UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
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PROGRAMA DE PÓS-GRADUAÇÃO EM ECOLOGIA

A INFLUÊNCIA DO HABITAT EM COMUNIDADES DE ANUROS EM UMA ÁREA NO LIMITE SUL DE DISTRIBUIÇÃO DA MATA ATLÂNTICA: IMPLICAÇÕES NO MANEJO E CONSERVAÇÃO

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À memória do professor Marcos Di-Bernardo que não pode ver nosso trabalho finalizado.

“*I'd like to share a revelation that I've had during my time in here.*

It came to me when I tried to classify your species and I realized that you're not actually mammals.
Every mammal on this planet instinctively develops equilibrium with the surrounding environment.

But you humans do not.

You move to an area, and you multiply and multiply, until every natural resource is consumed.

The only way you can survive is to spread to another area.

There is another organism on this planet that follows the same pattern.

Do you know what it is?

A virus.

Human beings are a disease, a cancer of this planet.

You are a plague.

And we are the cure.”

Trecho onde um sistema dotado de inteligência artificial descreve sua concepção do que realmente é nossa espécie em uma ficção que se passa em um tempo não muito distante. Filme Matrix.

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RESUMO

Em nosso estudo analisamos vocalizações de anuros em quatro banhados diferentes no Parque Estadual de Itapeva no limite sul de distribuição da Mata Atlântica (29º S, 49º W). Dados de campo foram coletados entre Novembro de 2005 e Fevereiro de 2006. Treze espécies de cinco famílias foram registradas: Hylidae (7), Leiuperidae (2), Leptodactylidae (2), Microhylidae (1) e Ranidae (1). Nossos dados indicam que as várias espécies de anuros exibem modelos diferentes de presença e ausência e abundância nos banhados, que são explicados pelas variáveis de habitat. As assembléias de anuros do estudo formaram duas categorias, as espécies que necessitam de habitats mais específicos e áreas com menos distúrbio e as espécies que ocorrem em áreas com distúrbio e sem distúrbio de habitat por ação antrópica. Atividades humanas e a subseqüente fragmentação do habitat são claramente relacionadas com a distribuição de todas as espécies de anuros, sendo que as espécies sensíveis são cada vez mais confinadas a manchas menores de habitat e as espécies generalistas são beneficiadas com mais áreas antropizadas.

Palavras-Chave: Influencia do habitat, Perda de habitat, Mata Atlântica, Anuran call survey, Amphibia, Anura, Parque Estadual de Itapeva, Brasil.

INTRODUÇÃO GERAL

Todos os organismos possuem uma relação direta com o ambiente onde vivem (Stiling, 1999). Compreender como funcionam tais relações, a influência de um sobre o outro e saber a sensibilidade de cada grupo a alterações no meio são informações preciosas para os estudos de relações ecológicas. Alguns grupos são menos tolerantes a alterações no meio e são considerados indicadores de qualidade ambiental, tais como peixes, invertebrados bentônicos e liquens. Dentre estes indicadores está um grupo que possui alta sensibilidade a modificações, os anfíbios. Esses organismos possuem estratégias reprodutivas muito peculiares e uma grande diversidade de modelos de história natural (Duellman e Trueb, 1994). Essas peculiaridades tornam este grupo de grande interesse acadêmico para a compreensão de suas relações com o entorno e os tornam ótimos biondicadores de qualidade ambiental.

Diversos trabalhos descrevem sérios problemas com declínios populacionais em anfíbios no mundo (Azevedo-Ramos e Galatti, 2002; Collins e Storfer, 2003; Cushman, 2006; Diniz-Filho et al., 2004; Eterovick et al., 2005; Knutson et al., 1999; Skelly et al., 2003; Young et al., 2001), e diversas são as causas apontadas para explicar os motivos causadores dos declínios. Collins e Storfer (2003), revisando a bibliografia até o momento, demonstram seis hipóteses que definem tais causas: introdução de espécies exóticas, super exploração, fragmentação e destruição de habitat, pesticidas e outros produtos químicos tóxicos, mudanças climáticas globais e doenças infecciosas. De todas estas causas, fragmentação e destruição de habitat tem sido considerada a maior de todas, e este assunto tem chamado maior atenção dos pesquisadores recentemente. Causas recentes, ocorrentes nos últimos 20 ou 30 anos, são as principais ameaças dessas extinções e sem dúvida alterações ambientais já causaram impacto nos organismos mais sensíveis e certamente terão causas mais severas em longo prazo para os demais organismos. Estima-se que muitas espécies de anfíbios tenham se extinguido nos últimos anos. Isto se dá por registros de coletas muito antigos em coleções científicas, que não se repete há muitos anos.

O Brasil é o país com a maior riqueza e de anfíbios anuros atualmente (SBH, 2007), porém também é considerado um dos países com maiores áreas desmatadas a cada ano, acabando continuamente com uma das maiores riquezas que possuímos, nossa biodiversidade. Eterovick et al. (2005) apresentam um referencial de como está a situação sobre declínios populacionais em anfíbios no Brasil e não diferente de outros trabalhos, perda de habitat é citado como um dos principais motivos. Porém mais estudos são necessários, pois a literatura ainda é muito escassa e muitas espécies ainda são pouco conhecidas, tornando todo o território nacional um ótimo local para estudos sobre o status das populações, buscando áreas prioritárias para manejo e conservação.

Dentre os principais biomas existentes no Brasil está a Mata Atlântica, listada entre os cinco mais importantes hotspots no mundo (Myers et al., 2000). Sua distribuição se estende do nordeste ao sul do Brasil e todos os trabalhos que descrevem declínios populacionais de anfíbios na Mata Atlântica se concentram no centro da distribuição deste Bioma. Sabe-se muito pouco sobre os ambientes existentes no extremo sul da Mata Atlântica, onde se localiza o Parque Estadual de Itapeva, local deste estudo (Fig. 1).

O enfoque principal deste trabalho foi o de identificar como variáveis de habitat influenciam as comunidades de anuros em quatro diferentes banhados (Fig. 2 a-d) no extremo Sul da Mata Atlântica, em uma área de mata de restinga com dunas e forte influência do oceano Atlântico, e avaliar de que forma as degradações das áreas causadas por distúrbios associados à perda de habitat afetam as comunidades de anuros nestes banhados no Parque Estadual de Itapeva, sul do Brasil.

Em relação ao Parque Estadual de Itapeva, diversos trabalhos envolvendo diversos organismos já foram desenvolvidos: plantas (Lindeman et al., 1975; Kindel 2002; Waechter, 1986;), interação inseto-planta (Fuhro, 2006), anfíbios (Colombo, 2004; Colombo e Vinciprova, 2001a; 2003b), aves, (Silveira, 2006); mamíferos (Cerveira e Kindel, 2000a; 2000b; Horn, 2005; Salermo, 2006); além dos levantamentos realizados através do plano de manejo para o Parque (SEMA, 2006) e um estudo sobre o impacto de rodovias da região sobre a fauna (Coelho, 2003). Dentre estes trabalhos descritos cabe salientar o de Dobrovolski (2006) que descreve a importância da preservação de banhados no Parque e demonstra que 7% da área coberta por esta classe de habitat foi reduzida entre 1974 e 2002. Colombo (2004) obteve uma lista de anuros, tendo registradas 27 espécies para toda a área do parque. O autor ressaltou que é possível que novas espécies ainda poderiam ser registradas na área, devido a presença de áreas favoráveis e pelo fato de muitas outras espécies terem sido registradas em outras áreas próximas de mata paludosa e florestas de regiões baixas próximas ao parque.

A seguir será apresentado um manuscrito produzido, a ser submetido ao periódico Biological Conservation.

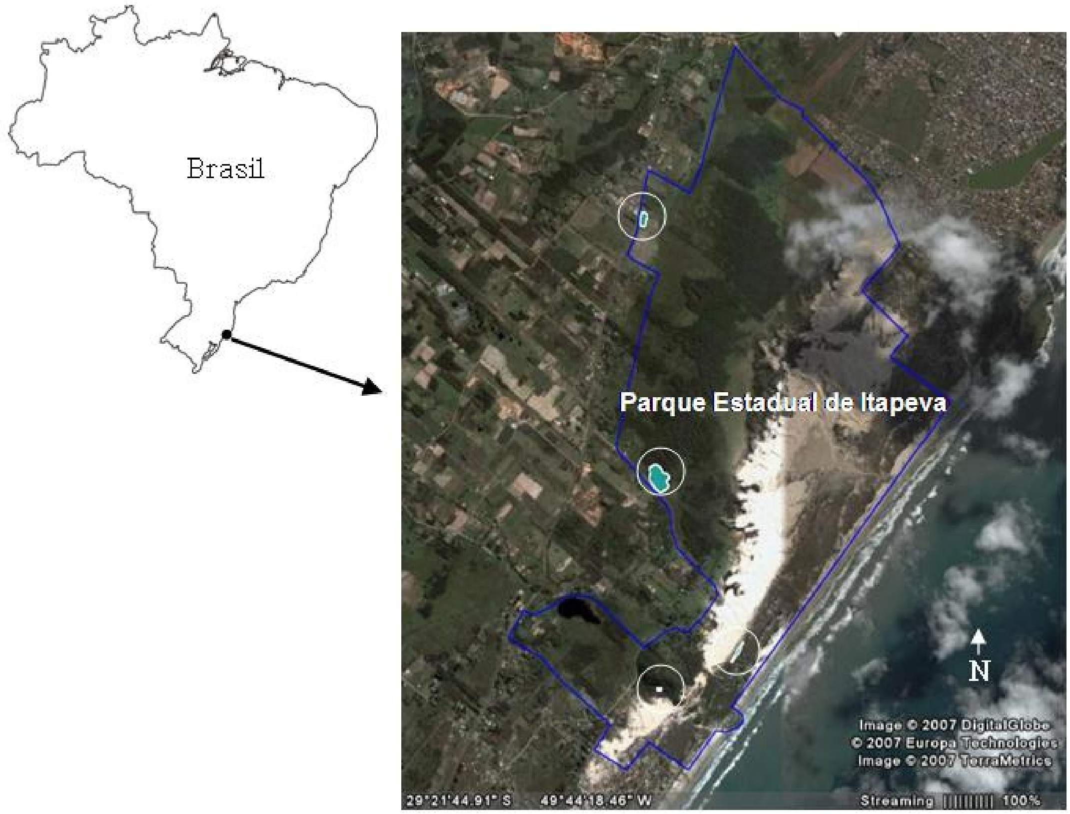

Fig. 1. Área do Parque Estadual de Itapeva (limites em azul) Torres, RS. Em destaques banhados estudados (A1, A2, A3 e A4).

Fig. 2 a. Área A1 (Banhado inserido dentro de matrix florestal).

Fig. 2 b. Área A2 (Banhado circundado por dunas).

Fig. 2 c. Área A3 (Banhado com vegetação rasteira e Mata Paludosa ao fundo) .

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HABITAT INFLUENCES ON AMPHIBIAN ASSEMBLAGES IN THE SOUTH LIMIT DISTRIBUTION OF BRAZILIAN ATLANTIC RAINFOREST: MANAGEMENT AND CONSERVATION IMPLICATIONS

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ABSTRACT

In our study we surveyed anurans through their calls in four different wetlands at the Parque Estadual de Itapeva in the south distribution limit of Atlantic rainforest (29º S, 49º W). Field work was carried out between November 2005 and February 2006. Thirteen species from five families were recorded in the study site: Hylidae (7), Leiuperidae (2), Leptodactylidae (2), Microhylidae (1) and Ranidae (1). Our data indicated that the various anuran species exhibit different patterns of presence/absence and abundance at the wetlands, explained by habitat variables. The complex anuran assemblages of the study sites included two categories, the species that require specific habitat requirements and undisturbed sites and the species that occur in both disturbed and undisturbed habitats. Human activities and subsequent habitat fragmentation are clearly related to the patchy distribution of all species of anurans, the sensitive species are confined to less patches and the generalist species clearly benefit from more anthropized areas.

Key-words: Habitat influences, Atlantic Rainforest, Habitat loss, Anuran call survey, Amphibia, Brazil.

INTRODUCTION

How altered landscape patterns affect the abundance and distribution of organisms is one of the most important problems in ecology (Lubchenko et al., 1991). Although numerous studies have examined the effects of fragmentation in landscapes with different proportions of suitable habitat for birds and mammals (see Andren 1994 for review) data on other vertebrate taxa are scarce. Nowadays amphibians have received a considerable attention in ecological and conservation studies since the decline of amphibian populations become a worldwide phenomenon (Azevedo-Ramos and Galatti, 2002; Collins and Storfer, 2003; Cushman, 2006; Diniz-Filho et al., 2004; Knutson et al., 1999; Skelly et al., 2003; Young et al 2001). In fact, many Amphibia taxa are in a very drastic situation; the red list of threatened and endangered species identified 59% out of 6140 species in some risk category (IUCN, 2006).

Fragmentation and habitat modification are the first cause of amphibians declines in the world (Collins and Storfer, 2003; Cushman, 2006; Diniz-Filho et al., 2004; Gibbs, 1998; Knap et al., 2003; Skelly et al., 2003; Ray et al., 2002; Krishnamurthy, 2003). Populations may be prone to local extinction as a result of the transformation and fragmentation of their habitat, due to the spatially and temporally dynamic nature of amphibian populations. Considerable efforts focusing on amphibian conservation are increasing around the world. However amphibian populations naturally fluctuate annually, due to drought, extreme temperatures and predation (Collins and

Storfer, 2003; Green, 2003). Understanding the difference between natural fluctuations and declines is the next step to identified anurans extinctions (Peachmann et al., 1991; Collins and Storfer, 2003; Cushman, 2006).

Amphibians are strongly linked to wetlands (Knutson et al., 1999; Petranka and Holbrook, 2006) and small seasonal wetlands, the primary breeding habitats of many amphibians, have diminished at alarming rates (Semlitsch and Bodie, 1998; Gibbs, 2000; McCauley and Jenkins, 2005). Restored wetlands and the correct preservation of wetlands contours and the buffer areas are needed to conserve amphibians.

The fragmentation of continuous habitats into patches reduces the vegetation suitable area and the natural protection of wetlands and increases the degree of isolation experienced by organisms inhabiting each patch. Patch occupancy can also be affected by patch quality (Sjögren-Gulve, 1994; Sarre et al., 1995; Dennis and Eagles, 1999) and by the characteristics of habitats contours (Vos & Stumpel, 1995; Pope et al., 2000; Joly et al., 2001). Amphibians are very sensitive to some environmental variables and often show strong site fidelity (Kleeberger and Werner, 1982; Marsch and Pearman, 1997; Sinsch, 1990) and low dispersal ability, so that environmental changes can strongly affect amphibian populations. Understand how the resistance of each species in altered landscape happens and identified all important variables to the species will be needed to do the correct management actions.

The knowledge about the status of amphibian populations and declines in South America is very scarce (Myers et al., 2000; Young et al., 2001; Eterovick et al., 2005). In Brazil, a few papers have concerned this subject (Bertoluci and Heyer, 1995; Guix et al., 1998; Heyer et al., 1988; Izecksohn and Carvalho-e-Silva, 2001; Papp and Papp, 2000; Pombal and Haddad, 1999; Silvano and Segalla, 2005; Weygoldt, 1989). One of the most biodiverse areas in the world is the Atlantic Rainforest. This biome has lost more than 90% of its the original forested area (Myers et al. 2000) due to human activities such as extensive deforestation, logging and fire. Myers et al. (2000) listed the Atlantic Rainforest among the five hottest hotspots for conservation priority in the world. The distribution of this biome ranged from the south (subtropical climate) to the northeast (tropical climate) in Brazil. Probably climatic variation has a great influence on the species composition across the latitudinal gradient of the Brazilian Atlantic Rainforest. Almost all amphibians decline publications in Brazil focused on central area of the Atlantic Rainforest, and little is known at the extreme south distribution where this work was conducted.

The purpose of this work was to evaluate how habitat variables might alter the local richness, abundance and composition of anuran assemblages in a subtropical area in southern limit distribution of Brazilian Atlantic rainforest. For this purpose, we evaluated richness, abundance and composition of anuran assemblages in a short spatial scale, and analyzed the influence of habitat variables in these patterns. Further, we discussed the implications of habitat characteristics for the management and conservation of anuran communities.

METHODS

2.1 *Study Site*

The study was conducted from November 2004 to February 2005 at Parque Estadual de Itapeva, a 1000-ha preserved area located at northeast of Rio Grande do Sul, the southernmost state of Brazil (29º S, 49º W) (Fig. 1). The study area is characterized by fixed and mobile dunes with restinga covering, coastal swamp forest, dry fields, wet fields, bogs and wetlands (Lindeman et al., 1975). This formation contains an important biodiversity and a great number of threatened species (Fontana et al., 2003).

Restingas are part of the Atlantic Rain Forest biome. This formation is characterized by drained and not drained sandy soil and the vegetation cover is very complex, composed by shrubs, herbs, and trees (Waechter, 1986). The vegetation is characterized by a great number of tropical genera, mainly belonging to the families Orchidaceae (*Vanilla*, *Epidendrum*, *Stelis*, *Maxillaria*, *Cyrtopodium*, *Oncidium*), Bromeliaceae (*Canistrum*, *Nidularium*, *Wittrockia*), Araceae (*Anthurium*, *Philodendrum*), Palmae (*Euterpe*, *Geonoma*, *Bactris*), Heliconiaceae (*Heliconia*), Clusiaceae (*Clusia*, *Rheedia*), Moraceae (*Ficus*), Cecropiaceae (*Codonanthe*, *Nematanthus*), Marcgraviaceae (*Marcgravia*) and Gesneriaceae (*Codonanthe*, *Nematanthus*) (Waechter, 1986).

2.2 *Survey methods*

We surveyed anuran through their calls, taking a measure of the relative abundance and richness of species in each swamp (see also methods on Herrmann et al., 2005).

Because wetland hydroperiod influence amphibian use of wetlands as breeding sites (Herrmann et al., 2005; Wellborn et al., 1996; Babbitt et al., 2003) we chose four permanent wetlands because temporary ponds can be breeding sites just after raining and one or two days later they can be dry. In fact, the area contains no more than six or seven breeding wetland sites for amphibians (including temporary and permanent wetlands). We sampled wetlands four times: November 18-22, December 27-30, January 23-26, and February 22-25. Sampling was made in each pond once at each month. This period was chosen because at this time we can find most of the species registered from the Itapeva Parque.

The sampling methods consisted at a presence and absence record and the estimate of the number of calling individuals of each species. This record was made once every thirty minutes from 20:00 until 23:00 (sun time) totalizing six records at each point per sampling. The surveys per pond were made by walking around the wetland to be sure that all species were detected. Individuals that we could not identify in the field by calls were preserved in 70% buffered alcohol and later identified to species in the laboratory using appropriate keys (Kwet and Di-Bernardo, 1999).

2.3 *Environmental variables*

We measured several habitat variables to examine relationship between the presence and abundance of amphibians and habitat characteristics. For each wetland we recorded: the shortest distance to the forest matrix (DIFM), the area of each pond (computed from the GPS TrackMaker software, version professional 13.1; Ferreira Junior, 2006) (AREA), water depth (none, low (less than 15 centimeters), medium (between 15 and 30 centimeters) or high (more than 30 centimeters) (WAHE), anthropization level at the contours of 25 meters of the area of each wetland (none (0%) (no presence of human's activities), low (until 30%) (low evidences of human's activities such as presence of tracks), medium (31-60%) (evidences of human's activities such as pasture and plantation) or high (>60%) (high evidence such as construction and roads) (ATLE), level of heterogeneous habitat at the contours of 25 meters of the area of each wetland (none (0%) (homogeneous vegetation habitat contours), low (until 30%) (most part of vegetation habitat are homogeneous (more than 70%)), medium (31-60%) (around 50% of the vegetation habitat are homogeneous) or high (>60%) (most part of vegetation habitat are homogeneous) (LHHA), degree of cover characterized by the percentage of vegetation cover; at the point (25, 50, 75 or 100%) (DCPO) and at the contours of 25 meters of the maximum of suitable area of each wetland (25, 50, 75 or 100%) (DCCO). Average temperature (day), temperature and relative humidity at 18:00 and 00:00 for each survey day were obtained from the 8 District of Meteorology of Porto Alegre.

2.4 *Statistical methods*

We represented richness by the logarithm number of species and we estimated abundance by the greater number of anuran calls in each pond in each night. To estimate density, we took a total and divided by area per pond. The climate variables were standardized by the total within variables. To remove the effect of climate variables we performed multiple linear regressions and used the residuals of the previous regressions to compare the swamps in terms of richness and abundance. For this, we calculated a Euclidean matrix between sampling units and performed ANOVA with randomization test with 10 000 iteractions (Pillar and Orlóci, 1996).

We used UPGMA on Euclidean data-matrix (Digby and Kempton, 1987) to classify the ponds in relation to the fauna of anurans. A Correspondence Analysis was used for ordinating the anuran species comparing they correlation with the habitat variables (Digby and Kempton, 1987). The tree-clustering factorial analyses were carried using Statistica (Statsoft, Inc., 2001 – Version 6). The Correspondence Analysis was made with SigmaPlot (Systat Software, Inc., 2006 – Version 10), all other analyses were performed using MULTIV 2.3.20 (Pillar 2004).

RESULTS

We found a total of thirteen anuran species, grouped in five families, Hylidae, Leiuperidae, Leptodactylidae and Microhylidae which showed different patterns of occupancy of the four ponds (Table 1), *Dendropsophus minutus* and *Scinax alter* were the most common species, occurring in all ponds, followed by *Physalaemus cuvieri* and *Lepdodactylus gracilis* found in A2, A3 and A4, *P. biligonigerus* found in A1, A2 and A4, *Lepdodactylus ocellatus* and *Elachistocleis ovalis* occurred in A3 and A4, and *S. squalirostris* occurred in A1 and A3. The other species were recorded in just one pond; *Hypsiboas faber*, *Sphaenorhyncus surdus* and *Lithobates catesbeianus* in A1. The habitat requirements of each species (Kwet and Di-Bernardo, 1999; Achaval and Olmos 2003; Pombal and Gordo 2004; Conte and Machado 2005) were compiled to compare our data with the current literature (Table 2).

The analysis of variance (ANOVA) showed a significant differences between groups ($p < 0.001$ for richness and $p < 0.002$ for abundance) as well the residues ($p < 0.007$ for richness and $p < 0.006$ for abundance). The greater richness and abundance was in A1 followed by A2, A4 and A3 (Fig. 2a, b). The UPGMA dendrogram, evaluated through bootstrap resamplimg, showed that the anuran species were spatially arranged according to four main groups (p = 0.22). The sites A3 and A4 appeared more similar to each other than the two other ponds (Fig. 3). Habitat variables showed how different each area was compared with other areas (Table 3). The Correspondence Analysis (89% of the explained variance on the two first axis) showed that the anurans species were spatially arranged according to the habitat variables (Fig. 4).

The most important habitat variable to explain the distribution of *Scinax squalirostris* was AREA, this species was little influenced by all other variables (group 1); *Hypsiboas pulchellus*, *Physalaemus biligonigerus* and *Scinax fuscovarius* had the greatest association with anthropization level (group 2); *Sphaenorhyncus surdus*, *Hypsiboas faber* and *Lithobates catesbeianus* are mostly associated with level of heterogeneous habitat, water depth and degree of cover at the contours (group 3) and the last group (*Dendropsophus minutus, Elachistocleis ovalis, Leptodactylus gracilis, L. ocellatus, Physalaemus cuvieri, P. biligonigerus* and *Scinax alter*) are most associated with degree of cover at the point, anthropized level and distance of forest matrix (group 4) (Fig 4).

DISCUSSION

Deforestation and fragmentation commonly cause species losses from tropical forests (Gupta 1998; Kolozsvary and Swihart, 1999; Perman, 1997; Steininger et al., 2001; Waldman and Tocher, 1998). The composition of sub-tropical anurans assemblages is correlated with natural environmental gradients and anurans communities vary on a gross scale depending on the presence of human activities

(Duellman, 1978; Pearman, 1997). However, the response of tropical and sub-tropical anurans assemblages to anthropogenic environmental variation is complex. Human activities and subsequent habitat fragmentation are clearly related to the patchy distribution of many anurans species, the sensitive species are more confined to less patches and the generalist species clearly benefit from more anthropization areas. Hylidae family was recognized on literature as more speciose in disturbed forest and in non-forested areas (Duellman, 1978); hylids frogs benefit from altered habitats and these are not in need protection (Pearman, 1997). However in our study a hylid frog *Sphaenorhynchus surdus*, included at red list of threatened and endangered species of Rio Grande do Sul (Fontana et al., 2003), *Hypsiboas faber* and the ranid *Lithobates catesbeianus* occur just on forest and are absent from anthropized open areas. An observation of this group are *L. catesbeianus*, is an alien species originated from North America, introduced in Brazil in the 1960s for meat commercialization, competing with local anurans and causing ecological problens (Dixo and Verdade, 2006).

Our data show that some species are more generalist and less sensible to changes at their environment than others. No relationships between wetland size and anuran species richness are reported, although habitat variables at the wetland and at the contours are extremely influential in species composition. Furthermore, the species found in the small wetland (A1) were not a subset of those found in large wetlands. The complex anuran assemblages of the study sites formed two categories, the species that have specific habitat requirements and undisturbed sites and the species that occur in disturbed and undisturbed habitat. Our study indicated that the various anurans species exhibit different patterns of presence/absence and abundance at the ponds. This is reflected by the habitat variables associated with each species. That is explained by habitat requirements of each species (Kwet and Di-Bernardo, 1999; Achaval and Olmos 2003; Pombal and Gordo 2004; Conte and Machado 2005)

Scinax squalirostris (Group 1) needs greater areas and doesn't need heterogeneous habitats. We found this species even without water at the point and around the point. *Hypsiboas pulchellus* and *S. fuscovarius* are associated with human's activities and water intermittence, what means a great capacity of colonizing news areas, they have little habitat requirements. *Hypsiboas faber*, *Lithobates catesbeianus* and *Sphaenorhyncus surdus* require forest habitats; these are the most sensitive species found at our study. The last group (*Elachistocleis ovalis*, *Dendropsophus minutus*, *Leptodactylus*. *gracilis*, *L. ocellatus*, *Physalaemus*. *cuvieri*, *P. biligonigerus* and *Scinax alter*) has significant association with human's activities, and basically don't need heterogeneous habitats, this group of species can occur in small water bodies and easily found by roads at north coast in Rio Grande do Sul.

In our study we showed that less altered habitat ponds are more diverse than more altered ponds, what means for generalist species, the negative association with distance of the forest matrix, high heterogeneous habitat and degree of cover at the contours and positive association with anthropized level. On the other hand, the species with specific habitat requirements are negatively associated with anthropized level and positively associated with water depth, high heterogeneous habitat, and degree of cover at the contours. Amphibians have relatively limited dispersal abilities (Driscoll, 1997; Lehtinen and Galatowitsch, 2001; Semilitsch and Bodie, 1998; Sinisch, 1990), the generalist species certainly are the first group to colonize anthropized areas, mainly for their broad tolerance, but these species are usually found in open areas what means the necessity to preserve open areas, not anthropized areas. The less altered areas were more diverse than altered areas and some species with specific requirements occur just at the no antropized pond. Eterovick and Barata (2006) describe that tadpole distribution among streams was influenced by arboreal vegetation cover at stream margins, what corroborated with our data for adults. This information show the high importance of habitat diversity.

Most of the species found at the study area are generalist and easily found in many altered habitats, on the other hand the species with specific habitat requirements species need non altered areas for development and reproduction. With the correct maintenance habitat of diversity and a strategic surrounding area, we can preserve as much specialist as generalist species.

The ability of a species to colonize a path from which it has been extirpated will depend on several factors, but certainly our data showed there is more probable to specific habitat requirements species colonize non altered habitats than altered habitats. Herrmann et al. (2005) states that quality of habitat surrounding breeding wetlands is important to most amphibians and it is necessary to consider the surrounding upland landscape in conservation strategies, we agree and suggest conservation of the natural succession of natural habitats, mainly the wetlands including ephemeral and permanent ponds, in agreement with Baker and Halliday (1999), Gibbs (1993), Oertli et al. (2002), and Vignoli et al. (2007).

Analyses of anuran survey data and wetland maps distributed across large areas are needed to understand landscape influences on anurans. Agreeing with Knutson et al 1999, the knowledge of habitat associations is critical if we hope to reverse declines in amphibian populations.

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Table 1 – Description of each pond based on percent composition of anurans calls at Parque Estadual de Itapeva.

Family and species	A1		A2		A3		A4	
	N	%	N	%	N	%	N	%
Hylidae								
Dendropsophus minutus	34	13	36	2	48	25	41	20
Hypsiboas faber	91	34	0	0	0	0	0	0
Hypsiboas pulchellus	0	0	4	2	0	0	0	0
Scinax alter	54	20	24	13	44	23	18	9
Scinax fuscovarius	0	0	6	3	0	0	0	0
Scinax squalirostris	0	0	4	2	7	4	0	0
Sphaenorhynchus surdus	73	27	0	0	0	0	0	0
Leiuperidae								
Physalaemus biligonigerus	11	4	36	20	0	0	37	18
Physalaemus cuvieri	0	0	49	27	41	22	45	22
Leptodactylidae								
Leptodactylus gracilis	0	0	17	9	28	15	40	20
Leptodactylus ocellatus	0	0	0	0	12	6	10	5
Michrohylidae								
Elachistocleis ovalis	0	0	6	3	10	5	13	6
Ranidae								
Lithobates catesbeianus	4	1	0	0	0	0	0	0
Total	267	100	182	100	190	100	204	100

Table 2 – Habitat requirements of each anuran found at Parque Estadual de Itapeva: (A) wetland inside de forest (B) wetlands in open areas (C) wetlands inside the forest and open areas as recorded at other sites (Kwet and Di-Bernardo, 1999; Achaval and Olmos, 2003; Pombal and Gordo, 2004; Conte and Machado, 2005).

Family and species	Habitat		
	A	B	C
Hylidae			
Dendropsophus minutus			x
Hypsiboas faber	x		
Hypsiboas pulchellus		x	
Scinax alter			x
Scinax fuscovarius		x	
Scinax squalirostris		x	
Sphaenorhynchus surdus	x		
Leiuperidae			
Physalaemus biligonigerus		x	
Physalaemus cuvieri		x	
Leptodactylidae			
Leptodactylus gracilis		x	
Leptodactylus ocellatus		x	
Michrohylidae			
Elachistocleis ovalis		x	
Ranidae			
Lithobates catesbeianus			x

Table 3 – Habitat variables measured for each area at Parque Estadual de Itapeva.

Variables / Areas	A1	A2	A3	A4
Distance of forest matrix (meters)	0	49	26	287
Water depth none (0) low (1) medium (2) high (3)	3	2	2	1
Anthropized level none (1) low (2) medium (3) high (4)	1	3	3	4
Level of Heterogeneous habitat none (1) low (2) medium (3) high (4)	4	2	2	1
Degree of cover at the point 25%, 50%, 75%, 100%	50	25	50	50
Degree of cover at the contours 25%, 50%, 75%, 100%	100	25	75	50
Area (ha)	0.0832	0.3485	2.6183	0.5403

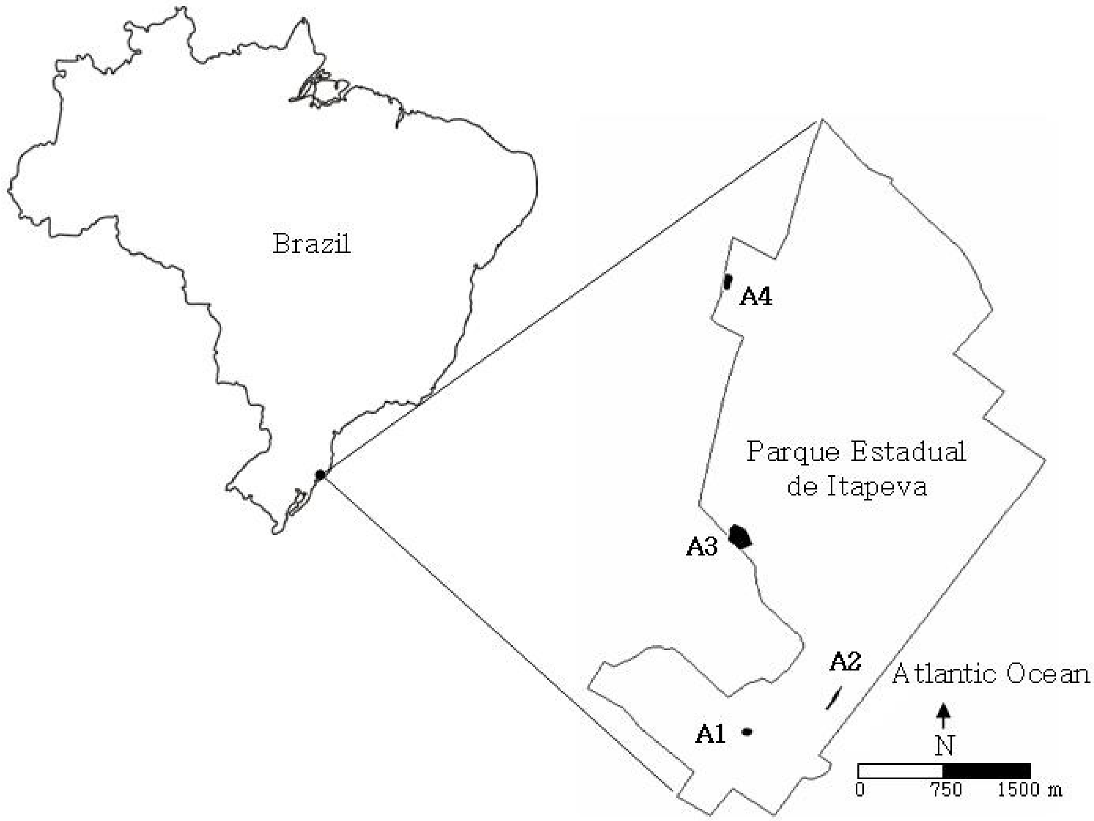

Fig.1. Parque Estadual de Itapeva, Rio Grande do Sul, Brazil (29° S, 49°W). Individual wetlands studied are indicated as A1-A4).

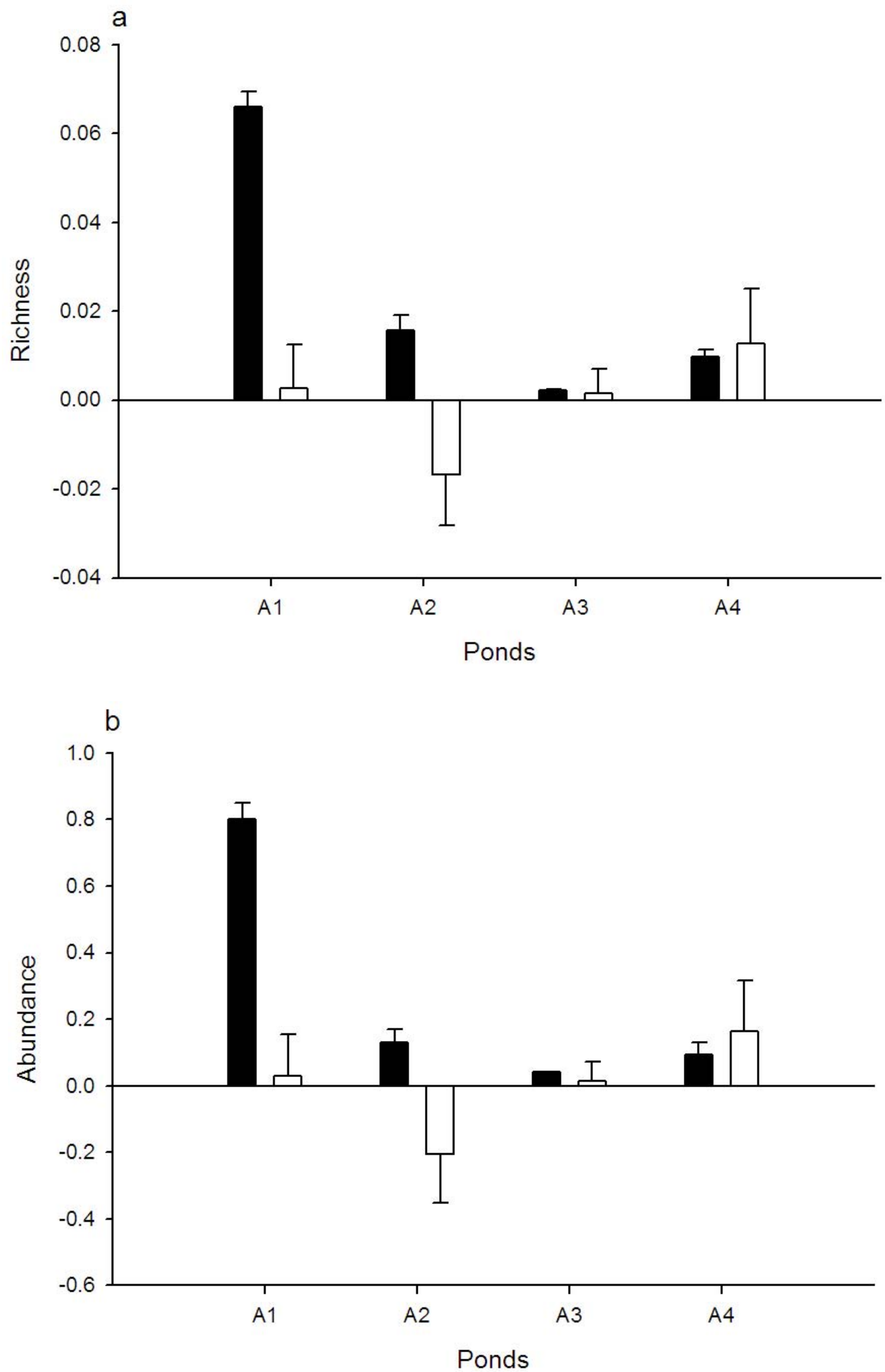

Fig. 2. Average Richness (a) and Abundance (b) (dark bars) and average without climate effects (open bars) of each pond at the four survey areas.

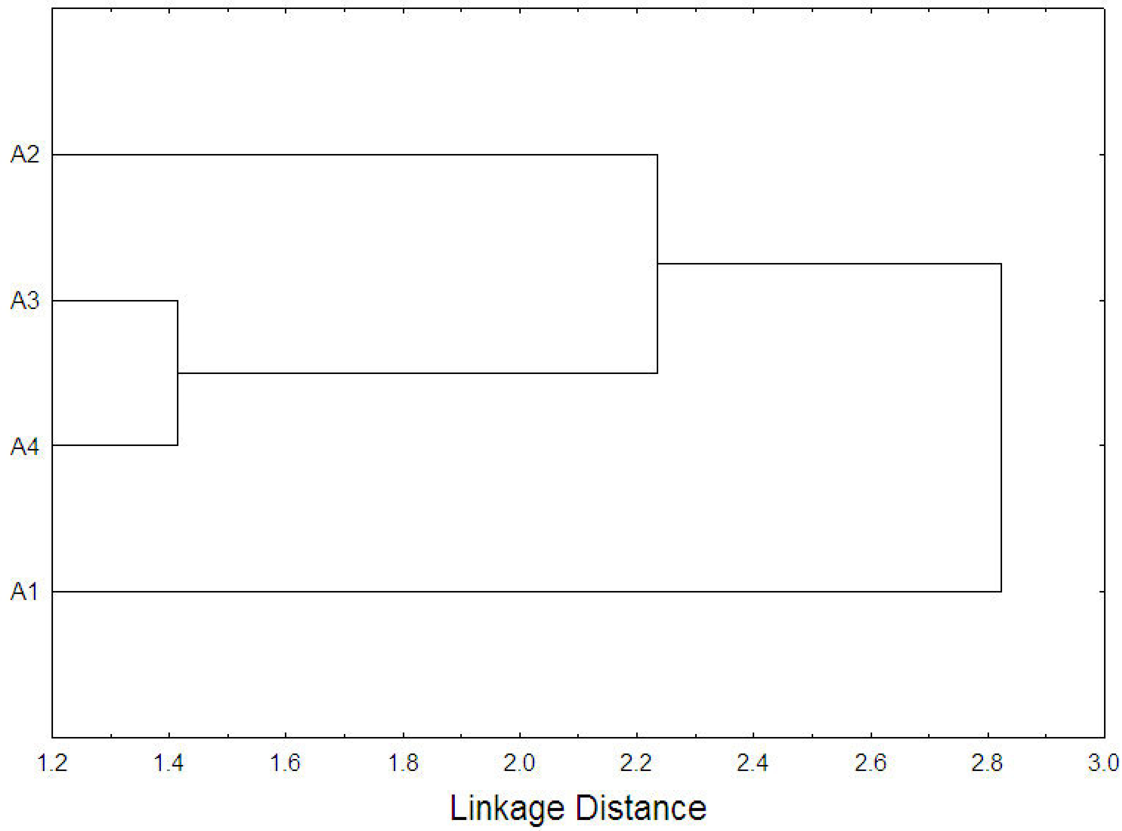

Fig. 3 - UPGMA dendrogram of the four ponds were describe by anurans species.

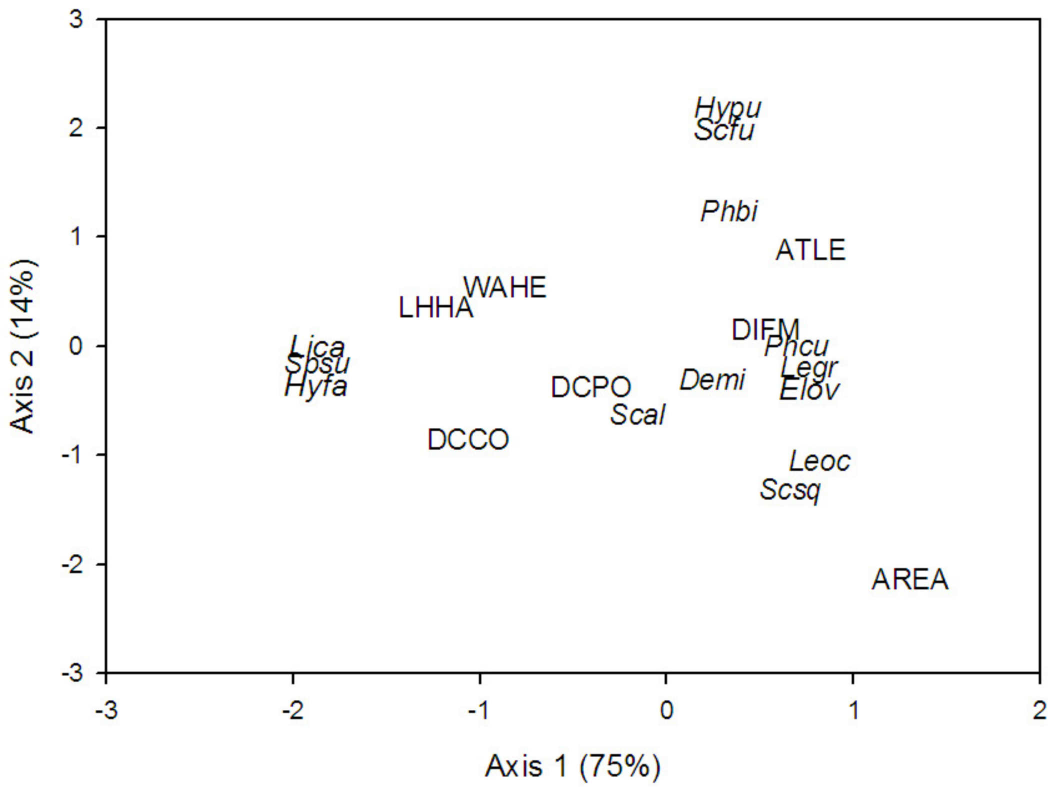

Fig. 4 - Correspondence analysis of anurans species described by habitat. Symbols: Anurans; *Hypu* = *Hypsiboas pulchelus*, *Scfu* = *Scinax fuscovarius*, *Lica* = *Lithobates catesbeianus*, *Scsq* = *Scinax squalirostris*, *Elov* = *Elachistocleis ovalis*, *Leoc* = *Leptodactylus ocellatus*, *Phbi* = *Physalaemus biligonigerus*, *Demi* = *Dendropsophus minutus*, *Phcu* = *Physalaemus cuvieri*, *Legr* = *Leptodactylus gracilis*, *Scal* = *Scinax alter*, *Spsu* = *Sphaenorynchus surdus*, *Hyfa* = *Hypsiboas faber*. Habitat variables; water depth = WAHE, distance of the forest matrix = DIFM, anthropized level = ATLE, level of heterogeneous habitat = LHHA, degree of cover at the point = DCPO, degree of cover at the contours = DCCO and AREA

CONSIDERAÇÕES FINAIS

A importância da conservação da biodiversidade é um tema bastante complexo e discutido atualmente por muitos pesquisadores, ambientalistas e defensores da natureza, as atitudes a serem tomadas visando este enfoque são a grande problemática atual. Ações de manejo e conservação são sugeridas em muitos artigos e debates com a sociedade, porém nem sempre executadas, pois parece que em muitos casos interesses particulares e políticos estão sempre em primeiro lugar.

O enfoque principal deste trabalho foi o de relacionar a associação de variáveis de habitat com assembléias de anuros, demonstrando quais variáveis são mais importantes para cada grupo de espécies, visando preservar espécies que possuem requerimentos de habitat mais específicos. O trabalho revela a necessidade de habitats menos alterados e florestais para *Sphaenorhyncus surdus e Hypsiboas faber*, espécies que ocorreram em somente uma das áreas de estudo, sendo que *S. surdus* é uma espécie que está citada na lista vermelha de espécies ameaçadas de extinção do Rio Grande do Sul.

Além do artigo apresentado nesta dissertação, com o mesmo conjunto de dados analisados, é possível que efetivamente seja produzida outra publicação envolvendo período de atividade das espécies, já que as amostragens ocorreram entre as 20:00 e 23:00 com intervalos de 30 minutos para o levantamento de riqueza e abundância. Outra importante informação não referenciada no artigo são os dados coletados entre as áreas de amostragens. Foram feitas transecções entre as áreas e demarcados cinco pontos eqüidistantes distribuídos entre cada área. Estes pontos tiveram o mesmo tratamento que as áreas em relação ao conjunto de variáveis de habitat, não tendo o mesmo tratamento em relação às variáveis de comunidade, pois em nenhum destes pontos foi encontrado a presença de corpos d'água, o que em nosso estudo é o fator determinante para presença de anuros. Estes pontos entre as áreas foram tomados para avaliar uma possível relação de uso de corredores entre as áreas. Estes dados ainda não foram trabalhados, pois após as coletas regulares de dados houve a idéia de que pudesse haver tal relação, sendo uma idéia posterior à proposta original deste trabalho. Tenho como hipótese que, apesar de não encontrar presença de água, nos pontos entre as áreas, eles possivelmente sirvam como corredores para algumas espécies que possam se deslocar em períodos em que não hajam temperaturas mais elevadas.

Por fim, a importância de restringir a ação antrópica, principalmente a atividade de rebanhos domésticos, é de suma importância para permitir a sucessão natural de áreas úmidas abertas e florestais. O que realmente está em risco no parque é esta sucessão, algumas áreas úmidas abertas estão sendo utilizadas para pastejo, interrompendo esta sucessão natural e não permitindo que populações de espécies de anuros que necessitam de habitats heterogêneos relacionados com coberturas vegetais diferenciadas ocupem novos habitats e se estabeleçam em novas áreas.

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BIOLOGICAL CONSERVATION

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