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Zooplankton body-size structure and biomass in tropical floodplain lakes: relationship with planktivorous fishes

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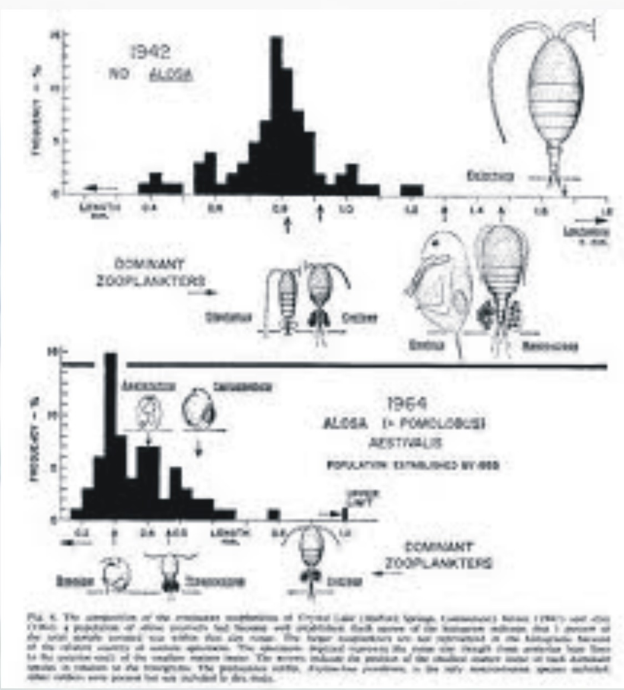
Introduction

Brooks and Dodson (1965) - the size-efficiency hypothesis



If the predation pressure is constant in tropical environments, the assessments concerning the size-selective predators hypothesis on the zooplankton community, in natural conditions, would be limited because the small-sized species numerically predominate in the community over time, since the zooplankton's predators be present.

The present study evaluated whether the size structure in the zooplankton community would be influenced by bottom-up and/or top-down mechanisms in isolated lakes from the Upper Paraná River floodplain (Figure 1), during both a rainy and a dry periods. This implies that the size-efficiency hypothesis may also explain the community structure, and may further contribute to the differentiation of the size spectrum from the community between tropical and temperate lakes.

We tested the size-selective predators hypothesis, and if size spectrum of the zooplankton community is associated with availability food.

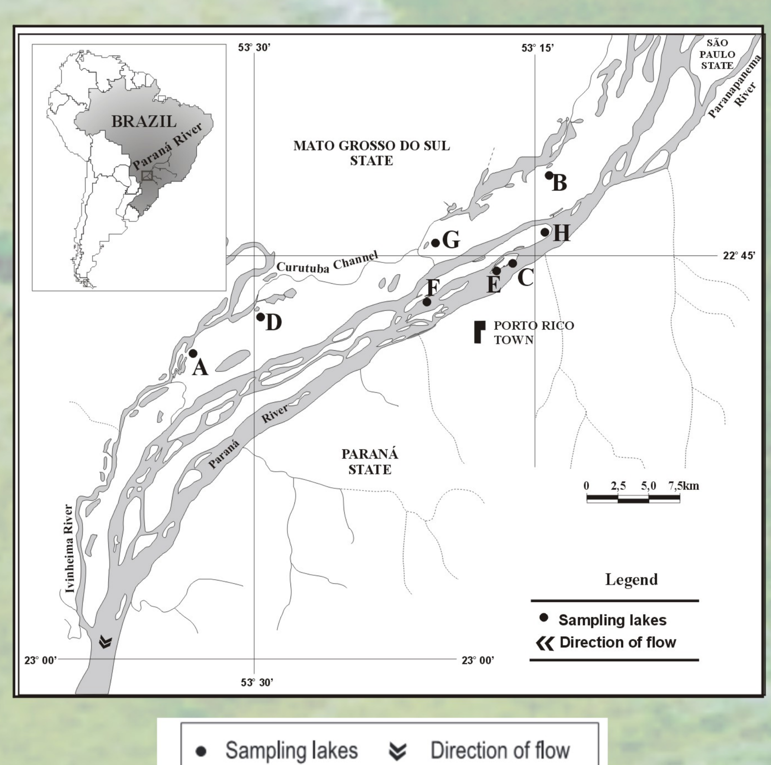


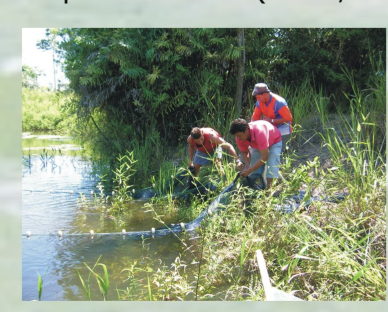
Figure 1. Study area and sampling lakes in the Upper Paraná River Floodplain (Capivara-A, Aurélio-B, Clara-C, Jacaré-D, Genipapo-E, Osmar-F, Traíra-G and Pousada-H).

Material and Methods

Limnological parameters: water temperature, dissolved oxygen (YSI oximeter), pH, electric conductivity (DIGIMED potentiometer), total alkalinity, water transparency (turbidimeter), chlorophyll-a and nutrients.

Zooplankton samples were undertaken at the subsurface (0.5 and 1.5 m) in the pelagic region, using a motorized pump and a plankton net (68 µm) (600 L/sample).

Fish were captured using 20 m seining nets (internal mesh of 0.5 cm opposite knots) operated during the day in littoral zones. The species abundances in every sample were indexed by the capture per unit effort (CPUE; number of individuals.100 m^2).



Zooplankton abundance (ind m^{-3}) was estimated counting at least 80 individuals in at least 3 each sub-samples.

Biovolume calculation for rotifers (at least 30 individuals of each species) was determined according to Ruttner-Kolisko (1977), and the biovolume values were converted to wet weights (10^6 µm^3 = 1 µg of wet weight) and the dry weight was estimated as 10% of wet weight.

The cladoceran and copepods biomass (at least 30 individuals of each species) were estimated through calculated length-weight relationships (from weighing in a micro-analytical balance of 10^7 g).

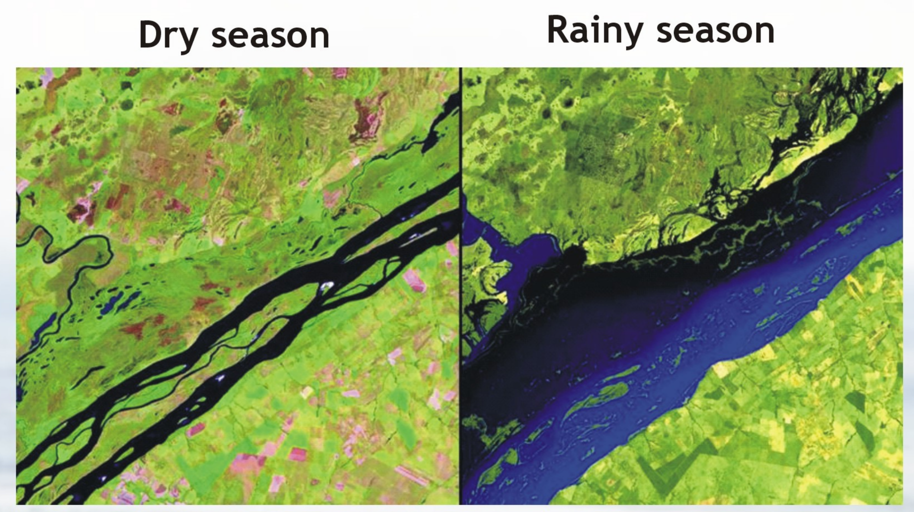
The organisms' length was measured considering:
(i) rotifers: the distance between the superior and inferior margin of carapace, without spines;
(ii) cladocerans: the distance from the head until the end of the carapace, without the helmet and spine;
(iii) copepods: the distance from the head until the genital segment.

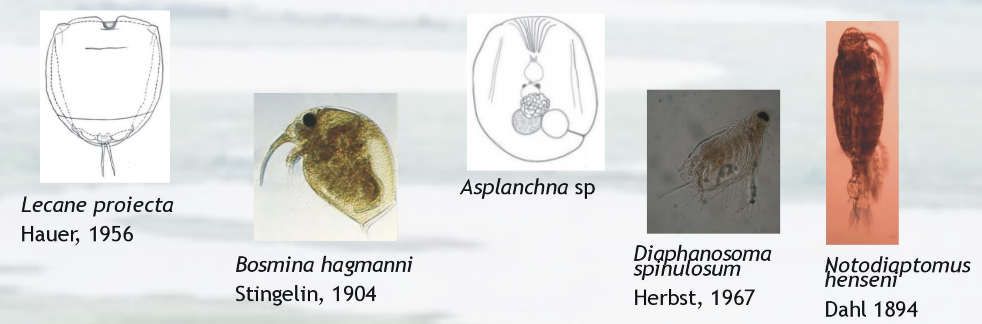
The individuals were classified as: smaller-sized, for those belonging to size class lesser than 300 µm; intermediate-sized, for those belonging to size class ranging from 301 to 600 µm; and larger-sized, for those individuals belonging to size class greater than 601 µm.

All individuals of fishes were identified, enumerated, weighed (g) and classified according to Britski et al. (1999). In order to indicate fishes species potentially consumers of zooplankton, we consulted bibliography for tropical fishes.

Linear regression analyses were carried out, separately, to verify as fish abundance and chlorophyll-a are associated with aggregate community properties (abundance and biomass) and with percentage of size classes on the community structure. The regression assumptions were tested through residual visualization.

Results





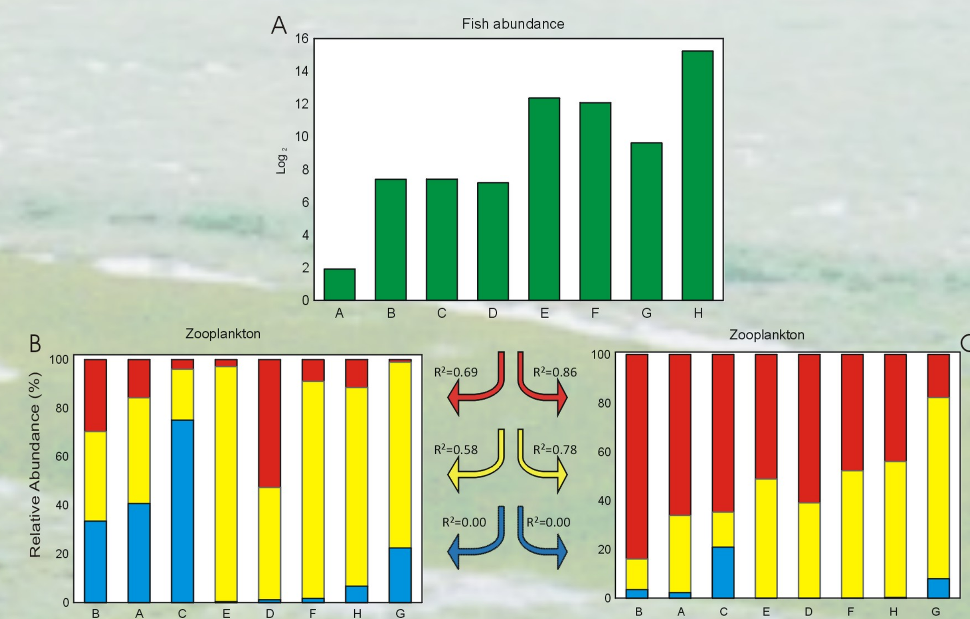


Figure 4. Representation of the simple regression analyses between zooplankton and fish abundance obtained in the lakes during the dry season (August-2000). a) Density of fishes (CPUE); b) Relative abundance; and c) Relative biomass. R2 - coefficient of determination resultant of linear regression. Black, gray and dotted percents are >600, 301-600 and <300 size classes, respectively.

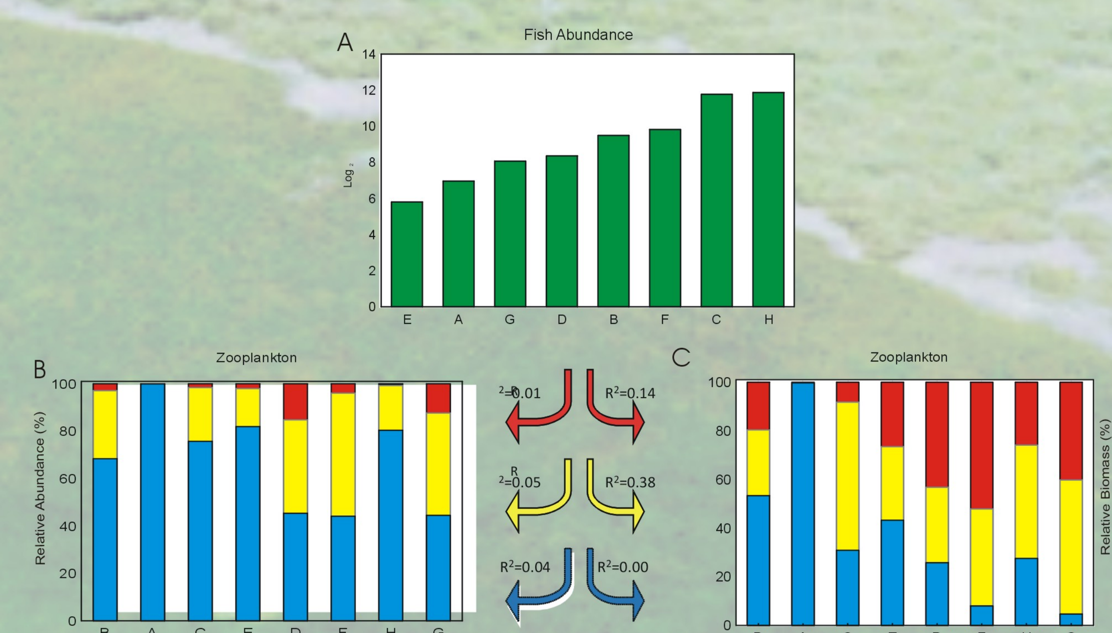


Figure 5. Representation of the simple regression analyses between zooplankton and fish abundance obtained in the lakes during the rainy season (February-2001). a) Density of fishes (CPUE); b) Relative abundance; and c) Relative biomass. R2 - coefficient of determination resultant of linear regression. Black, gray and dotted percents are >600, 301-600 and <300 size classes, respectively.

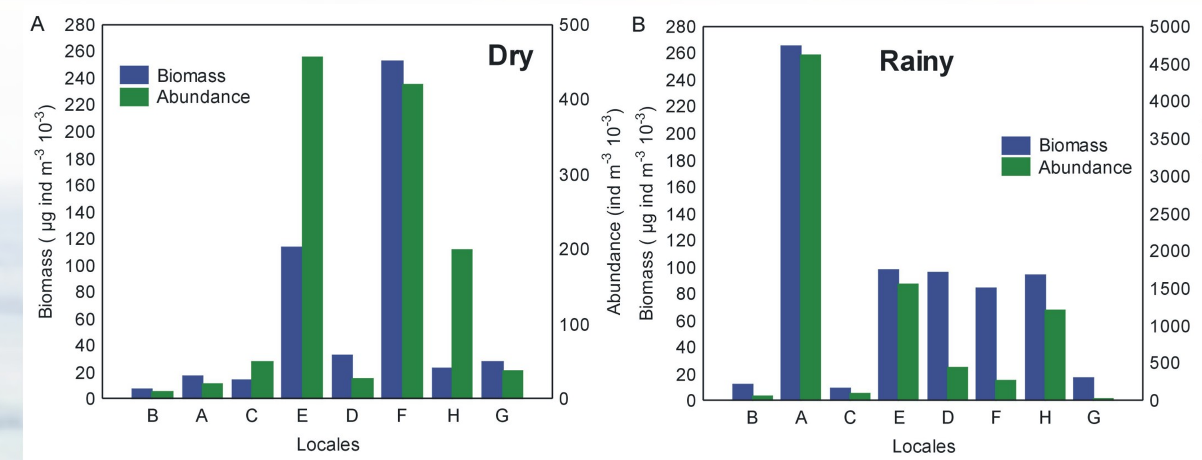


Figure 3. Biomass and abundance of the zooplankton community in the lakes (Capivara-A, Aurélio-B, Clara-C, Jacaré-D, Genipapo-E, Osmar-F, Traíra-G and Pousada-H) during the dry and rainy seasons

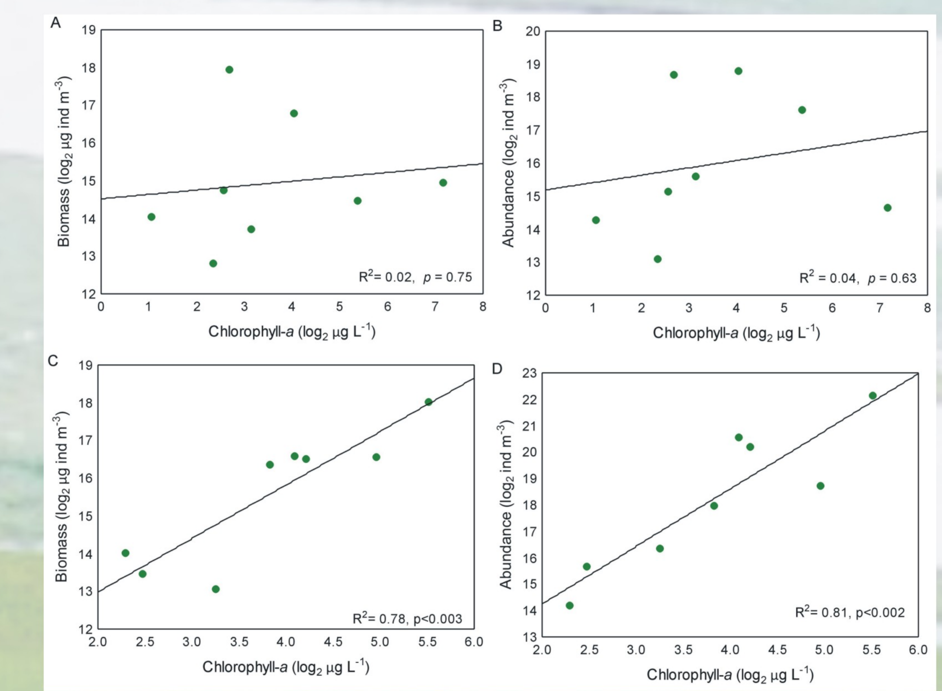


Figure 6. Association of the biomass and abundance of zooplankton with chlorophyll-a the lakes during the dry (a and b) and rainy (c and d) seasons.

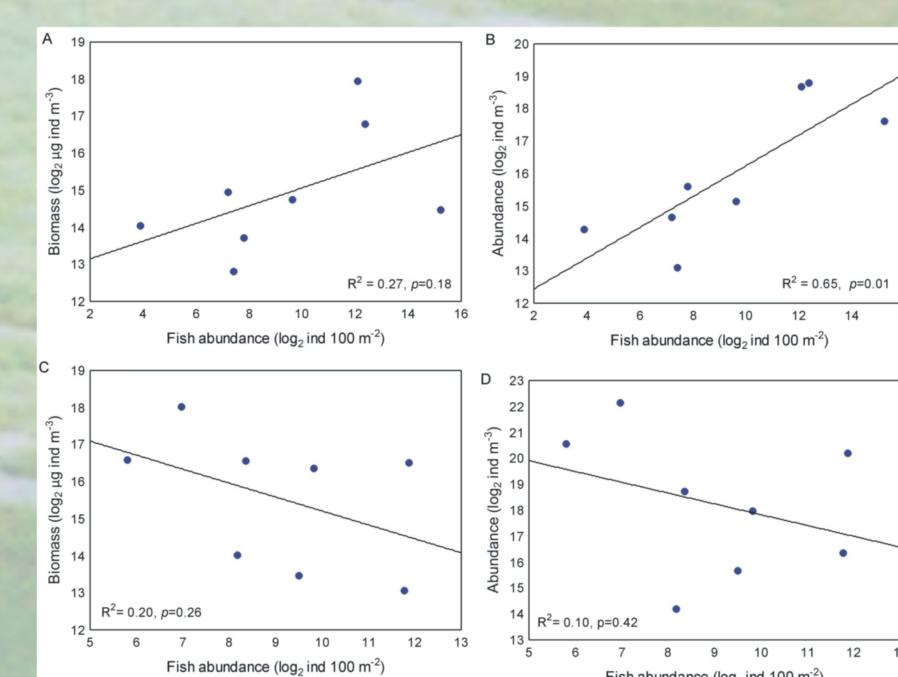


Figure 7. Association of the biomass and abundance of zooplankton with fish abundance (CPUE) in the lakes during the dry (a and b) and rainy (c and d) seasons.

Discussion

The present study evidenced the positive significant association of the density and biomass of zooplankton with fish density, as seen during the dry period (Figure 7a and b). This could disguise the predation effect on the individuals, once this effect was remarkable only in the class of larger size (Figure 4), consequently decreasing the density and biomass larger-sized individuals and increasing density and biomass intermediate-sized individuals. This implicates a direct and negative effect of the predation on larger-sized individuals, as well as indirect and positive effect on the small-sized individuals. It indicated evidence to top-down effect in this period, mainly affecting the size structure of the community, in which there was a removal of larger-sized individuals.

The positive association between the abundance and biomass of zooplankton with the fish abundance may also suggest that the predator density does not exert a predation pressure on the community; but other effect would act positively on the structure of these two communities, promoting a concordance between them, or that the predation effect is not enough to negatively influence the structure of the zooplankton community. Thus, the explanation for the increase in zooplankton density and biomass total would be the direct influence of autotrophic production, or an indirect influence, as for fish excretion, that would also influence the same production (Attayde and Hansson, 2001).

In the rainy period, we did not verify a significant and direct relationship between the abundance of fish and the size classes of the zooplankton community (Figure 5), the biomass and abundance of the community were also associated with local productivity, represented by the chlorophyll-a concentration (Figure 6c and d). This association evidenced that the increase in resource availability favored increment of individuals. The productivity has been reported as the most important factor regulating the zooplankton biomass (because it reflects the increase in resource availability), but it also has been associated to the size structure, i.e., more productive environments will present a predominance of small-sized individuals, and the inverse will be observed in less productive environments (Masson et al., 2004). Thus, in the rainy period a bottom-up effect may be more important than top-down one, on the size structure of the zooplankton community.

Conclusion

We verified that the main hypothesis of this study was partially confirmed because it was supported only one sampling season; however this suggests that different mechanisms act on the size structure of the zooplankton community between the analyzed periods.

Acknowledgements

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