DOI: http://dx.doi.org/10.1590/1519-6984.17512

Aquatic insect community structure under the influence of small dams in a stream of the Mogi-Guaçu river basin, state of São Paulo

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Received: August 21, 2012 – Accepted: January 22, 2013 – Distributed: February 28, 2014
(With 4 figures)

Abstract

The fragmentation of lotic systems caused by construction of dams has modified many aquatic communities. The objective of this study was to analyse changes in the aquatic insect community structure by discontinuity of habitat created by dams along the Ribeirão das Anhumas, a sub-basin of the Mogi-Guaçu River (state of São Paulo, Brazil). Entomofauna collection was carried out in 10 segments upstream and downstream of five dams along the longitudinal profile of the stream, with a quick sampling method using a D net (mesh 250 mm) with 2 minutes of sampling effort. The insects were sorted and identified to the lowest possible taxonomic level and analysed by the Shannon diversity index, β diversity, richness estimated by rarefaction curves and relative participation of functional feeding groups. The results showed a slight reduction in diversity in the downstream segments, as well as along the longitudinal profile of the stream. However, there were no significant differences in abundance and richness between the upstream and downstream segments, indicating that the dams did not influence these variables. Differences were observed in the functional feeding groups along the longitudinal profile. Predator and gatherer insects were dominant in all segments analysed. The feeding group of shredders was more abundant in the segment DSIII with the participation of *Marilia* Müller (Odontoceridae – Trichoptera), although we observed a decrease of shredders and scrapers with the decrease of the canopy cover reducing values of β diversity in the continuum of Ribeirão das Anhumas. This result demonstrated the importance of the conservation of the riparian vegetation in order to maintain the integrity of the stream.

Keywords: aquatic macrofauna, riparian vegetation, habitat discontinuity, reservoir.

Estrutura da comunidade de insetos aquáticos sob influência de pequenas represas em um ribeirão da bacia do Rio Mogi-Guaçu, Estado de São Paulo

Resumo

A fragmentação de sistemas lóticos causadas pela construção de represas tem causado modificação na estrutura das comunidades aquáticas. O objetivo deste estudo foi analisar as mudanças na estrutura da comunidade de insetos aquáticos decorrentes da descontinuidade de habitat criada por represamentos ao longo do Ribeirão das Anhumas, uma sub-bacia do rio Mogi-Guaçu (Estado de São Paulo, Brasil). A coleta da entomofauna foi realizada em 10 segmentos à montante e à jusante de cinco represas ao longo do perfil longitudinal do ribeirão, pelo método de varredura com rede D (malha 250 mm) e esforço amostral de 2 minutos. Os insetos foram triados e identificados até o menor nível taxonômico possível e os diferentes grupos foram analisados pelo índice de diversidade de Shannon, diversidade β, riqueza estimada pela curva de rarefação e participação relativa dos grupos funcionais de alimentação. Os resultados apontaram ligeira redução na diversidade nos trechos à jusante, bem como ao longo do perfil longitudinal do ribeirão. Todavia, não houve diferenças significativas na abundância e riqueza entre os segmentos à montante e à jusante das represas, indicando que os represamentos não influenciaram nessas variáveis. Os resultados apontaram diferenças nos grupos funcionais de alimentação ao longo do perfil longitudinal. Os insetos predadores e coletores foram os grupos de alimentação predominantes em todos os segmentos analisados. O grupo dos insetos fragmentadores foi mais abudante no segmento DSIII com a participação de *Marilia* Müller (Odontoceridae- Trichoptera), embora observado um decréscimo de fragmentadores e rapaspadores com a redução da cobertura vegetal, reduzindo os valores dediversidade b no perfil longitudinal do Ribeirão das Anhumas. Os resultados demonstraram a importancia da conservação da vegetação ripária para a manutenção da integridade do ribeirão.

Palavras-chave: macrofauna aquática, vegetação ripária, descontinuidade de habitat, represa.

1. Introduction

The fragmentation of lotic systems due to dam construction causes impacts on aquatic animals that depend on the waterflow for dispersion. The isolation of communities in sites both upstream and downstream of dams, results over time, in the extinction of local populations, preventing the natural re-colonisation of the communities (Merrill et al., 2001).

With the development of knowledge in hydrology, many activities have been conducted in the rivers for economic purposes, such as construction of large dams and of courses for navigation. These factors have been responsible for many changes in aquatic ecosystems (Rodrigues, 2009). According to Johnson et al. (2001), there has been a worldwide increase in the number of large dams since the 1950s, turning lotic systems into lentic ones, causing extensive loss of habitat and fragmenting around 60% of watersheds, while still maintaining a flow of water. At the same time, many small reservoirs have been built along small rivers or streams for the most diverse purposes (irrigation, aquaculture, recreation and livestock).

Aquatic insects, the richest and most abundant in aquatic communities, may also be affected by the impoundment of rivers and streams. The distribution of this group in these environments is directly related to food availability, substrate type, and physical and chemical characteristics of water (Callisto et al., 2005), but little is known about the interference of habitat fragmentation caused by dams in this community (Monaghan et al., 2005). In view of this question, the objective of this study was to analyse changes in the aquatic insect community structure resulting from the disruption of habitats caused by small dams constructed along a stream of the Mogi-Guaçu sub-basin, in the state of São Paulo (Brazil).

2. Study Area

Ribeirão Anhumas is a little river located in the midwest of the state of São Paulo belonging to the watershed of Mogi Guaçu River. This stream, with a drainage basin of 14,653 km^2 (Santos, 1999), runs through nearly 30 km between coordinates 21° 86'S, 47° 98'W and 21° 62'S, 47° 98'W, and flows into the Ribeirão das Cabaceiras. The vegetation of the Ribeirão das Anhumas is composed of stretches of preserved riparian vegetation, savanna forest and semi-deciduous forest. Along its longitudinal profile, there are five dams ranging from 300 to 3000 metres in length used for various activities such as agricultural irrigation, recreational activities (fishing and boating) and collection of water for human consumption.

3. Material and Methods

3.1. Aquatic fauna

The study was carried out in 10 segments of the Ribeirão das Anhumas (five upstream - US and five downstream - DS) in stretches with 50 metres upstream and downstream of each dam (see Figure 1), by the quick sampling method using a D net (mesh of 250 mm), with sampling effort of two minutes. In each segment three samples were collected. The specimens were sorted and identified to the lowest possible taxonomic level, using the following identification keys: Trivinho-Strixino (2011), Pepinelli (2011), Domínguez and Fernández (2009), Domínguez et al. (2006), Pes et al. (2005), Costa et al. (2000), Nieser and Melo (1997), Lecci and Fröehlich (2007).

The main physical and chemical variables (dissolved oxygen, temperature, pH and electric conductivity) were determined in the field using the Horiba multisensor (model U10), followed by the environmental characterization of the segments sampled, as in the Protocol of Environmental Characterisation Biota / FAPESP (Suriano, 2008). The superficial flow speed was estimated by the float method (see Table 1).

3.2. Data analysis

The aquatic insect community was analysed for numerical and relative contribution of each taxon in the stream segments using the Shannon diversity index, the Pielou evenness and dominance index. Student´s *t*-test was used to verify significant differences in community abundance and richness between the stream segments. The richness was estimated by the method of rarefaction computed by the Monte Carlo method (Hulbert, 1971; Bispo and Oliveira 2007) using the lowest abundance (150 individuals). The β diversity between each two successive segments, and also between forested and non forested stretches, was evaluated using the dissimilarity index, with the statistical software STATISTICA (version 5.1). The logarithms converted abundances [log (x+1)] were used to calculate a similarity matrix among the segments using the Morisita index. The clustering was measured by UPGMA and distortions generated were evaluated by the Cophenetic Correlation index. The taxa were grouped into functional feeding categories according to the classification of Merritt and Cummins (1996), and supplemented by regional studies of Chironomidae larvae (Trivinho-Strixino and Strixino, 1998; Janke and Trivinho-Strixino, 2007); in the comparative analysis, the relative participation of each guild was considered. The following feeding categories were considered: predators, scrapers, shredders and collectors. A PCA analysis was used to verify if there were differences in insect feeding categories in the upstream and downstream segments of the stream.

4. Results

The main environmental characteristics of the Ribeirão das Anhumas are shown in Table 1. The total number of insects collected in the 10 segments and their respective functional feeding categories is presented in Tables 2, 3 and 4. In total, 2498 insect specimens in 92 taxa, distributed in 40 families were analysed. Chironomidae was the most abundant and diverse family in all segments studied, representing approximately 60% of individuals and 36% of insect genera. *Polypedilum* (with 14.0%) was the most representative taxon of the community, being present in almost all segments of the stream. *Pentaneura*,

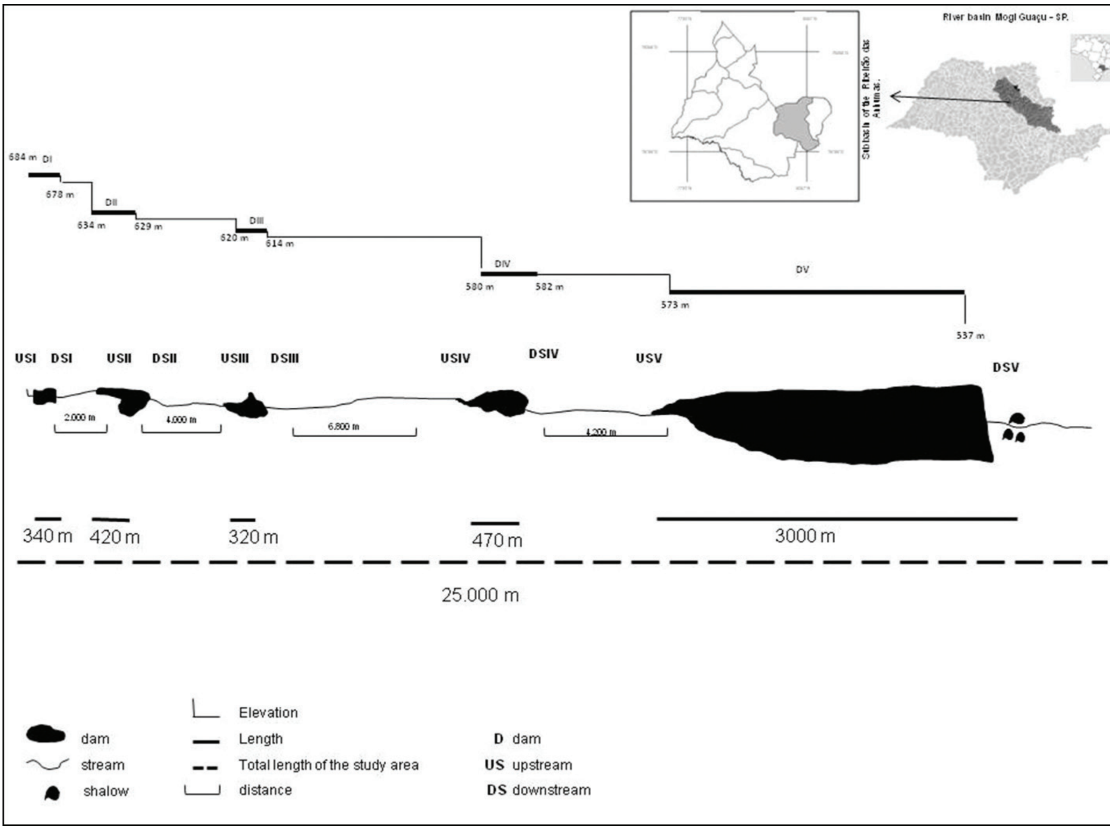

Figure 1. Geographic location of the hydrographic basin of Ribeirão das Anhumas (central region of São Paulo state) and schematic representation of the longitudinal profile with indication of the dams and segments studied. (D) – dam, (US) – upstream, (DS) – downstream.

Table 1. Environmental characterization of the segments upstream and downstream of five dams along the longitudinal profile of the Ribeirão das Anhumas (São Paulo, Brazil).

	Segment									
	DI		**DII**		**DIII**		**DIV**		**DV**	
	USI	**DSI**	**USII**	**DSII**	**USIII**	**DSIII**	**USIV**	**DSIV**	**USV**	**DSV**
Canopy	Closed		Closed		Half		Absent		Absent	
Cond. (μS.cm^{-1})	0.1	0.1	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3
D.O. (mg.L^{-1})	4.87	8.47	7.63	9.00	6.8	8.43	5.33	5.97	8.07	8.75
pH	5.62	5.94	6.03	6.32	5.8	5.65	6.37	6.83	6.53	6.53
water temperature (°C)	16.7	17.8	19.3	19.1	20.0	19.0	17.7	19.0	17.0	20.01
width (m)	0.94	1.00	1.00	3.00	2.4	5.77	7.00	5.67	3.83	5.67
Current velocity (cm.s^{-1})	5	4	4	3	5	7	7	6	4	4
depth (m)	0.18	0.25	0.16	0.27	0.26	0.50	1.21	1.24	0.80	0.42

(D) – dam, (US) – upstream, (DS) – downstream.

Ablabesmyia and *Larsia* (Chironomidae) were also representative, contributing respectively with 7.8%, 5.0% and 5.0% of the total entomofauna. Student's *t*-test showed no significant differences between the segments sampled ($p > 0.05$), indicating no apparent interference of habitat disruption in the aquatic insect community. The cluster analysis showed differences in insect fauna between the segments, delimiting three groups: one gathering in the stretches near the headwaters of the stream (USI-DSII), another in the intermediate section (USIII-DSIII) and the last found in the posterior segments of the stream (USIV-DSV) (see Figure 2). A small reduction in the Shannon diversity (as shown in Table 5) was observed, as well as in the richness in the segments downstream of the dams. The β diversity index showed the highest values in first upstream and downstream segments (USI to USIII) indicating low similarity between these forested portions of stream. The remaining segments (DSIII to DSV) showed

Table 2. Number of specimens and functional feeding categories for Odonata, Ephemeroptera and Hemiptera taxa in upstream and downstream segments of the five dams in the Ribeirão das Anhumas. (FFC) functional feeding categories; (C) collectors; (Sh) shredders; (Sc) scrapers; (Pr) predators. (D) – dam, (US) - upstream, (DS) – downstream.

Genus	FFC	Segment										Total
		DI		DII		DIII		DIV		DV		
		USI	DSI	USII	DSII	USIII	DSIII	USIV	DSIV	USV	DSV	
Odonata												
Limnetron Förster	Pr	1	-	-	-	-	-	-	3	-	-	4
Argia Rambur	Pr	2	1	1	-	-	-	-	-	-	-	4
Archeogomphus Williamson	Pr	8	-	7	2	1	-	1	-	-	1	20
Hetaerina Hagen	Pr	2	6	1	1	1	-	1	35	2	3	52
Heliocharis Selys	Pr	-	-	9	3	-	-	-	-	-	-	12
Epipleoneura William	Pr	-	-	-	-	-	1	-	-	-	-	1
Idioneura Sekys	Pr	-	-	-	-	-	-	-	1	2	6	9
Neoneura Selys	Pr	-	-	-	-	3	-	12	38	-	-	53
Cannaphila Kirby	Pr	20	-	-	-	-	-	1	-	-	-	21
Libellula Linnaeus	Pr	17	1	3	1	-	-	7	23	12	11	75
Orthemis Hagen	Pr	-	-	-	20	1	-	3	-	-	-	24
Ephemeroptera												0
Caenis Stephens	Co	1	-	-	-	4	-	15	10	-	-	30
Miroculis Edmundis	Co	20	-	-	-	-	-	-	-	-	7	27
Paracleodes Day	Co	-	-	-	-	-	-	10	-	7	-	17
Hemiptera												0
Tenagobia Bergroth	Sc	-	1	-	-	-	-	-	-	-	16	17
Paravelia Polhemus	Pr	-	-	-	-	-	-	-	-	-	1	1
Rhagovelia Mayr	Pr	2	-	1	-	-	-	-	-	2	-	5
Brachymetra Mayr	Pr	1	-	1	-	-	-	-	-	-	-	2
Charmatometra Kirkaldy	Pr	-	-	3	1	-	-	-	-	-	-	4
Curicta Stål	Pr	-	1	-	2	-	-	-	-	-	-	3
Ranatra Fabricius	Pr	-	1	-	-	-	-	-	-	-	-	1
Mesovelia Mulsant & Rey	Pr	-	-	2	-	-	-	-	-	-	-	2
Neoplea Esaki & China	Pr	-	-	-	-	-	-	-	3	-	-	3
Abedus Say	Pr	1	-	-	1	-	-	-	2	-	-	4
Belostoma Laitrelle	Pr	1	-	-	2	1	-	-	4	-	-	8
Horvathinia Montandon	Pr	1	-	-	1	-	-	-	-	-	-	2
Weberiella De Carlo	Pr	-	11	1	2	-	-	-	-	-	-	14
		77	22	29	36	11	1	50	119	25	45	415

low β diversity, indicating great similarity in the insect communities of this section (see Figure 3). The β diversity when comparing forested and non-forested stretches also indicated low values in non-forested stretches, respectively 9.04 and 1.74.

The analysis of functional feeding categories indicated predominance of predators and collectors in all segments analysed (as shown in Table 5). The PCA analysis also delimited the first upstream segments (USI, USII and USIII) (see Figure 4) where the participation of shredders and scrapers was more representative, in the other segments these guilds were reduced or absent.

5. Discussion

The Serial Discontinuity Concept (SDC) created by Ward and Stanford (1983), has served as a basis for studying the interference of the construction of dams in aquatic invertebrate communities. This study highlights the changes caused by dams on biotic communities such as the reduction in abundance or even the elimination of some species, while others may arise or increase their abundance after stabilization of the flow in the river bed. The wildlife that inhabits the stretches downstream of these impoundments has to adapt to new environmental conditions (Ward and Stanford, 1979; Pardo et al., 1998). In studies that analysed the changes resulting from the construction of small dams on the community of aquatic invertebrates, significant differences in richness and Shannon diversity were commonly not found (Chessman et al., 1987; Maroneze et al., 2011). However, after the construction of spillways, significant differences in abundance and differences in the functional feeding group structure, with the replacement of filter-collectors by gathering-collectors were observed (Maroneze et al., 2011). It can be inferred

Table 3. Number of specimens and functional feeding categories of Trichoptera, Plecoptera, Coleoptera and Lepidoptera taxa in upstream and downstream segments of the five dams in the Ribeirão das Anhumas. (Legends as in Table 2).

Gênero	FFC	Segment										Total
		DI		DII		DIII		DIV		DV		
		USI	DSI	USII	DSII	USIII	DSIII	USIV	DSIV	USV	DSV	
Trichoptera												
Macronema Pictet	Co	-	1	19	4	-	-	-	-	-	1	25
Macrostemum Kolenati	Co	-	-	-	-	18	45	-	-	3	7	73
Marilia Müller	Sh	5	3	1	12	22	1	2	1	-	-	47
Alterosa Blahnik	Co	1	-	-	-	-	-	1	7	-	-	9
Chimarra Stephens	Co	-	-	-	-	-	-	-	1	-	-	1
Mortoniella Ulmer	Sh	5	1	-	-	-	-	-	-	-	-	6
Philloicus Müller	Sh	-	3	-	-	-	-	-	-	-	-	3
Grumicha Müller	Co	-	-	1	-	9	1	-	-	-	-	11
Cynerllus Banks	Co	-	-	1	-	-	17	7	-	3	3	31
Cernotina Ross	Co	-	-	-	-	-	7	8	3	1	3	22
Nectopsyche Müller	Sh	-	-	-	1	-	-	-	-	-	-	1
Oecetis McLachlan	Sh	-	-	-	-	-	-	-	1	3	-	4
Triplectides Kolenati	Sh	-	-	6	1	4	-	-	-	-	-	11
Hydroptila Dalman	Sc	-	-	-	-	-	-	-	2	19	-	21
Plecoptera												
Kempnyia Klapálek	Pr	1	-	2	-	2	10	-	-	-	-	15
Coleoptera												
Gyretes Brullé	Pr	7	19	-	17	-	-	-	2	-	-	45
Dryops Olivier	Pr	1	-	3	2	-	-	-	-	-	-	6
Anticura Spangler	Pr	-	6	-	-	-	-	-	-	-	-	6
Hydrocanthus Say	Pr	-	17	-	-	-	-	-	-	1	-	18
Bidessonotus Régimbart,	Pr	-	-	-	1	-	-	-	3	-	-	4
Copelatus Erichson	Pr	2	-	-	1	-	-	-	-	-	-	3
Derovatellus Sharp	Pr	-	-	-	1	-	-	-	-	-	-	1
Hydrovatus Motschulsky	Pr	-	-	1	-	-	-	-	-	1	-	2
Notaticus Zimemrman	Pr	-	-	-	-	-	-	-	1	-	-	1
Ranthus Lac	Pr	-	-	1	-	-	-	-	-	-	-	1
Austrolimnus Carter & Zeck	Sc	-	-	2	4	-	1	-	-	-	-	7
Heterelmis Sharp	Sc	-	3	6	1	-	1	-	-	-	-	11
Microcylloepus Hinton	Sc	-	-	2	5	-	1	-	-	-	-	8
Stegoelmis Hinton	Sc	-	-	-	-	1	1	-	-	-	-	2
Xenelmis Hinton	Sc	-	-	1	-	3	-	-	-	-	-	4
Lepidoptera												
Parapoynx Guenée	Sh	-	-	-	-	-	-	3	-	-	-	3
Synclita Lederer	Sh	-	1	-	-	-	-	-	-	-	-	1
		22	54	46	50	59	85	21	21	31	14	403

that the discontinuity of small dams in the Ribeirão das Anhumas did not have an impact on the aquatic insect fauna, as the results were similar to the studies mentioned above. However, the environmental characteristics of the surrounding segments as well as the hydrological channel of the stream were important factors influencing the community composition of aquatic insects in the continuum of Ribeirão das Anhumas.

According to Heino (2009), the structure of aquatic insect communities changes in a spatial scale according to the substrate modification. Consequently, the substrate provided by the riparian vegetation (leaf, wood) proved to be the environmental factor that most influenced in the diversity of insects (Bispo et al., 2002; Song et al., 2009). The dense cover vegetation in segments USI, DSI, USII and DSII certainly contributes to more environmental heterogeneity in these areas, favoring a highest richness, Shannon index and β diversity in the continuum. Streams with high input of larger organic particles (leaves, branches, trunks and fruits), generally promote a great availability of niches, favoring the establishment of numerous species (Straka et al., 2012).

Table 4. Number of specimens and functional feedings categories of Diptera in upstream and downstream segments of the five dams in the Ribeirão das Anhumas. (Legend as in Table 2).

Genus	FFC	Segment										Total
		DI		DII		DIII		DIV		DV		
		USI	DSI	USII	DSII	USIII	DSIII	USIV	DSIV	USV	DSV	
Culicoides Latreille	Pr	8	4	12	18	-	-	10	-	-	19	71
Simulium Latreille	Co	3	-	3	-	-	-	2	-	-	-	8
Limnophila Alexander	Pr	3	-	2	1	-	-	-	-	-	-	6
Tabanus Linnaeus	Pr	-	-	-	1	-	-	-	-	-	1	2
Asheum Sublette & Sublette	Co	-	-	1	1	-	-	-	-	-	12	14
Beardius Reiss & Sublette	Co	-	-	-	-	5	-	6	1	-	-	12
Cladopelma Kieffer	Co	-	-	-	-	-	-	1	-	-	-	1
Chironomus Meigen	Co	7	11	-	3	-	-	3	8	1	88	121
Chironomus detritricola Correia & Trivinho-Strixino	Co	42	-	-	-	-	-	-	-	-	-	42
Cryptochironomus Kieffer	Co	-	-	-	-	1	-	1	3	-	1	6
Endotribelos Grodhaus	Sh	25	-	2	-	5	-	1	-	1	-	34
Endotribelos sp. 2	Sh	-	-	21	2	3	2	2	-	-	-	30
Goeldichironomus Fittkau	Co	-	2	-	8	-	-	-	-	-	-	10
Parachironomus Lenz	Co	-	-	-	-	-	28	-	-	1	-	29
Pelomus Reiss	Co	-	1	12	12	-	2	-	-	1	-	28
Pelomus sp. 3	Co	-	-	-	-	-	-	-	-	4	-	4
Polypedilum Kieffer	Co	18	2	32	50	-	-	152	83	14	-	351
Stenochironomus Kieffer	Sh	5	1	10	1	2	3	-	-	1	-	23
Riethia Kieffer	Co	-	-	-	-	-	-	-	-	-	1	1
Caladomyia Säwedall	Co	2	9	2	-	2	4	-	-	2	2	23
Rheotanytarsus Thienemann & Bause	Co	-	-	1	3	-	2	1	-	2	-	9
Tanytarsus v. d. Wulp	Co	2	2	10	3	2	4	5	3	12	12	55
Tanytarsus caipira Trivinho-Strixino & Strixino	Co	14	3	2	2	-	-	-	-	1	-	22
Corynoneura Winnertz	Co	-	-	2	-	-	-	-	-	-	-	2
Cricotopus v. d. Wulp	Co	-	-	-	-	-	-	-	-	2	-	2
Gymnometriocnemus Goetghebuer	Co	-	-	1	-	-	-	-	-	-	-	1
Lopescladius Oliveira	Co	4	-	-	-	-	-	-	-	-	-	4
Nanocladius Kieffer	Co	1	6	1	1	-	1	-	-	2	-	12
Onconeura Andersen and Sæther	Co	2	-	3	2	-	-	1	-	-	-	8
Parametriocnemus Goetghebuer	Co	1	-	-	-	-	-	-	-	-	-	1
Paracladius Hirvenoja	Co	-	-	-	-	-	-	26	1	-	-	27
Procladius Skuse	Pr	-	-	-	-	9	-	1	-	2	-	12
Clinotanypus Kieffer	Pr	-	-	1	-	-	-	-	-	-	-	1
Coelotanypus Kieffer	Pr	-	-	1	-	40	1	22	13	5	-	82
Denopelopia Roback & Rutter	Pr	-	-	-	-	-	-	-	14	-	-	14
Djalmabaptista Fittkau	Pr	-	-	4	3	3	-	8	5	59	-	82
Fittkaumyia Karunakaran	Pr	-	-	-	-	-	-	-	-	-	1	1
Guassutanypus Roque & Trivinho-Strixino	Pr	27	1	-	-	-	-	-	-	7	-	35
Ablabemyia Johannsen	Pr	5	1	4	3	1	6	28	30	30	22	130
gr. *Thienemannimyia* Fittkau	Pr	-	4	-	-	-	-	-	-	-	-	4
Labrundinia Fittkau	Pr	-	2	2	-	-	16	-	-	-	-	20
Larsia Fittkau	Pr	4	72	-	16	7	15	21	-	1	1	137
Pentaneura Philippi	Pr	-	2	28	82	-	49	-	4	15	15	195
		173	123	157	212	80	133	291	165	163	175	1672

According to Vinson and Hawkins (1998), some hydraulic characteristics of the streams, such as increased water flow and decreased allochthonous input, as observed in the DSIII segment, can influence the reduction in quantity and quality of habitat. These variables changes, observed from segment DSIII, could explain the reduction of the Shannon and β diversity values in the continuum. This segment is classified as third order, with bed substrate composed by sand and rock, a feature that should have influenced in the reduction of diversity and the cluster grouping, separating it from the two first forested segments. Unlike the faunal composition of the forested segments, the absence of riparian vegetation and increased channel width and depth of the segments USIV, DSIV, USV and DSV, promoted a more similar faunal composition (lowest β diversity values), due to lower availability of niches and food resources.

The distribution of functional feeding groups in the longitudinal profile of the Ribeirão das Anhumas was similar to that obtained by Roque and Trivinho-Strixino (2001) in the Fazzari stream (São Carlos - SP), which were also dominated by predators followed by gathering-collectors. This may be related to low water velocity and accumulation of organic matter in areas of deposits in the stream beds, which allows the establishment of the predator group, facilitating the capture of prey. The ability to obtain and use fine organic matter as a food resource is a common behaviour of many larvae of Chironomidae (Berg, 1995). The availability of food resources is related to the continued rapid decomposition of leaf litter promoted by microbial activity in tropical streams (Dudgeon, 1982; Covich, 1988; Mathuriau and Chauvet, 2002; Dobson et al., 2003). Due to this increased availability of particulate organic matter (FPOM), many authors suggest that tropical streams have low participation of shredders (Dudgeon, 2000; Buss et al., 2002; Dobson et al., 2003), a fact also observed in this study. Although in the present study a decrease in abundance of some taxa with the decreasing cover vegetation was observed, the prevalence of some shredders and scrapers, as the chironomids larvae of *Stenochironomus* and *Endotribelos* and the Elmidae larvae (groups which are dependent of dead plant material as food resource and habitat), was noticed in the forested stretches (Borkent, 1984; Berg, 1995; Passos et al., 2003; Roque et al., 2005; Roque and Trivinho-Strixino, 2008; Corbi & Trivinho Strixino, 2008). The largest relative contribution of this feeding category in the segment DSIII was related to the presence of larvae of *Marilia* and also by the presence of woody debris in the shore of this stream segment. These groups of insect were absent in the non-forested segments USIV, DSIV, USV and DSV, and also in the stretches with submerged aquatic macrophytes, a possible resource of food for shredders and scrapers. Nevertheless the greater heterogeneity promoted by macrophyte beds (Albertoni and Palma-Silva, 2006) resulted in a slight increase of the diversity in these segments. The decrease of β diversity along the segments of Ribeirão das Anhumas was influenced by the reduction of these feeding groups. This result demonstrated the importance of the conservation of the riparian vegetation to maintain the integrity of the river.

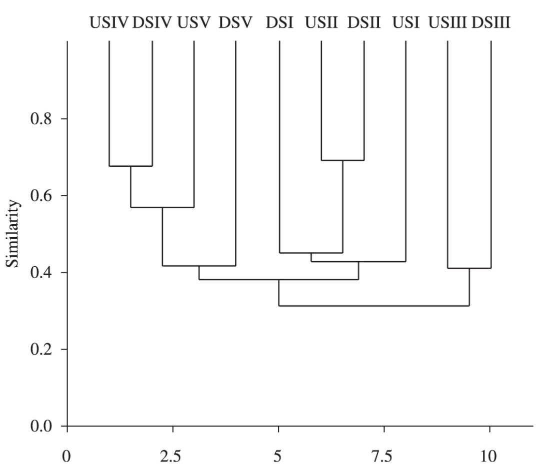

Figure 2. Dendrogram representing the similarity among insect fauna (Morisita, cophenetic correlation = 0.80) collected in upstream and downstream segments of the five dams of the Ribeirão das Anhumas. (Legend as in Figure 1).

Table 5. Main community characteristics of the aquatic insect in the upstream and downstream segments of the five dams in the Ribeirão das Anhumas. (Legend as in Table 1).

	Segments									
	DI		**DII**		**DIII**		**DIV**		**DV**	
	USI	**DSI**	**USII**	**DSII**	**USIII**	**DSIII**	**USIV**	**DSIV**	**USV**	**DSV**
Abundance	272	199	232	298	150	219	362	305	219	234
Taxa number	38	32	46	42	25	24	31	29	32	23
Shannon_H	3.02	2.54	3.18	2.72	2.57	2.40	2.35	2.54	2.66	2.30
Dominance_D	0.07	0.16	0.06	0.12	0.12	0.13	0.20	0.13	0.12	0.18
Equitability_J	0.83	0.73	0.83	0.73	0.80	0.76	0.68	0.75	0.77	0.73
Predators	41.91	74.87	38.79	61.07	46.00	44.75	31.77	59.34	63.47	34.62
Scrapers	1.84	2.51	4.74	3.36	2.67	1.83	0.00	0.66	8.68	6.84
Shredders	12.87	4.02	17.67	5.70	30.00	3.20	2.21	0.66	2.28	0.00
Collectors	43.38	18.59	38.79	29.87	21.33	50.23	66.02	39.44	25.57	58.55

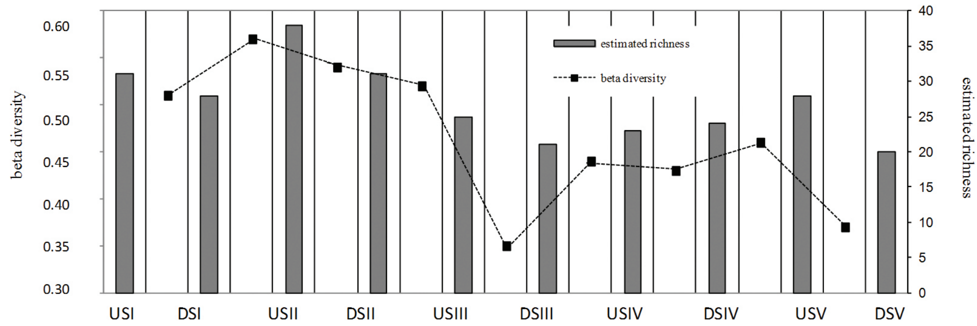

Figure 3. Taxa richness estimated by rarefaction curves and β diversity in the upstream and downstream segments of the five dams along the longitudinal profile of the Ribeirão das Anhumas. (Legend as in Figure 1).

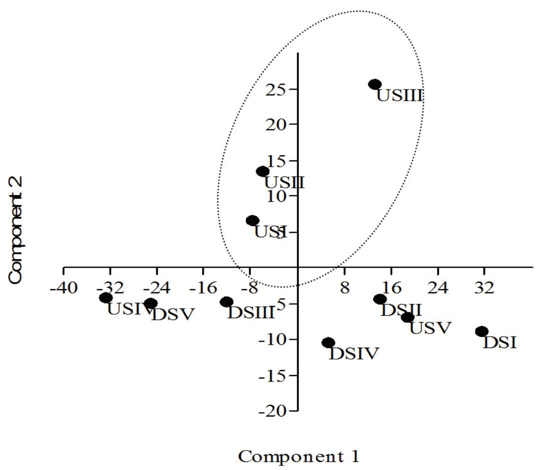

Figure 4. PCA analysis for insect functional feeding groups in the upstream and downstream segments of the five dams of the Ribeirão das Anhumas (component 1=74%; component 2= 24%). The delimited area indicates forested segments with greater contribution of shredder insects. (D) – dam, (US) – upstream, (DS) – downstream.

6. Conclusions

There were no significant differences in abundance and richness of aquatic insects between the upstream and downstream segments, indicating that the dams did not influence these variables. As the knowledge of the influence of discontinuity river promoted by dams in Brazil on the aquatic biota are still scarce, further studies are needed to obtain more definitive information about these impacts on aquatic insect community. Differences were observed in the functional feeding groups along the longitudinal profile wherein the participation of shredders and scrapers were present in the segments with preserved riparian vegetation. The higher input of CPOM arising of the riparian vegetation observed in the forested segments promoted higher heterogeneity of habitat, influencing higher values of Shannon index and β diversity for the aquatic insect community of the Ribeirão das Anhumas.

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