

Macrobenthic diversity on different habitats in an altitudinal lake surrounded by *Eucalyptus* plantations and secondary Atlantic Forest (southeast Brazil)

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RESUMO: Diversidade de macroinvertebrados bentônicos em diferentes habitats em um lago de altitude cercado por plantações de *Eucalyptus* e mata atlântica secundária (sudeste do Brasil). Foi estudada a distribuição sazonal da comunidade de macroinvertebrados bentônicos em diferentes habitats na Lagoa do Teobaldo (Antônio dias, MG) nos períodos de chuvas e seca de 1997. Este ecossistema localiza-se na altitude de 900 m, na bacia do Rio Piracicaba, no trecho médio do Rio Doce (19°30'84" S; 42°47'28" W). Na área de entorno encontram-se plantações de *Eucalyptus* spp. e mata atlântica secundária. As amostras de sedimento foram coletadas em triplicatas com uma draga de Eckman-Birge, em três estações amostrais (regiões litorâneas e região limnética). Os resultados evidenciaram maior riqueza de macroinvertebrados bentônicos na região litorânea com mata atlântica secundária, seguida da região limnética e, finalmente, da região litorânea com plantações de *Eucalyptus* spp. As larvas de Chironomidae (Diptera, Insecta) predominaram numericamente nas três áreas. Foram calculados os índices de riqueza, equitabilidade e diversidade de Shannon-Wiener com os dados da identificação taxonômica das larvas de Chironomidae ao nível de gênero. Treze gêneros de Chironomidae, das subfamílias Tanypodinae (*Ablabesmyia*, *Labrundinia*, *Larsia*), Orthocladinae (*Nanocladius*, *Procladius*), e Chironominae (*Chironomus*, *Cladopelma*, *Fissimentum*, *Goeldichironomus*, *Parachironomus*, *Phaenopsectra*, *Polypedilum*, *Nimbocera*) foram identificados. Oligochaeta, Ephemeroptera, Odonata e Heteroptera foram encontrados em baixas densidades nos habitats estudados. A elevada ocorrência de exúvias de larvas de Chironomidae sugere uma baixa taxa de decomposição da matéria orgânica no sedimento. Os resultados obtidos evidenciaram uma clara diferenciação entre as regiões litorâneas e limnéticas, além de uma provável influência das plantações de *Eucalyptus* sobre a distribuição da macrofauna bentônica, relacionada à qualidade da matéria orgânica disponível no sedimento.

Palavras-chave: bentos, Chironomidae, impacto ambiental, plantações de *Eucalyptus*.

ABSTRACT: Macrobenthic diversity on different habitats in an altitudinal lake surrounded by *Eucalyptus* plantations and secondary Atlantic forest (southeast Brazil). The seasonal distribution of benthic macroinvertebrates community in different habitats in Lagoa Teobaldo (Antônio Dias, MG) was studied during the rainy and dry periods of 1997. This ecosystem is located at an altitude of 900 m a.s.l., within the Piracicaba River basin at the Rio Doce middle stretch (19°30'84" S; 42°47'28" W). Its surroundings show *Eucalyptus* spp. plantations and secondary Atlantic forest. Sediment samples were collected in triplicate with an Eckman-Birge dredge, at three sampling stations (shorelines and limnetic zone). The results evidenced a greater richness of benthic macroinvertebrates in the littoral zone with secondary forest, followed by the limnetic

zone, and, finally, the littoral zone with *Eucalyptus* plantations. Chironomidae larvae (Diptera, Insecta) predominated numerically in the three areas, and, based upon its taxonomic identification at genera level, the index of richness, evenness and Shannon-Wiener diversity was calculated. Thirteen Chironomidae genera of Tanypodinae (*Ablabesmyia*, *Labrundinia*, *Larsia*), Orthocladinae (*Nanocladius*, *Procladius*), and Chironominae (*Chironomus*, *Cladopelma*, *Fissimentum*, *Goeldichironomus*, *Parachironomus*, *Phaenopsectra*, *Polypedillum*, *Nimbocera*) were identified. Oligochaeta, Ephemeroptera, Odonata and Heteroptera were found in low densities in the studied habitats. The high occurrence of Chironomidae larvae exuviae suggests a low rate of organic matter decomposition in the sediment. Data evidenced a clear differentiation between littoral and limnetic zones, besides a probable influence of *Eucalyptus* plantations over the benthic macrofauna distribution, relative to the quality of the organic matter available in the sediment.

Key-words: benthos, Chironomidae, environmental impact, *Eucalyptus* plantations.

Introduction

Eucalyptus monocultures in the aquatic ecosystem shorelines account for a low quality energetic input into the benthic communities, especially when litter texture and chemical composition are considered (Bunn, 1988; Pozo, 1993; Molinero et al., 1996; Pozo et al., 1997). For this reason, some functional groups are impaired, such as the shredders *Tipula lateralis* incapable of surviving upon a diet based on *Eucalyptus* leaves (Canhoto & Graça, 1995).

The diversity of benthic macroinvertebrates communities in lacustrine ecosystems is directly influenced by sediment granulometric composition, organic matter content, and nutritional quality (considering the amount of carbon, nitrogen and phosphorus) (Callisto & Esteves, 1996a e b; Gonçalves et al., 1998). Among benthic organisms, Chironomidae larvae (Diptera, Insecta) have been widely used as water quality and anthropic influence bioindicators (Callisto et al., 1998a e b; Marques et al., 1999). Due to the high species diversity (estimated more than 15,000 species worldwide, less than 10% scientifically described), representatives of this family are found in all types of continental aquatic environments (Cranston, 1995). Several researchers have been evaluating the Chironomidae diversity, based on larvae and pupae exuviae studies in biomonitoring programs thanks to their efficiency as a biological tool with relatively low-cost sample processing, and its easy taxonomic identification (Hardwick et al., 1995).

The great majority of ecological studies conducted in tropical lacustrine ecosystems have been based on rainy and dry periods seasonality. In Minas Gerais State, this seasonality is characterised not just by pluviometric differences, but also by accentuated differences in air and water temperatures, with strong influence over the lacustrine metabolism (Henry et al., 1997; Tundisi, 1997).

The present study aimed to evaluate the hypothesis that *Eucalyptus* plantations induces changes in community structure and benthic macroinvertebrates distribution in an altitude lake. The major objective was to evaluate benthic macrofauna diversity with emphasis on Chironomidae larvae, comparing both limnetic and littoral zones within two distinct areas, one of which bordered by secondary forest (Atlantic forest remnant), and the other by *Eucalyptus* plantations.

Study area

Lagoa Teobaldo is located in Antônio Dias Municipality, Minas Gerais State (19°30'84" S; 42°47'28" W), within Ribeirão Severo sub-basin, a left shore tributary of Piracicaba River (Rio Doce mean portion). It is a triangular-shaped lake, with maximum depth of 7 meters in the limnetic zone, and 1.3 meter in the shorelines. Lagoa Teobaldo is characterized by relatively warm waters, with water temperature

ranging from 18.2 °C (dry period) to 27.0 °C (rainy period); slightly acidic to neutral with pH between 5.2 (rainy) and 7.0 (dry), being slightly higher in the littoral zone bordered by secondary forest; median oxygenation with dissolved oxygen concentrations between 0.2 mg/L (rainy) and 10.4 mg/L (dry). During the rainy period, an increase in allochthonous matter input was observed, with consequent electric conductivity elevation (8.5 µS/cm in the dry period and 59.5 µS/cm in the rainy period).

Material and methods

Samples were collected in the rainy (March) and dry (August) periods of 1997. Sediment samples were collected in triplicate using an Eckman-Birge dredge, in three sampling stations (shoreline with secondary forest, shoreline with *Eucalyptus* spp. plantations and limnetic zone), fixed with formaldehyde, and packed into plastic bags. In the laboratory, they were rinsed through a 250 µm mesh sieve and sorted under a stereomicroscope. Chironomidae larvae were identified using 10% lactophenol solution under microscope with a 400X magnification. The collected organisms were deposited in the Benthic Macroinvertebrates Collection from Laboratório de Limnologia/Ecologia de Bentos, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Brazil, following methodology described in Callisto *et al.* (1998c).

Results and discussion

Chironomidae was the dominant group in the three sampling stations, representing 89.7% and 98.3% in the limnetic zone, 98.0% and 99.0% in the littoral zone, and 97.6% and 68.4% in the littoral zone with *Eucalyptus* plantations, in rainy and dry periods, respectively. A few Heteroptera (Gerridae), Trichoptera (*Oxyethira* and *Ochrotrichia*), Ephemeroptera (Baetidae), and Oligochaeta were also found (Table 1). A total of thirteen genera of Tanypondinae (*Ablabesmyia*, *Labrundinia*, *Larsia*), Orthocladinae (*Nanocladius*, *Procladius*) and Chironominae (*Chironomus*, *Cladopelma*, *Fissimentum*, *Goeldichironomus*, *Parachironomus*, *Phaenopsectra*, *Polypedillum*, *Nimbocera*) were identified. In addition, three unidentified genera were grouped as Tanytarsini genera varia.

In the limnetic sample station, only Chironomidae larvae exuviae belonging to *Ablabesmyia*, *Nanocladius*, *Chironomus*, *Goeldichironomus*, *Parachironomus*, *Polypedillum* genera and Tanytarsini genera varia, were found. Larvae exuviae are an important biodiversity record, because they reflect the taxonomic composition present in the ecosystem. Moreover, the high amount of fourth instar larvae exuviae found (with

Table 1: Benthic macrofauna abundance (Ind/m²) in the studied habitats during the rainy and dry periods of 1997. Note: Amphipoda Gamaridae and Oligochaeta were considered as non-insects.

Taxa	Limnetic		Natural		<i>Eucalyptus</i>	
	rainy	dry	rainy	dry	rainy	dry
Non insects	3.45	-	0.65	1.04	-	15.79
Odonata	-	-	-	-	-	10.53
Lepdoptera	-	-	0.65	-	-	-
Ephemeroptera	-	1.72	0.65	-	2.38	-
Heteroptera	3.45	-	-	-	-	-
Trichoptera	3.45	-	-	-	-	5.26
Diptera	-	-	-	-	-	-
Chironomidae larvae	-	-	5.19	4.17	97.62	57.89
Chironomidae exuvia	89.66	98.28	92.86	94.79	-	10.53

head, torax and abdomen) suggests a slow rate of organic matter decomposition in the sediment, probably related to a low microbial activity. In lakes, where this activity is intense, a high decomposition rate is observed, and larvae exuviae occurrence is scarce. The presence of Oligochaeta together with Chironominae exuviae is related to the sediment characteristics which is rich in organic matter, and to the morphometry of Teobaldo's Lake basin, situated in a valley with strong border declivity, and intense allochthonous organic matter input in the rainy period. This fact favors the high load of fertilizers used in *Eucalyptus* plantations to be taken into the aquatic ecosystem, probably reflecting the main anthropic activity in the drainage basin.(Figure 1).

In the shoreline with secondary forest, Chironomidae distribution was clearly differentiated between rainy and dry periods. In the rainy period, a greater predator richness was observed, represented by Tanypodinae genera (*Ablabesmyia*, *Labrundinia*, *Larsia*). This fact suggests

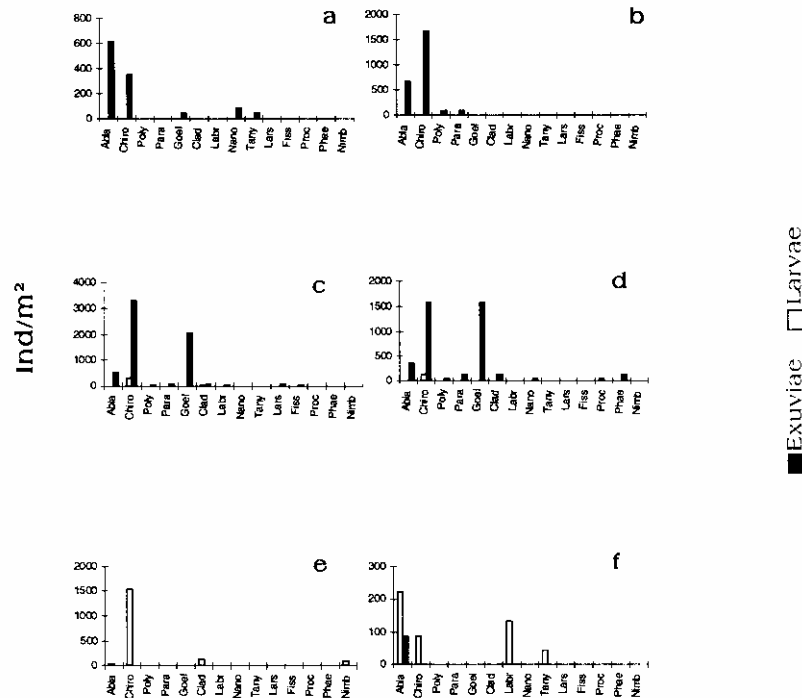


Figure 1: Chironomidae larvae and exuviae density (Ind/m²) in the three sampling stations, during the rainy and dry periods of 1997. **Note:** (a) limnetic, rainy; (b) limnetic, dry; (c) natural, rainy; (d) natural, dry; (e) Eucalyptus, rainy; (f) Eucalyptus, dry; (Abia) *Ablabesmyia*; (Chir) *Chironomus*; (Poly) *Polypedilum*; (Para) *Parachironomus*; (Goel) *Goeldichironomus*; (Clad) *Cladopelma*; (Labr) *Labrundinia*; (Nano) *Nanocladius*; (Tany) *Tanypodini*; (Lars) *Larsia*; (Fiss) *Fissimentum*; (Proc) *Procladius*; (Phae) *Phaenopsectra*; (Nimb) *Nimbo-cera*.

a more stable microhabitat conditions, probably due to a well-developed bank of floating aquatic macrophytes, with *Salvinia auriculata* predominance, characterizing a well-defined ecotone between aquatic and terrestrial surroundings (Callisto *et al.*, unpublished data).

In the littoral zone bordered by *Eucalyptus* plantations, a low taxonomic richness was observed, in comparison with the other sampling stations. Besides, *Ablabesmyia* exuviae were found only in the dry period. Exuviae absence might suggest some local "instability", reflecting on a greater difficulty in Chironomidae larvae colonization. This fact might be related to the strong border declivity which favors a greater allochthonous organic matter input into the aquatic ecosystem. In addition, it was observed that the aquatic macrophytes present in that area shows smaller leaves, smaller rhizosphere,

occupying a restrict area in the littoral zone. Even more distinction deserves the presence of Odonata nymphae, voracious carnivores which could be exerting an effective control over Chironomidae and Oligochaeta populations.

Chironomus and *Goeldichironomus* are typical organic sediments inhabitants, also reflecting the abundance of gross particulate organic matter, composed mainly by vegetal detritus (Nessimian, 1995; Nessimian & Sanseverino, 1995). *Goeldichironomus* larvae associated with aquatic macrophytes detritus are frequent, living in the periphyton or as leaf miners (Callisto *et al.*, 1996c).

According to Epler (1995), *Nanocladius* larvae are generalists and inhabit oligotrophic to mesotrophic lakes, and not frequently, are present in moderately eutrophic lakes. In Lagoa Teobaldo, only *Nanocladius* larvae exuviae were found in the limnetic and the littoral zone with secondary forest stations. *Cladopelma*, *Phaenopsectra* and *Nimbocera* larvae are common in sandy sediments, and, with their high organic matter content, they can resist to organic matter low concentration periods. *Parachironomus* and *Polypelum* are generalists, with many miners species in aquatic macrophytes. *Polypedilum* has a great number of species in Brazil the great majority of which are still unknown (Bidawid & Fittkau, 1994).

Analysing the benthic macroinvertebrates communities structure in the three sampling stations, it was observed that the littoral zone with secondary Atlantic forest remnants showed a greater taxonomic richness of Chironomidae larvae, and also a greater diversity, followed by the limnetic and the littoral zones with *Eucalyptus* plantation sample stations. On the other hand, evenness data showed an inverse pattern, while comparing the rainy and dry periods (Figure 2).

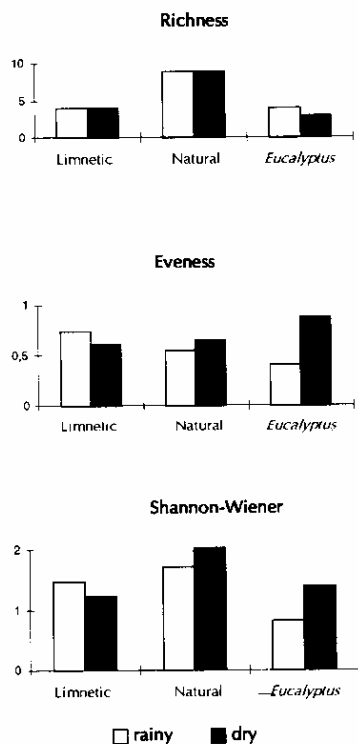


Figure 2: Richness, evenness, and Shannon-Wiener diversity (H) values recorded for the studied habitats, during the rainy and dry periods of 1997.

The results obtained in this research represent a contribution towards the knowledge of benthic macrofauna diversity in altitudinal lakes in Brazil. Moreover, Chironomidae larvae taxonomic composition has proved to be strongly influenced

by the characteristics of the sampled habitats, and by the allochthonous matter input, while comparing an area with *Eucalyptus* plantations and another with secondary Atlantic forest remnants.

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