Growth, recruitment, and mortality parameters for *Astyanax altiparanae* Garutti and Britski, 2000 and *A. schubarti*, Britski, 1964 (Pisces, Characidae) in the Upper Paraná River floodplain, Brazil

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ABSTRACT. Data for the characid *Astyanax altiparanae* and *A. schubarti*, collected from March 1993 to February 1994, were used for studies of growth, recruitment, and mortality. The results for the *A. altiparanae* indicated asymptotic growth (L_∞) of 18.0cm (standard length) and growth rate (k) of 0.26; the total mortality (Z) estimated from the different methods was 2.23 and two recruitment periods were observed during the year, one in March and the other in November, coinciding with the reproductive season of the species. For *A. schubarti* a k value of 0.25 and an asymptotic length value of 12.0cm were obtained; the natural mortality rate was 0.84; for this species two recruitment periods were also observed, the first coinciding with the highest spawning level, and the second soon afterwards.

Key words: *Astyanax altiparanae, A. schubarti,* FISAT, growth, mortality, Brazil.

RESUMO. Crescimento, recrutamento e mortalidade de *Astyanax altiparanae* Garutti & Britski, 2000 e *A. schubarti*, Britski, 1964 (Pisces, Characidae) na planície de inundação do alto rio Paraná, Brasil. Dados dos caracídeos *Astyanax altiparanae* e *A. schubarti*, coletados entre março de 1993 e fevereiro de 1994, foram utilizados nos estudos do crescimento, recrutamento e mortalidade. Os resultados para *A. altiparanae* indicaram o crescimento assintótico (L_∞) de 18,0cm (comprimento padrão) e taxa de crescimento (k) de 0,26; a mortalidade total (Z) estimada através de diferentes métodos foi de 2,23 e o dois picos de recrutamento foram observados durante o ano, um em março e o outro em novembro, coincidindo com a estação reprodutiva da espécie. Para *A. schubarti* o valor de k foi de 0,25 e o comprimento assintótico obtido foi de 12,0cm; a mortalidade natural foi de 0,84; para esta espécie dois períodos de recrutamento também foram observados, o primeiro coincidindo com o nível alto de desova e o segundo após este período.

Palavras-chave: *Astyanax altiparanae, A. schubarti,* FISAT, crescimento, mortalidade, Brasil.

Introduction

Knowledge of the parameters of growth, recruitment, and mortality of fish species is very important for studies of fisheries biology, and it is fundamental for rational management of fish stocks (Weatherly and Gill, 1987; Brothers, 1987; Ferreira and Russ, 1994). According to Antoniutti *et al*. (1985), growth is the quantitative aspect of development; therefore, knowledge of its characteristics constitutes important information about the population dynamics.

The "tambiú", *Astyanax altiparanae* and the "lambari de rabo amarelo" *A. schubarti*, are fodder species, i.e. maximum length less than 20cm and serve as food for many other species of fishes, birds, and other animals. These species are extremely important because they are dominant on the floodplain (Agostinho *et al*., 1997), in addition to serving as a key link in the food chain and in maintaining the equilibrium of this important ecosystem.

Study of the life cycle of the "tambiú" is relatively recent. Only one investigation, on growth of *A. bimaculatus* (*A. altiparanae* was considered for a long time as *A. bimaculatus*), was previously carried out in Brazil, by Santos *et al*. (1991). For *A. schubarti* the life cycle was studied by Nomura *et al*. (1975a, b, c) and Giamas *et al*. (1992).

This study is part of a series of investigations on the biology of the principal fodder species in the Upper Paraná River floodplain. Fodder species are so named because of their small size, and because support many piscivores of the region. The objective of this study was to estimate the growth parameters and patterns of

recruitment and mortality of *Astyanax altiparanae* and *A. schubarti*, from the Upper Paraná River floodplain, Mato Grosso do Sul State, Brazil.

Material and methods

The specimens were collected monthly on the Upper Paraná River floodplain (22°40'-22°50'S and 53°15'-53°40'W) (Figure 1), from March 1993 through February 1994. Standardized hauls and stationary nets of 3cm between opposite knots were used. A subsample was used to establish the length frequency distribution. The standard length was measured in centimeters. The analysis was performed using the programs ELEFAN I and II (Gayanilo *et al*., 1989), to estimate the parameters discriminating growth, recruitment, and mortality. For the analyses, 1844 *A. altiparanae* specimens and 661 *A. schubarti* specimens were used.

t_o = 0 was adopted, since the value obtained from the empirical formula of Pauly (1980a) for both species is improbable for them.

The equation of Beverton and Holt (1957) and the equation of Ault and Ehrhardt (1991), inclused in the FISAT program (Gayanilo *et al*., 1996), was used to estimate total mortality (Z). Natural mortality (M) was calculated by the empirical formula of Pauly (1980b), and the equation of Rikhter and Efanov (1976) was obtained using FISAT. The mortality from fishing (F) and the exploitation rate (E) were derived from the values de Z and M obtained using ELEFAN.

Results and discussion

1. Growth

The raw data were restructured with ELEFAN I, plotting the curves (Figure 2) from the growth parameters determined from the distribution. The growth parameters permitted us to obtain von Bertalanffy's equation for the species $SL=L_\infty\ [1-e^{k(t-t0)}]$ (SL = Standart length), therefore:

$SL = 18.0\ [1-e^{-0.26(t)}]$ for A. altiparanae and;
$SL = 12.0\ [1-e^{-0.25(t)}]$ for A. shubarti

For *A. altiparanae* (Figure 2a), the results indicated that this species reached an age of 4 years, the last year not being represented. Santos *et al*. (1991) observed for *A. bimaculatus* (for a long time *A. altiparanae* was considered *A. bimaculatus*), that the species presented 17.8cm (L) and 0.21 (k). For the same species, Nomura *et al*. (1975a) observed similar results. In this work, the values k were higher (0.26). Results show that the small size of the species that growth rate (k) is typical of species with short life cycles on the floodplain.

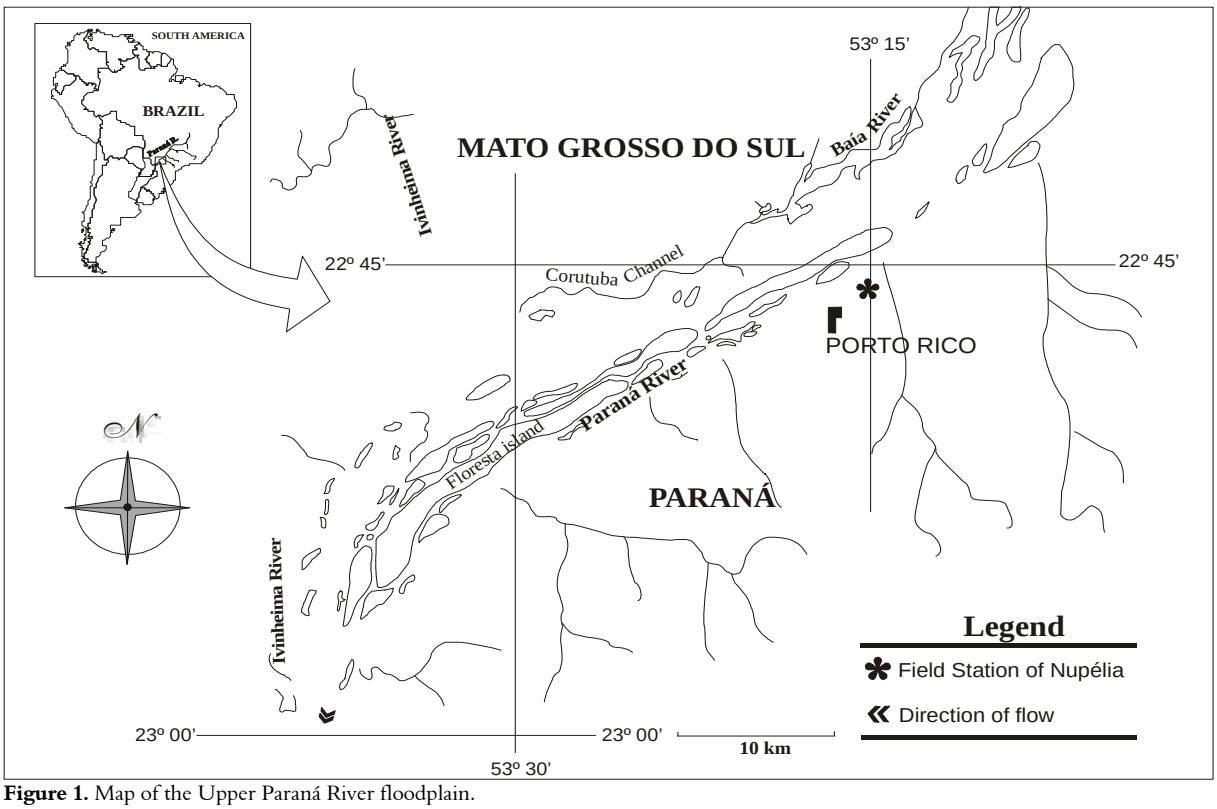

Figure 1. Map of the Upper Paraná River floodplain.

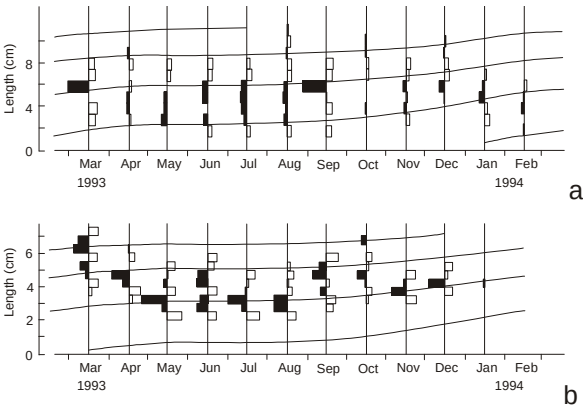

Figure 2. Growth curve superimposed over the reestructured length-frequency data for a) *Astyanax altiparanae* and b) *A. schubarti* in the Upper Paraná River floodplain (L_∞ = 18.0cm, k = 0.25 year-[1])

For *A. schubarti*, the growth curves calculated using ELEFAN I indicated three complete and one incomplete cohort (Figure 2b). The species reached an asymptotic length ($L\infty$) of 12.0cm and a growth rate (k) of 0.25. The number of cohorts was similar to that found for females of the same species by Giamas *et al*. (1992) using the method of retrocalculation, but asymptotic length was lower in this work. It is important to emphasize that the amplitude of size found by the authors was higher. The value for asymptotic length is slightly higher than the maximum size of 10.6cm recorded for this species by Vazzoler (1996). Results found by Nomura *et al*. (1975a) showed that the asymptotic length of the males is much lower than that of the females, as the values of k had been much higher. The results obtained can be related to the presence of males in the sampling used for re-analysis. Higher values of k had been re-analyzed, but the results of Rn (better it adjust of the curve) were very low.

2. Mortality

The values for total mortality (Z), natural mortality (M), mortality from fishing (F), and the exploitation rate (E) for *A. altiparanae* and *A. schubarti*, obtained from the length-converted catch curve (Figure 3) and by other methods appear in Table 1.

Table 1. Results for parameters of total mortality (Z), natural mortality (M), mortality from fishing (F) and exploitation rate (E) for *Astyanax altiparanae* and *A. schubarti* on the Upper Paraná River floodplain, Brazil.

	Z					M		F	E
Species	1	2	3	4	5	6	7	8	9
A. altiparanae	2.51	2.13	2.07	2.23	079	0.79	0.79	1.72	0.69
A. schubarti	1.79	1.65	1.53	1.65	0.86	0.83	0.84	0.93	0.52

1 = length-converted catch curve; 2 = Beverton and Holt (1957); 3 = Ault and Ehrhardt (1991); 4 = Mean values; 5 = Pauly (1980a); 6 = Rickhter and Efanov (1976); 7 = Mean values; 8 = Derived from mean values F=Z-M; 9 = Derived from means values by the equation E=F/Z

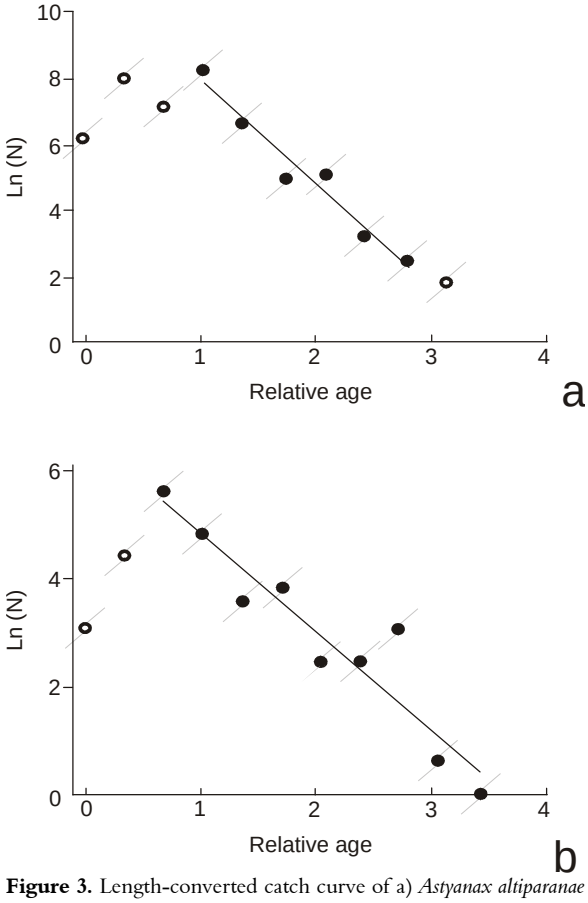

Figure 3. Length-converted catch curve of a) *Astyanax altiparanae* and b) *A. schubarti* in the Upper Paraná River floodplain.

For *A. altiparanae*, the greatest difference among values was found for total mortality (Z). Z obtained by the length-converted catch curve is high. Other methods did not show great difference. The mean value is indicated as the final result of this estimate. Natural mortality is low and the values from mortality by fishing and the exploitation rate are higher.

For *A. schubarti* the results of the estimates are lower than those of *A. altiparanae*. Mean Z is 1.65. As regards natural mortality, there is no difference between the diverse methodologies used. Results of mortality by fishing and the exploitation rate are lower than ones for "tambiú", but the values are still considered high.

Natural mortality for both species is low and mortality by fishing and the exploitation rate had been very high. These species are poorly exploited and renews themselves naturally, and are the preferred food of many other species of fish, birds, and other animals. The most logical result to consider that the natural mortality either high and F and E is low. In this way, Z either had exclusively to M. Therefore, both species can consider total

mortality as being 2.23 for *A. altiparanae* and 1.65 for *A. schubarti*.

According to Pauly (1980b), natural mortality is the result of three components: physiological mortality, caused by disease, old age, or both (in the absence of predators); selective mortality, caused by diminished performance of individuals, because of disease, old age, or both, making them accessible to predators; and risk mortality, unrelated to any physiological mechanism, and proportional only to the probability of encountering potential predators; this component predominates in small fish. Because of the small size of *A. altiparanae* and *A. schubarti*, the high rate of natural mortality is included in the risk component, which is quite large.

3. Recruitment

Both species presented two periods of recruitment related to the reproductive periods. (Figure 4).

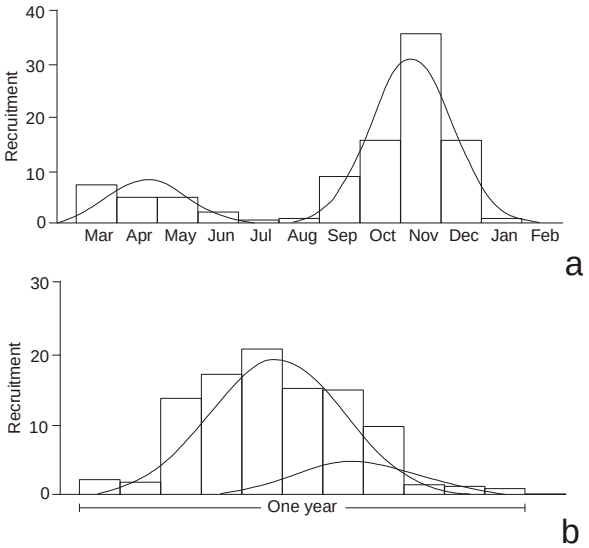

Figure 4. Recruitment pattern of a) Astyanax altiparanae and b) A. schubarti in the Upper Paraná River floodplain.

For *A. altiparanae*, the results indicated two periods of recruitment, one in March-April and another of high intensity in November (Figure 4a). The monthly distribution of length class frequencies (Figure 5a) implied that juvenile individuals enter the population mainly in March-April, when the species is at the end of its reproductive period, and also during November, when it is beginning reproduction (Vazzoler, 1996). However, initial length classes (1.8cm) were present during the entire year (Figure 5a).

For *A. schubarti* (Figures 4b and 5b) was observed the occurrence of two recruitment periods, one in May-June, and the second coinciding with the reproductive peak (November). The occurrence of two main recruitment periods in a tropical region was expected. In this system recruitment is not continuous, since the entry of juveniles follows seasonal patterns related to reproduction, which is acentuated in floodplain species (Winemiller, 1989). Although the two species came in mixed schools, the differences observed in the growth can be due to diverse factors, being possible detach: the genetic drift, gonadal development and the potential of growth of each specie, as well as resulting of the difference between the habit feed (*A. altiparanae* can be considered insectivorous and *A. schubarti* herbivorous).

Acknowledgements

This article is part of the multidisciplinary project "Environmental studies of the Paraná River floodplain in the area encompassing the mouth of the Paranapanema River and the Itaipu Reservoir", undertaken with the assistance of PADCT/CIAMB. The authors thanks CNPq for financial support and Nupélia (Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura) for logistical support and Dr. Janet W. Reid for translating the text into English.

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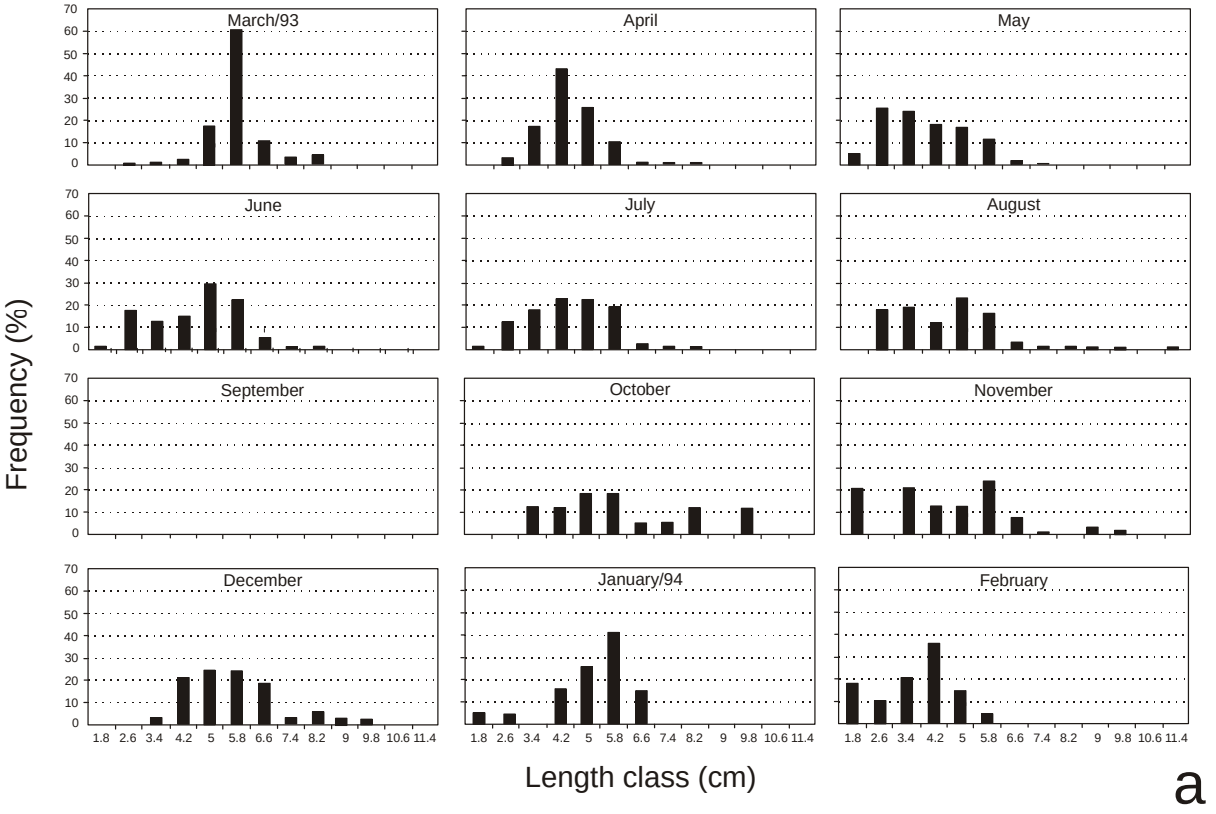

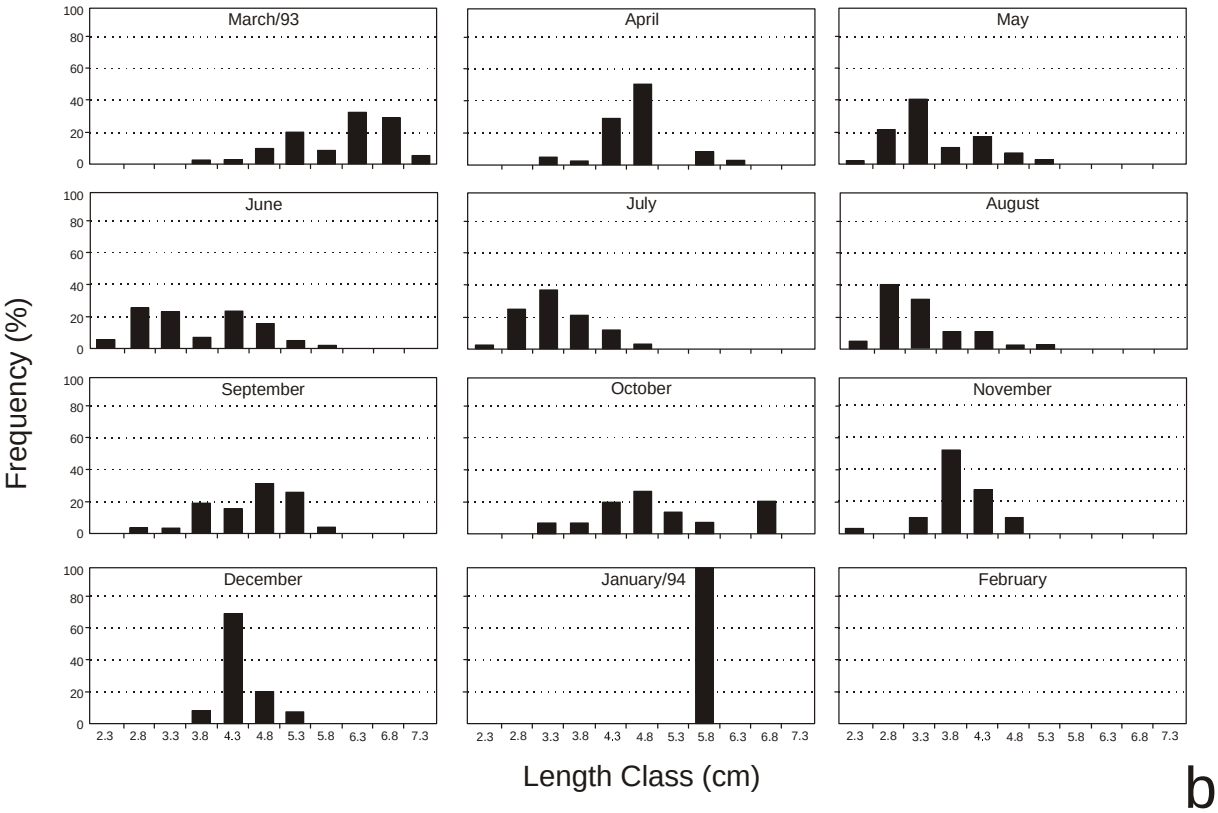

Figure 5. Distribution of length class frequency, by month, for a) *Astyanax altiparanae* and b) *A. schubarti* on the Upper Paraná River floodplain.

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Received on July 13, 2004.
Accepted on November 19, 2004.