	39,5	25,6	9,3	A / C	F / O
Hypsiboas albomarginatus	11	2,2	×		×	×	×	A	**F** / O
Hypsiboas albopunctatus	55	11,1	9,1	25,5	36,4	23,6	5,5	A / **C**	F / O
Hypsiboas faber	25	5,1	0,0	20,0	64,0	12,0	4,0	**A** / C	F / O
Hypsiboas pardalis	6	1,2			×	×	×	A	F / O
Hypsiboas semilineatus	57	11,5	5,3	10,5	49,1	33,3	1,8	**A** / C	F / O
Phyllomedusa rohdei	5	1,0			×	×	×	A	F
Pseudis bolbodactyla	7	1,4	×	×	×	×	×	A / **C**	F / O
Scinax alter	57	11,5	10,5	7,0	45,6	31,6	5,3	A	F / O
Scinax argyreornatus	61	12,3	3,3	4,9	55,7	36,1	0,0	A	**F** / O
Scinax fuscovarius	18	3,6	11,1	0,0	61,1	27,8	0,0	A / C	F / O
Brachycephalidae									
Eleutherodactylus binotatus	8	1,6		×	×	×	×	**A** / C	F
Leptodactylidae									
Leptodactylus fuscus	2	0,4			×	×			
Leptodactylus ocellatus	14	2,8	7,1	21,4	28,6	21,4	21,4	A / C	F / O
Leiuperidae									
Physalaemus aguirrei	4	0,8	×		×	×	×	A	F / O
Microhylidae									
Stereocyclops incrassatus	1	0,2				×		**A** / C	F
Chiasmocleis schubarti	1	0,2			×			**A** / C	F
Total	494	100,0							

Discussion

Studies focusing on anuran communities within the Atlantic Forest have commonly evidenced a high number of species. HADDAD (1988) recorded 29 anuran species for Parque Nacional da Serra da Canastra. FEIO (1990) ob-

l habitat requirements of frogs
= forest; O = open landascapes;
on in bold.

ıce % Mrz	Distribution	Habitat
11,1	A	F / O
	A / **C**	F / **O**
	A / **C**	F / **O**
×	A	F
	A	**F** / O
0,0	**A** / C	**F** / O
0,0	A / C	F / O
×	**A** / C	F / O
25,0	**A** / C	**F** / O
9,3	A / C	F / O
×	A	**F** / O
5,5	A / **C**	F / O
4,0	**A** / C	F / O
×	A	F / O
1,8	**A** / C	F / O
×	A	F
×	A / **C**	F / O
5,3	A	F / O
0,0	A	**F** / O
0,0	A / C	F / O
×	**A** / C	F
21,4	A / C	F / O
×	A	F / O
	A / C	F
	A / C	F

number of species. HADDAD
29 anuran species for Parque
ra da Canastra. FEIO (1990) ob-

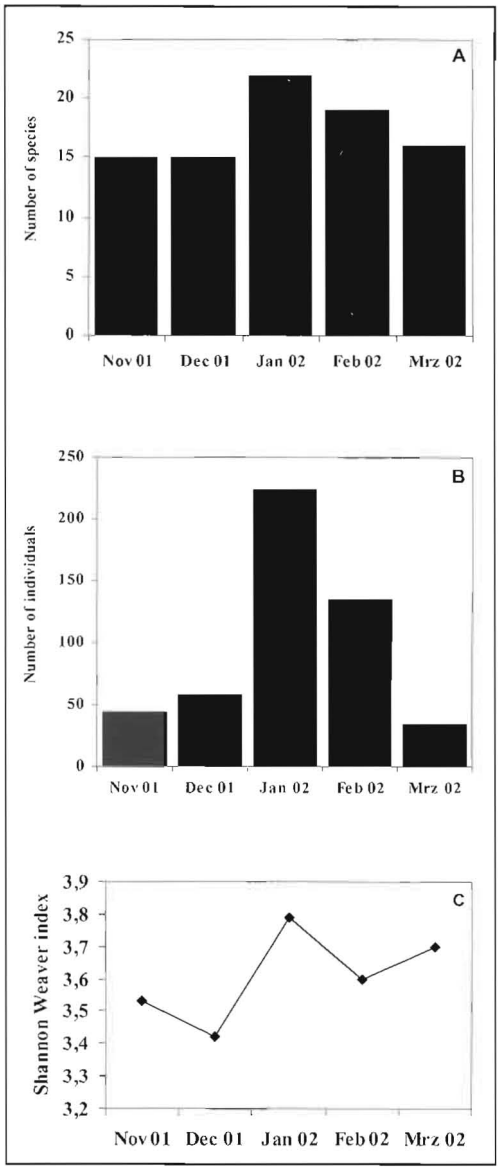

Fig. 1. Number of species (a), number of individuals (b), and Shannon-Weaver diversity index (c) per month.

tained 26 species for Parque Estadual de Ibitipoca (MG). HADDAD & SAZIMA (1992) found 24 species in Serra do Japi (SP). ROSSA-FERES & JIM (1994) found 22 species in the region of Botucatu (SP). FEIO & CARAMASCHI (2002)

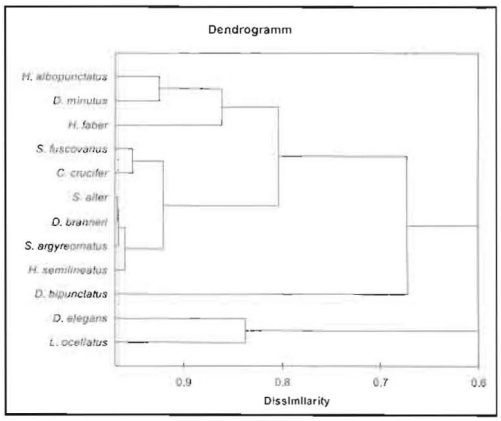

Fig. 2. Cluster analysis showing the main similarities among species according to monthly abundance obtained in a permanent pond.

found 46 species for the Rio Jequitinhonha (MG). POMBAL (1997) pointed out 19 species for Serra de Paranapiacaba (SP), PRADO & HADDAD (2005) listed 34 species for a swamp in the Reserva Biológia de Duas Bocas (ES), RÖDDER et al. (2006) listed 50 species for the Santa Lúcia Biological Station in Santa Teresa (ES) and TEIXEIRA et al. (2007) have found 15, 16 and 19 Taxa inhabiting three human modified lagoons near Anchieta (ES). The numbers of species that occur in a specific habitat depend upon the number of microhabitats available and the success of colonization by the species. Furthermore, the numbers of species, which are known to inhabit a specific area, depend on the sampling effort and so it is important to pay attention on this making comparisons. As a general pattern, it appears that Atlantic Rainforest communities inhabiting undisturbed areas are commonly more diverse than communities inhabiting human modified Atlantic Forest habitats or areas within the much drier Cerrado-Caatinga Biom.

Next to the diversity of taxa it is important to pay attention toward abundance patterns. It is possible to divide the total number of species into taxa which occur in large numbers and those which are only represented by few individuals. The last group can often be characterized as transitional species which normally do

not breed in the studied habitat. Due to their low abundance they have only a low effect on competition within assemblages. The community analyzed here was dominated by *D. minutus*, *D. branneri*, *H. albopunctatus*, *H. faber*, *S. alter*, *S. fuscovarius*, *H. semilineatus* and *S. argyreornatus* (Fig. 3), the remaining species are suggested to be species with a reproductive period which was not covered during the survey time or to be transitional species.

Fig. 3. *Scinax argyreornatus* is a typical Atlantic Forest species and one of the most common hylids at many sites in Espírito Santo.

The anuran community studied in here was mainly composed of species widely distributed throughout the Atlantic Rainforest and Cerrado-Caatinga Biom (*C. crucifer* (Fig. 4), *H. albopunctatus*, *D. branneri*, *D. minutus*, *D. elegans*, *H. faber*, *H. semilineatus*, *L. ocellatus*, *P. bolbodactyla* (Fig. 5), *S. fuscovarius*). All these species are generalists inhabiting a great variety of habitats. *Dendropsophus bipunctatus*, *S. alter*, and *S. argyreornatus* are species whose distribution is restricted to the Atlantic Rainforest Biom and which can be considered as more specialized. Comparing this community with other assemblages inhabiting undisturbed areas within the Atlantic Rainforest, such as described by Heyer et al. (1990), Prado & Haddad (2005) and Rödder et al. (2006), it is evident that the number and abundance of typical Atlantic Forest species is reduced here and compared with locations within the Cerrado-Caatinga Biom the community share more species. Grandinetti & Jacobi (2005) analyzed an anthropogenic disturbed area in Rio Acima (MG) and found a total number of 14 species. The analyzed area shared 6 species – all generalists - with our assemblage. Although the anuran diversity in the Suruaca's Lagoon was higher than in Rio Acima, it appears that this human modified habitat is mainly colonized by generalist species, which can become invasive in deforested and agricultural used landscapes. The communities studied by Teixeira et al. (2007) are also more similar to the community analyzed herein than to the communities described by Heyer et al. (1990), Prado & Haddad (2005) and Rödder et al. (2006). These human modified landscapes within the original Atlantic Rainforest Biom provide a microclimate more similar to the Cerrado-Caatinga

Fig. 5. *Pseudis bolbodactyla* inhabits mainly bodies of water in the Cerrado and Caatinga, but occurs also in deforested areas in Espírito Santo.

rgyreornatus is a typical Atlantic
d one of the most common hylids
Espírito Santo.

cted to the Atlantic Rainforest
ch can be considered as more
mparing this community with
ges inhabiting undisturbed ar-
Atlantic Rainforest, such as de-
ER et al. (1990), PRADO & HAD-
l RÖDDER et al. (2006), it is evi-
umber and abundance of typi-
rest species is reduced here and
locations within the Cerrado-
the community share more spe-
ETTI & JACOBI (2005) analyzed
nic disturbed area in Rio Acima
nd a total number of 14 species.
rea shared 6 species – all gen-
our assemblage. Although the
y in the Suruaca's Lagoon was
Rio Acima, it appears that this
d habitat is mainly colonized by
ies, which can become invasive
nd agricultural used landscapes.
ies studied by TEIXEIRA et al.
more similar to the community
than to the communities de-
ER et al. (1990), PRADO & HAD-
d RÖDDER et al. (2006). These
ed landscapes within the origi-
inforest Biom provide a micro-
imilar to the Cerrado-Caatinga

Biom than to the Atlantic Forest Biom which is characterized by more fluctuating humidity and temperature course during the day. The effect of these invasive species is still widely unknown, but it is high likely that these species compete with the native taxa and may suppress them. Further studies should focus on these effects and the change in species composition due to human made environmental changes.

Acknowledgements

We thank HÉLIO Q.B. FERNANDES for identifying the plants.

References

CARDOSO, A.J. & J.E. MARTINS (1987): Diversidade de anuros durante o turno de vocalizações, em comunidade neotropical. – Papéis Avulsos de Zoologia, **36**(23): 279-285.

CORRÊA, M.P. (1975): Dicionário das Plantas Úteis do Brasil e das Exóticas Cultivadas. Ministério da Agricultura, Rio de Janeiro, Volume VI, 777 p.

FEIO, R.N. (1990): Aspectos ecológicos dos anfíbios registrados no Parque Estadual do Ibitipoca. Minas Gerais (Amphibia. Anura) – Tese de Mestrado, Museu Nacional do Rio de Janeiro, 106 pp.

FEIO, R.N. & U. CARAMASCHI (2002): Contribuição ao conhecimento da herpetofauna do nordeste do estado de Minas Gerais, Brasil – Phyllomedusa, **1**(2): 105-111.

GORDON, C.E. (2000): The coexistence of species. – Revista Chilena de Historia Natural, **73**(1): 175-198.

GRANDINETTI, L. & C.M. JACOBI (2005): Distribuicao estacional e espacial de uma tacxocenose de anuros (Amphibia) em uma área antropizada em Rio Acima – MG. – Lundiana, **6**(1): 21-28.

HADDAD, C.F.B. (1998): Biodiversidade dos Anfíbios no Estado de São Paulo. – S. 17-26. in: CASTRO, R.M.C. (Ed.): Biodiversidade do Estado de São Paulo. Brasil: Síntese do Conhecimento ao Final do Século XX. 6: Vertebrados – São Paulo (FAPESP).

HADDAD, C.F.B. & I. SAZIMA (1992): Anfíbios anuros da Serra do Japi. – Pp. 188-211. in: MORELLATO, L.P.C. (Ed.): História Natural da Serra do Japi Campinas (Editora da UNICAMP/FAPESP).

HEYER, W.R., A.S. RAND, C.A.G. CRUZ, O.L. PEIXOTO & C.E. NELSON (1990): Frogs of Boracéia. – Arquivos de Zoologia, **31**(4): 231-410.

IUCN (2006): Conservation International and NatureServe. Acessable at www.globalamphibians.org. Download on December 20th 2006.

MORELLATO, L.P.C. & C.F.B. HADDAD (2000): Introduction: the Brazilian Atlantic Forest. – Biotropica **32**(4b): 786-792.

POMBAL, J.P. (1997): Distribuição espacial e temporal de anuros (Amphibia) em uma poça permanente na Serra de Paranapiacaba. sudeste do Brasil – Revista Brasileira de Biologia, **57**(4): 583-594

PRADO, G.M. & J.P. POMBAL (2005): Distribuição espacial e temporal dos anuros em um brejo da reserva biológica de duas bocas, sudeste do Brasil. – Aquivos de Museu Nacional, Rio de Janeiro, **63**(4): 687-705.

ROSSA-FERES, D.C. & J. JIM (1994): Distribuição sazonal em comunidades de anfíbios anuros na região de Botucatu, São Paulo – Revista Brasileira de Biologia, **54**(2): 323-334.

RÖDDER, D., R.B. NARCIZO, R.L. TEIXEIRA & W. PERTEL (2006): Bemerkungen zur Anurendiversität und -ökologie in einem Reservat im Atlantischen Regenwald in Südost Brasilien. – Sauria, **28**(4): 27-38.

TEIXEIRA, R.L., D. RÖDDER, G.I. ALMEIDA, J.A.P. SCHINEIDER, G.C. ZEIDAN & S.A. LOPES (2007): Artzusammensetzung und jahreszeitliche Abundanzmuster bei drei Anurengesellschaften an der Küste Südost-Brasiliens. – Sauria, **29**(1): 33-45.

Eingangsdatum: 28.03.2007

Authors

ROGÉRIO L. TEIXEIRA
& RODRIGO BARBOSA FERREIRA
Museu de Biologia Mello Leitão
Av. José Ruschi 4
29650-000 Santa Teresa-ES, Brazil

DENNIS RÖDDER
Zoologisches Forschungsmuseum
Alexander Koenig
Adenauerallee 160
D-53113 Bonn, Germany