Available online at www.sciencedirect.com
SCIENCE DIRECT®
Acta Oecologica 27 (2005) 9–16
ACTA OECOLOGICA
INTERNATIONAL JOURNAL OF ECOLOGY
www.elsevier.com/locate/actoec

Original article

Fish assemblages associated with *Egeria* in a tropical reservoir: investigating the effects of plant biomass and diel period

Fernando Mayer Pelicice [a,*], Angelo Antonio Agostinho [b], Sidinei Magela Thomaz [b]

[a] *Postgraduate Course in Ecology of Inland Aquatic Ecosystems, Maringá State University, Maringá, Paraná, Brazil*
[b] *Department of Biology/NUPELIA, Maringá State University, Paraná, Brazil*

Received 15 March 2004; accepted 23 August 2004

Available online 13 October 2004

Abstract

Studies investigating fish/macrophyte associations in the neotropics are rare. Aquatic vegetation enhances structural complexity of the environment, potentially influencing predator–prey relationships. The present work characterizes fish assemblages associated with beds of *Egeria*, a submerged rooted macrophyte, in Rosana Reservoir, Brazil. The main subject of this study was to investigate effects of plant biomass and diel period on fish assemblage attributes (density, total weight, taxa richness and diversity), testing the hypothesis that macrophyte density and diel period greatly influences fish assemblage structure. Fishes were sampled with a 1-m^2 throw trap at morning, midday and dusk, at six sites. The assemblages were primarily composed of small-sized species (e.g. Characiformes) and juveniles, with few large species (Gymnotiformes and Cichlidae). Around 95% of the individuals were captured in habitats with medium and high vegetation biomass. Fish assemblage attributes differed significantly with respect to macrophyte biomass. Highest values of these attributes were observed in maximum plant biomass, in contrast with trends observed in previous works, where higher values (mainly of fish density) were found in intermediate plant coverage. Oxygen, temperature and pH were within normal ranges, therefore, variation in assemblage attributes is assumed to be explained primarily by plant density. No pattern of diel variation was observed, perhaps reflecting sedentary characteristics of these taxa. Results from this study illustrate that procedures to reduce macrophyte density in reservoirs of the Paraná-Tietê-Paranapanema systems, may cause strong alterations in the fish assemblages, resulting in lower fish density, biomass and species richness of taxa utilizing *Egeria* beds.

Keywords: Fish assemblage; Macrophyte stands; Habitat structure; Reservoir management

1. Introduction

Aquatic macrophytes play a fundamental role structuring aquatic environments and increasing spatial complexity (Benson and Magnuson, 1992; Weaver et al., 1996; Weaver et al., 1997; Grenouillet and Pont, 2001). Aquatic habitats with higher structural complexity can maintain more fish species and individuals due to the presence of suitable spawning substrates, abundant food resources and refuges against predators (Rossi and Parma de Croux, 1992; Dibble et al., 1996; Duffy and Baltz, 1998; Agostinho et al., 2003).

To understand structuring processes in relation to aquatic macrophytes, studies generally follow one of the three approaches: (i) macrophyte presence, (ii) vegetation density, (iii) and plant morphologic characteristics (Killgore et al., 1989; Dionne and Folt, 1991; Chick and McIvor, 1997; Dibble and Harrel, 1997; Meschiatti et al., 2000; Agostinho et al., 2002). These differences in approach reflect different spatial scales, ranging from habitat to micro-habitat.

Studies concerning fish/macrophyte associations in tropical environments are rare, with the majority focusing only on the macrophyte presence, which limits small-scale inferences (Cordiviola de Yuan et al., 1984; Araujo-Lima et al., 1986; Delariva et al., 1994; Hendersen and Hamilton, 1995; Meschiatti et al., 2000). The Paraná River Basin supports a diverse icthyofauna and aquatic flora, as much in species composition as in functional groups (Agostinho et al., 1995; Thomaz et al., 2003), however little is known about the ecological aspects of this interaction. Great dispersal abilities (Santamaría, 2002), allied with widespread impoundment of

* Corresponding author. Present address. Bloco H90, 5790, Avenida Colombo, 87020900 Maringá, Paraná, Brazil.
E-mail address: fmpelicice@ig.com.br (F.M. Pelicice).

1146-609X/$ - see front matter © 2004 Elsevier SAS. All rights reserved.
doi:10.1016/j.actao.2004.08.004

rivers in this basin, favors the development of large stands of certain macrophyte groups. Recently, proliferation of submerged plants has been noticed in several reservoirs of Paraná-Tietê-Parananema Basins, especially the species *Egeria najas* and *Egeria densa* which form large beds in littoral areas (Thomaz and Bini, 1999; Marcondes et al., 2003). This phenomenon has an enormous potential in compromising water multiple uses (Bianchini-Júnior, 2003).

The present work characterizes the structure of fish assemblages associated with *Egeria densa* and *E. najas* beds in Rosana Reservoir, Paranapanema River, and related differences in assemblage structure to macrophyte biomass, diel periodicity and abiotic variables. We tested the hypotheses that: (i) presence and biomass of aquatic macrophytes are determinant factors on the composition and structure of fish assemblages in this reservoir, resulting in habitats with higher values of fish density, total weigh, species richness and diversity; and (ii) diel period influences fish activity, resulting in changes in assemblage structure during a day period inside macrophyte beds.

2. Material and methods

2.1. Study area

The Paranapanema River is a major tributary of the Upper Paraná River Basin and forms the division between Paraná and São Paulo states (22°36′S, 52°52′W). Samples were collected in Rosana Reservoir (Fig. 1), the last reservoir in a cascade along the Paranapanema River. Rosana dam was completed in 1986, flooding a shallow (depths usually lower than 10 m) area of 276 km^2. Total drainage area of the reservoir is 99,000 km^2, with a water residence time of approximately 18.6 days (CESP, 1998). The reservoir is characterized by large beds of *E. densa* and *E. najas*, species

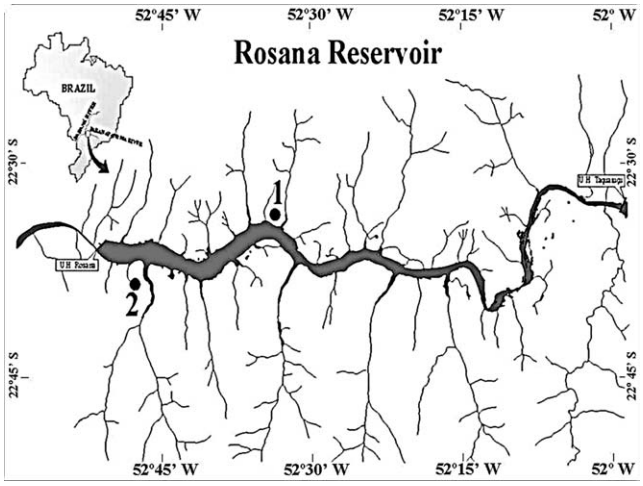

Fig. 1. Rosana Reservoir, the last reservoir of Paranapanema River before its confluence with the Paraná River. Sampling sites: (1) region of Euclides da Cunha Paulista district, São Paulo State; (2) region of Diamante do Norte district, Paraná State.

native to this basin (Cook and Urmi-Konig, 1984), that form patches of different densities in depths <2 m. One of the main limiting factors to submerged macrophyte growth is underwater radiation (Thomaz and Bini, 1999). In Rosana Reservoir, colonization by submerged macrophytes is facilitated by low turbidity and lower phytoplanktonic primary production than in other southeastern systems (CESP, 1998).

2.2. Data collection

A total of 59 samples were collected between January 15 and 21, 2003 in beds of *E. densa* and *E. najas* at six sites (Fig. 1). Three sites were located in Euclides da Cunha Paulista district (n = 28), São Paulo State (22°34′07″S, 52°33′34″W), and three in Diamante do Norte district (n = 31), Paraná State (22°38′29″S, 52°47′16″W) closer to the dam. Sampling sites were selected to incorporate the full range of densities of *Egeria* and maximum depth <1.4 m, due to equipment restriction. Samples were collected in three diel periods: morning (6:00 h; n = 20), midday (13:00 h; n = 21) and dusk (18:30 h; n = 18).

A 1-m^2 throw trap was used to sample fish and macrophytes. The trap was constructed with a 1.5-m height aluminum frame with small mesh (0.5 cm) covering all laterals. At each site a boat was silently positioned above the *Egeria* bed and used as a platform for trap deployment. Immediately following boat positioning, the trap was quickly thrown into the water and pressed to the bottom. A suite of physicochemical variables was measured following trap deployment: oxygen (mg/l and % of saturation), temperature (°C), pH, conductivity (μS/cm) and depth (m). Transparency (Secchi, m) was measured in deeper sites close to sampling stations. Next, macrophytes were removed from the trap, washed and weighed (wet weight). A subsample was kept for drying (60 °C for 7 days) to obtain macrophyte biomass in dry weight (DW g m^{-2}). Dry weight biomass was determined for 41 samples (morning and midday periods) and classified as low (0–70 g m^{-2}), medium (71 and 200 g m^{-2}) or high macrophyte densities (200–530 g m^{-2}). In the 18 remaining samples (dusk period), macrophyte biomass was visually classified into low, medium and high categories.

After vegetation removal, fish were collected with an aluminum dip-net (49 × 49 cm frame and 0.5 cm net mesh size). Hauls were made inside the trap area, until 10 successive hauls resulted in no additional individuals captured. To evaluate dip net capture efficiency, 5 l of sodium hypochlorine were poured into the area following the dip-netting protocol of two collections. The water was mixed vigorously and the dip-net procedure repeated to capture any remaining individuals. All fish captured were preserved in 10% formulin, taken to the laboratory and subsequently identified, counted, measured (standard length) and weighed.

2.3. Statistical analysis

To evaluate completeness of fish taxa sampling, a taxa accumulation curve was constructed using all 59 samples.