Fish fauna of a temporary lake in an Amazonian Conservation Area.

CHELLAPPA[1], S; SÁ-OLIVEIRA[2], J.C. & CHELLAPPA[1], N.T.

[1] Post-Graduate Programme in Aquatic Bioecology, Department of Oceanography and Limnology, Center of Bioscience, Universidade Federal do Rio Grande do Norte, Praia de Mãe Luíza, s/n, Natal, RN, Brazil. CEP: 59.014-100. E-mail: bama@dol.ufrn.br; chellappa@dol.ufrn.br

[2] Department of Biology, Universidade Federal do Amapá, UNIFAP, Rodovia JK, Km 02, Macapá, Amapá, Brazil. CEP: 68.900-000. E-mail: juliosa@unifap.br

ABSTRACT: Fish fauna of a temporary lake in an Amazonian Conservation Area. The characterization of fish fauna of a region is important for protection, conservation and sustainable utilization of these biological resources. Studies were conducted to determine the fish fauna of a temporary lake in the Environmental Protection Area of the River Curiaú, Amapá, during July 2001 to June 2002, including both dry and wet seasons. Six bimonthly fishing operations were conducted and the fishes were captured from the lake, using a set of seven dragnets, each of 20m in length and 2m in height, with different mesh sizes, varying from 24 to 100 mm. Variables, such as, rainfall, water temperature and dissolved oxygen were registered on a bimonthly basis. A total of 1,333 fishes were captured, which were distributed among 46 species of Osteichthyes and one of Chondrichthyes. The maximum number of species belonged to the order Characiformes, followed by Perciformes and Siluriformes. The most frequent and abundant species were Hoplosternum littorale (6.7%), Astyanax fasciatus (5.5%) and Gymnotus sp.1 (4.5%). The lowest rainfall values were registered during July, September and November 2001 and the highest was in March 2002. The water temperature was high during the dry season (July to December 2001), whereas the dissolved oxygen concentrations were high throughout the wet season (January to June 2002).

Key words: Ichthyofauna, Amazon flood plains of the River Curiaú, Fish diversity.

RESUMO: Ictiofauna de um lago temporário numa Área de Conservação da Amazônia. A caracterização da ictiofauna de uma região é importante para a proteção, conservação e utilização sustentável desses recursos biológicos. Estudos foram realizados para determinar a ictiofauna de um lago temporário em uma Área de Proteção Ambiental do Rio Curiaú, Amapá, durante o período de Julho 2001 a Junho 2002, incluindo ambos os períodos de estiagem e de chuvas. Seis operações de pescaria bimestrais foram realizadas e os peixes foram capturados de um lago, usando sete redes de 20m de comprimento e 2m de altura, com tamanhos de malha variando de 24 a 100 mm. Variáveis, tais como, pluviosidade, temperatura da água e oxigênio dissolvido foram registrados bimestralmente. Foi capturado um total de 1333 peixes, distribuídos em 46 espécies de Osteichthyes e uma de Chondrichthyes. Characiformes foi o grupo com maior número de representantes, seguido de Perciformes e Siluriformes. As espécies com maior freqüência e abundância nas pescarias foram Hoplosternum littorale (6,7 %), Astyanax fasciatus (5,5%) e Gymnotus sp.1 (4,5%). Os menores valores pluviométricos foram registrados durante julho, setembro e novembro 2001 e o maior foi em março 2002. A temperatura da água foi elevada durante o período de estiagem (julho a dezembro 2001), enquanto as concentrações de oxigênio dissolvido foram altas ao longo do período de chuvas (janeiro a julho 2002).

Palavras-chave: Ictiofauna, Planície de inundação amazônica do Rio Curiaú, Diversidade dos peixes.

Introduction

Seasonal variation is caused by fluctuations in rainfall and wind regimes, which leads to regular flooding of immense tracts of the Amazon riverbanks causing floodplains, thus expanding the freshwater environments (Sá-Oliveira, 2000). The climatological and hydrological variables of this region can be used as basic factors in order to understand the functional dynamics of these ecosystems. The hydrological pulses of the Amazon-Curiaú river system transform the floodplains into a great ecotone (Sá-Oliveira et al., 2004). High diversity of fish species is one of the main characteristics of river-floodplain systems in tropical regions (Agostinho et al., 1995).

The river-floodplains offer a high diversity of habitats and food resources, and as a consequence, there is an elevated number of fish species encountered, along with variations in abundance and body size (Agostinho et al., 1997). The ichthyofauna of river-floodplain systems, their diversity and adaptations explain the complexity of organism-environment interactions and their remarkable phenotypic plasticity permits them to overcome the pulse character of the river basin (Val, 1996).

The Environmental Protection Area of the River Curiaú, in Macapá/Amapá, forms a part of the great Amazonian River Complex, and this area has recently been subjected to variations due to anthropic activities, such as, urbanization and road construction. These activities had an impact on the environment, which created diverse problems (Forman & Alexander, 1998). The River Curiaú ecosystems are presently under varied scientific investigations, in order to preserve these fragile ecosystems.

The present study was conducted to determine the species composition of fish communities in a temporary lake in a floodplain of the River Curiaú, Amapá, in an Amazonian Conservation Area and to contribute to the diversity of Neotropical fishes in a temporary lake in an Amazonian Conservation Area.

Material and methods

Study area

The River Curiaú is an equatorial forest river, located within the Environmental Protection Area, in the Municipality of Macapá, Amapá, Brazil (00° 14' 58" to 00° 14' 17" N and 50° 56' 54" to 51° 07' 46" W). This study area included a floodplain lake, approximately of 1.5 hectares, which was affected by the variation of dry and flood seasons. During the dry season, which extended from July to December 2001, there was a great reduction in the volume of water, whereas during the rainy season, from January to June 2002, this lake was full of floodwater. Throughout the maximum rainfall season, which extended from May to June 2002, this lake established a connection with the floodplains of River Curiaú. However, the connection between the River Curiaú and the River Amazon was permanent throughout the year.

Sampling

During the period of July 2001 to June 2002, six bimonthly fishing operations were conducted in a temporary lake of the floodplains of the River Curiaú. Each fishing operation had duration of 12 hours. The fishes were captured from the lake, using a set of seven dragnets, each of 20 meters in length and 2 meters in height, with different mesh sizes, varying from 24 to 100 mm. Complementary fishing nets, such as, dragnets, cast nets, hook and line and hand nets were also used. The fishing nets were used in the deeper parts of the lake during both seasons. The fishes were identified, numbered, labeled and their morphometric and meristic measurements were registered. The fishes that could not be identified up to the species level were preserved in 10% formalin solution and were deposited in the Zoology Laboratory of the Federal University of Amapá, UNIFAP.

Data concerning rainfall was obtained from the Meteorology Unit of the Empresa Brasileira de Infraestrutura de Aeroportos (INFRAERO/AP), in Macapá, Amapá.

The water temperature and dissolved oxygen of the temporary lake were registered coinciding with the six bimonthly fishing operations during the study period. The water temperature was obtained using a thermometer INCOTERM 2309, with a precision of 0.1°C. The dissolved oxygen was measured (mg L^{-1}) using an oxymeter YSI Model 51B.

Results

A total of 1,333 fishes, belonging to 46 species of Osteichthyes and 1 species of Chondrichthyes, were captured during the study period. Table 1 provides a list of the fish species encountered in the temporary lake of River Curiaú and their percentage contribution. Of the 47 fish species captured, 11 species had special adaptations for aerial respiration, which are indicated in Table 1.

Table 1: Fish species encountered in the temporary lake of River Curiaú.

Family	Species	%
Potamotrygonidae	Potamotrygon sp.	0.07
Anostomidae	Leporinus sp.1	0.97
	Leporinus sp.2	1.20
Characidae	Astyanax fasciatus	5.47
	Astyanax sp.1	4.12
	Astyanax sp.2	3.97
	Hemigrammus unilineatus	4.05
	Hemigrammus ocellifer	2.32
	Hemigrammus sp.	2.02
	Triportheus elongatus	4.12
	Anodus sp.	1.65
Erythrinidae	Hoplias malabaricus *	1.57
	Hoplerythrinus unitaeniatus *	1.87
Serrasalmidae	Serrasalmus marginatus	2.17
	Serrasalmus nattereri	2.47
	Serrasalmus spilopleura	1.57
	Serrasalmus rhombeus	1.50
	Serrasalmus piraya	1.72
Electrophoridae	Electrophorus electricus *	1.35
Gymnotidae	Gymnotus sp.1	4.50
	Gymnotus sp.2	3.45
	Gymnotus carapo	0.60
Rhamphichthyidae	Rhamphichthys rostratus	0.52
Doradidae	Acanthodoras sp.	2.70
Auchenipteridae	Auchenipterichthys sp.	0.45
Pimelodidae	Rhamdia quelen	2.85
Callichthyidae	Hoplosternum littorale *	6.75
	Megalechis personata *	3.22
	Megalechis thoracata *	2.40
	Callichthys callichthys *	1.65
Loricariidae	Hypostomus sp. *	0.60
Synbranchidae	Synbranchus marmoratus *	0.15
Sciaenidae	Plagioscion sp.	0.45

Cont.: Table 1

Family	Species	%
Cichlidae	Astronotus ocellatus	1.57
	Aequidens sp.	2.85
	Apistograma sp.	2.47
	Cichla monoculus	1.65
	Cichla sp.	0.90
	Cichlasoma festivum	1.95
	Cichlasoma severum	1.87
	Crenicichla sp.	1.35
	Pterophyllum scalare	2.70
	Geophagus daemon	3.00
	Geophagus brasiliensis	3.15
	Geophagus sp.	1.42
Osteoglossidae	Osteoglossum bicirrhossum *	0.45
Lepidosirenidae	Lepidosiren paradoxa *	0.07
TOTAL = 18 families	**31 genera and 47 species**	**100**

*Fish species with special adaptations for aerial respiration.

The fishes belonging to Osteichthyes consisted of 46 species, pertaining to 6 orders, 31 genera and 17 families (Fig. 1). Only one species of stingray, Potamotrygon sp. belonged to Chondrichthyes. There was a dominance of species belonging to Characiformes, followed by Perciformes and Siluriformes. The most abundant species were Hoplosternum littorale, Astyanax fasciatus and electric fish Gymnotus sp.1. The family Cichlidae was represented by 12 different species, followed by Characidae with 8 species and Serrasalmidae with 5 species (Fig. 2).

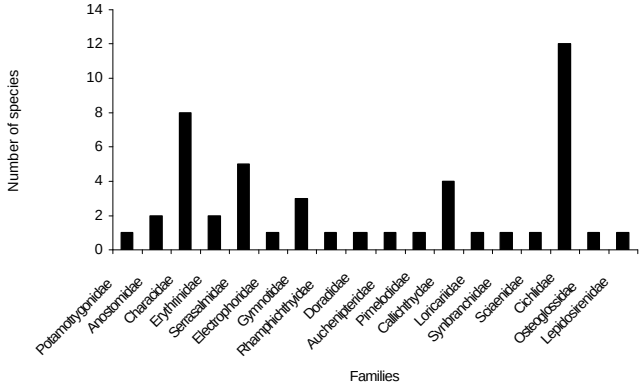

Figure 1: Number of fish species encountered in the temporary lake of River Curiaú.

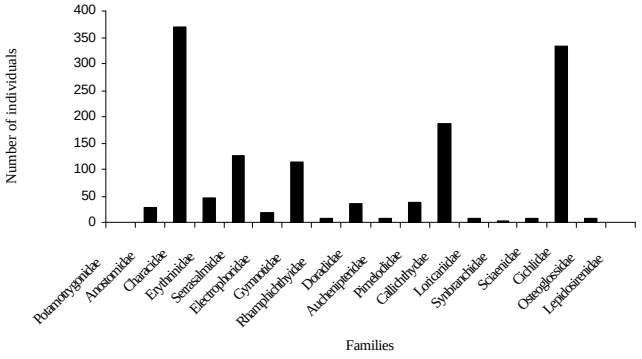

Figure 2: Number of individuals representing each fish family encountered in the temporary lake of River Curiaú

A striking variation in the rainfall pattern was observed throughout the study period. The lowest rainfall values were registered during July, September and November 2001, and the highest rainfall value was observed during March 2002. The mean values of water temperature registered during the study period indicated slight seasonal variation, with low temperatures during March and May 2002. The lowest water temperature was registered in March 2002 and the highest water temperature was registered in January 2002. The dissolved oxygen of the surface waters was low during September and November 2001, coinciding with the dry season. The highest value of dissolved oxygen of the surface waters was registered in January 2002 (Fig. 3).

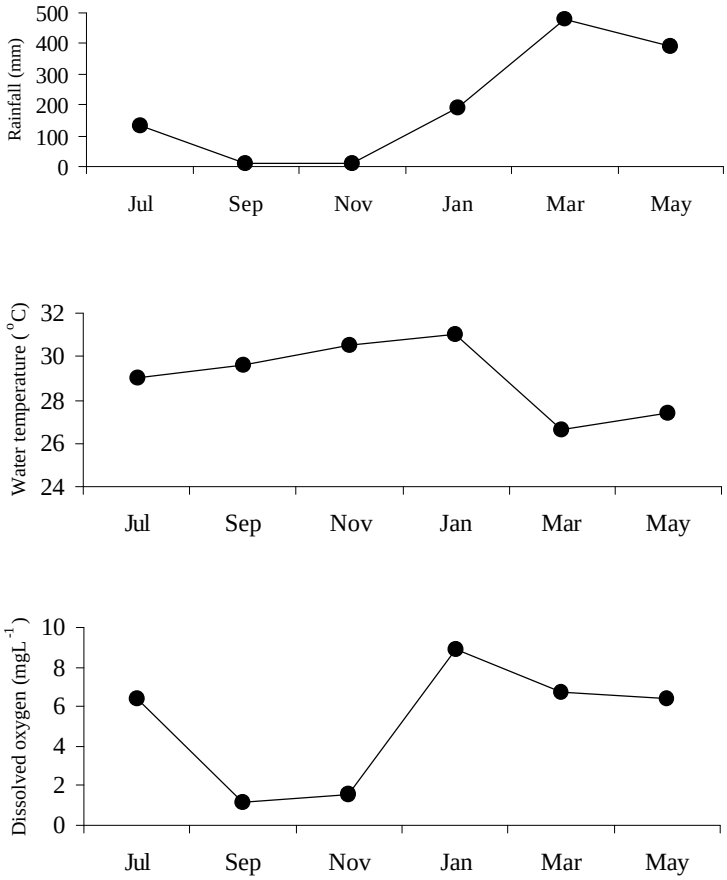

Figure 3: Variation of rainfall, surface water temperature and dissolved oxygen in the temporary lake of River Curiaú.

Discussion

The 47 fish species registered in this study are considered rather expressive, considering that the fishes were collected from a temporary lake. The temporary lakes are natural nurseries, where many fish species migrate from the adjacent rivers during the rainy season. Many fish species belonging to Characiformes and Siluriformes move into the inundated temporary lake at high water to spawn and feed, subsequently returning to low-water channels as the water level falls (Agostinho et al., 1997). The characins (Characiformes) and catfishes (Siluriformes) dominated

the ichthyofauna of the Amazonian River Complex, and these two groups together reached up to 85% of the fish fauna (Lowe-McConnell, 1999).

The present study registered the richness and abundance of species belonging to Characiformes (Characidae), Perciformes (Cichlidae) and Siluriformes (Callichthyidae) in a temporary lake of the Amazon-Curiaú river system. The adaptive radiations and abundance of the family Characidae are fascinating in the Neotropical region (Araújo-Lima & Goulding, 1998). The current study registered a dominance of species belonging to Characiformes in a temporary lake of the flood plains of the River Curiaú in Amapá, which forms a part of the great Amazon River System. Another abundant fish species in the flood plains was Hoplosternum littorale (Callichthyidae), corroborating with a previous study (Sá-Oliveira & Chellappa, 2002). The cichlids occupy a prodigious range of ecological niches and have a natural distribution in the Amazon-Curiaú river system. They possess marked specialization for living under special environmental conditions, which include rheophilic forms, leaf-litter inhabitants, deep-bodied forms living amongst aquatic plants and those living in lentic ecosystems (Chellappa, 2000, Chellappa et al., 1999a & 1999b).

The drastic reduction in the level of dissolved oxygen during the months of September and December was possibly due to the large amounts of decomposing plant material in the water, which lead to oxygen depletion in the temporary lake. Consequently, deoxygenation became a generalized problem as the water temperature rises. A study on the seasonal migration of fishes in an Amazonian temporary lake indicated that the temporary lake was extremely deficient in oxygen and that of the 132 species captured, approximately 40 species had special respiratory adaptations enabling them to use atmospheric air and were capable of living in hypoxic conditions (Junk, 1984).

The fishes of the Amazon basin have developed a marked degree of physiological plasticity that allows them to adapt to a highly variable natural environment (Val & Almeida-Val, 1995). Fishes with special adaptations to withstand deoxygenated conditions remained in the temporary lake and had special adaptations for aerial respiration to survive in oxygen deficit situations. Adaptations to survive in low oxygen levels include the use of superficial oxygenated layers for branchial respiration. This is helped by the vascularised labial projections, as in Osteoglossum bicirrhossum. The respiratory organ derived of the bucal cavity in Electrophorus electricus is used strictly for aerial respiration, and in Synbranchus marmoratus the same is used for facultative aerial respiration. The stomach lining in Hypostomus sp. (Loricariidae) and the intestine in Hoplosternum littorale are used for aerial respiration. The swimbladder is highly vascularised in Hoplerythrinus unitaeniatus, Hoplias malabaricus and Lepidosiren paradoxa serving for aerial respiration. The use of the stomach or the intestine seems to be a speciality among the Neotropical fishes, possibly related to reduced rates of feeding during the dry periods, when respiratory adaptations are necessary for their survival (Lowe-McConnell, 1999).

Many fish species enter the temporary lakes immediately after the rainy season, when high water levels, rich in nutrients and oxygen and with dense planktonic growth are encountered, thus turning into good breeding grounds for the fish. After breeding, the fishes continue to use the lake as feeding ground until the water level remains high (Araújo-Lima & Goulding, 1998).

The key to Amazon fish community structure lies in the mobility of the fishes, as many of them move from rivers in and out of river-floodplain systems and flooded forests with changing water levels. The connection between the river and floodplain lakes enables free movement of the fishes towards the temporary lakes, thus influencing the relative abundance of the ichthyofauna of the Amazon-Curiaú floodplain systems.

References

Agostinho, A..A., Vazzoler, A.E.A. de M. & Thomaz, S.M. 1995. The high River Paraná basin: limnological and icthyological aspects. In: Tundisi, J.G., Bicudo, C.E.M. & Matsumura-Tundisi, T. (eds.) Limnology in Brazil, Rio de Janeiro: ABC/SBL. 59-103p.

Agostinho, A..A., Júlio Jr, H.F. Gomes, L.C., Bini, L. M. & Agostinho, C.S. 1997. Composição, Abundância e Distribuição espaço-temporal da ictiofauna. In: Vazzoler, A.E.A. de M., Agostinho, A..A. & Hahn, N.S. (eds.) A Planíce de inundação do alto rio Paraná. Maringá: EDUEM. p.179-208.

Araújo-Lima, C. A. R.M. & Goulding, M. 1998. Os frutos do Tambaqui – Ecologia, Conservação e Cultivo na Amazônia. Brasília: CNPq. 186p.

Chellappa, S. 2000. A Review on Reproductive Strategies and Ecology of Cichlid Fishes of Northeastern Brazil. Revista de Ecologia Aquática Tropical, 10:5-11.

Chellappa, S., Yamamoto, M. E. & Cacho, M. S. R. F. 1999a. Reproductive behaviour and Ecology of two species of Cichlid fishes. In: Val, A. L. & Almeida-Val, V. M. (eds.) Biology of Tropical Fishes. Manaus:INPA. p.113-126.

Chellappa, S., Yamamoto, M. E. & Cacho, M. S. R. F & Huntingford, F. A. 1999b. Prior residence, body size and dynamics of territorial disputes between male freshwater angelfish. Journal of Fish Biology, 55:1163-1170.

Forman, R. T. T. & Alexander, L. E. 1998. Roads and their major ecological effects. Annual Reviews Ecology & Systematics, 29:207-231.

Junk, W.J. 1984. Ecology, Fisheries and Fish culture in Amazonia. In: H. Sioli (ed.) The Amazon – Limnology and Landscape Ecology of a mighty tropical river and its basin. Dordrecht. p.443-476.

Lowe-McConnelll, R.H. 1999. Estudos Ecológicos de Comunidades de Peixes Tropicais. São Paulo: USP, 535p.

Sá-Oliveira, J.C. 2000. Ecologia e Reprodução do tamuatá, Hoplosternum littorale Hancock, 1828 (Osteichthyes: Siluriformes: Callichthyidae) da área de Proteção Ambiental do Rio Curiaú, Macapá, AP. UFRN, Natal. 110p. Master's Dissertation.

Sá-Oliveira, J.C. & Chellappa, S. 2002. Fecundidade e tipo de desova do tamuatá, Hoplosternum littorale Hancock (Osteichthyes: Siluriformes) no Rio Curiaú, Macapá, Amapá. Revista Brasileira de Zoologia, 19(4):1053-1056.

Sá-Oliveira, J.C., Chellappa, N.T. & Chellappa, S. 2004. Caracterização limnológica dos ecossistemas aquáticos da Área de Proteção Ambiental do Rio Curiaú, Macapá, AP. In: Chellappa, N.T., Chellappa, S. & Passavante, J.Z.O. (eds.) Ecologia Aquática Tropical. Servgraf: Natal. p.13-30.

Val, A.L. 1996. Surviving low oxygen levels: Lessons from fishes of the Amazon. In: Val, A.L., Almeida-Val, V.M.F. & Randall, D.J. (eds). Physiology and Biochemistry of the fishes of the Amazon. Manaus: INPA. p.59-73.

Val, A.L. & Almeida-Val, V.M.F. 1995. Fishes of the Amazon and their environment: Physiological and Biochemical aspects. Springer Verlag, Heidelberg, 224p.

Received: 13 April 2005
Accepted: 27 September 2005