Chironomidae (Diptera) Larvae in streams of Parque Estadual de Campos do Jordão, São Paulo state, Brazil.

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ABSTRACT: Chironomidae (Diptera) larvae in streams of Parque Estadual de Campos do Jordão, São Paulo State, Brazil. The distribution of the Chironomidae larvae was analyzed in streams of Parque Estadual de Campos do Jordão, in Campos do Jordão-Brazil. The samples were collected with a Surber sampler in six stations. Forty-three taxa were identified belonging to the subfamilies Chironominae, Orthocladiinae and Tanypodinae. Analyses indicated aff. Pseudochironomus sp_1 as the most abundant genus, followed by Corynoneura, aff. Omisus and Thienemanniella. The highest taxa richness was found in Campo do Meio stream whereas the highest diversity, similarity and evenness indexes values were found in the Galharada stream and its tributary. Multivariate Correspondence Analyses revealed that the dominant entomofauna was associated with the sampling sites, and their ordination was correlated with possible anthropic influences.
Key-words: Chironomidae, Diptera, larvae, aquatic insects, streams.

RESUMO: Larvas de Chironomidae (Diptera) em córregos do Parque Estadual de Campos do Jordão, São Paulo, Brasil. Este trabalho teve como objetivo o estudo da distribuição das larvas de Chironomidae nos Córregos Galharada, Campo do Meio e Casquilho do Parque Estadual de Campos do Jordão (PECJ), Campos do Jordão-SP. As larvas foram coletadas com amostrador tipo Surber em seis pontos de coleta e foram identificados 43 táxons pertencentes às subfamílias Chironominae, Orthocladiinae e Tanypodinae. As análises quantitativas indicaram aff. Pseudochironomus sp_1 como gênero mais abundante, seguido de Corynoneura, aff. Omisus e Thienemanniella. A maior riqueza de táxons foi registrada no córrego Campo do Meio. Entretanto, no córrego Galharada e seu afluente foram obtidos os maiores valores dos índices de diversidade, equidade e similaridade. Ainda, os resultados da Análise de Correspondência indicaram ser a entomofauna dominante associada aos pontos de coleta e o ordenamento dos mesmos pode ser interpretado como possíveis influências antrópicas.
Palavras-chave: Chironomidae, Diptera, larvas, insetos aquáticos, córregos.

Introduction

The family Chironomidae (Diptera) constitutes an important group of aquatic insects, there are estimated to be as many as 15,000 species. They are the most widely distributed and frequently the most abundant insects in freshwater environments, including temporary aquatic systems (Cranston, 1995). Their larvae often display high density and diversity in most habitats (Coffman & Ferrington, 1984).

Little is known about the richness of species in the Neotropical region. Only 709 species belonging to 155 genera have been reported (Spies & Reiss, 1996). In Brazil 168 species have been reported, distributed in 32 genera (Trivinho-Strixino & Strixino, 1999). Several authors have investigated the distribution and occurrence of Chironomidae genera in some regions of Brazil (Fittkau, 1971; Nessimian & Sanseverino, 1995; Serrano et al., 1998; Marques et al., 1999; Stur et al., 2000). In São Paulo State, according to Roque et al. (2000), most of the studies on the Chironomidae ecology in low order streams were

carried out in the mid-western region of the state, pointing to a highly diversified fauna. However, these studies still offer little information, what suggests the need for new faunal surveys. Also, according to Fittkau (2001), a large part of the species has yet to be discovered.

The objective of this study was to analyze the structure and distribution of Chironomidae (Diptera) larvae in low order streams in the Parque Estadual de Campos de Jordão (PECJ), in Campos de Jordão, São Paulo State, Brazil, considering the scarcity of studies in the Serra da Mantiqueira and the peculiarities of this region, such as higher altitudes and mild temperatures throughout the year, which distinguish it from other regions of São Paulo State.

Material and methods

Study Area

The Parque Estadual de Campos de Jordão is located in the municipality of Campos de Jordão, São Paulo State, Brazil, between 22°30' and 22°41'S and 45°27' and 45°31'W. It consists of 8,341.86 ha, with an average altitude of 1,650m (Schroeder-Araujo et al., 1986) (Fig. 1).

According to Troppmair (2000), the annual average temperature is 16-18°C, with maximum 24°C and minimum 6-8°C. The weather is subtropical of altitude (Cfa) and the annual precipitation rate is high (1,700 to 2,000mm).

The watercourses in this park belong to the Sapucaí-Guaçu river basin, of which the streams in this study are 1st to 4th order tributaries. Six collection sites were established (Fig.1): A – a tributary of the Galharada stream; B – the Galharada stream, near the mouth of this tributary; C – downstream of the waterfall in the Galharada stream; D – the Galharada stream, former camping site; E - the Campo do Meio stream, near the mouth of the Sapucaí-Guaçu river; and F – the Casquilho stream.

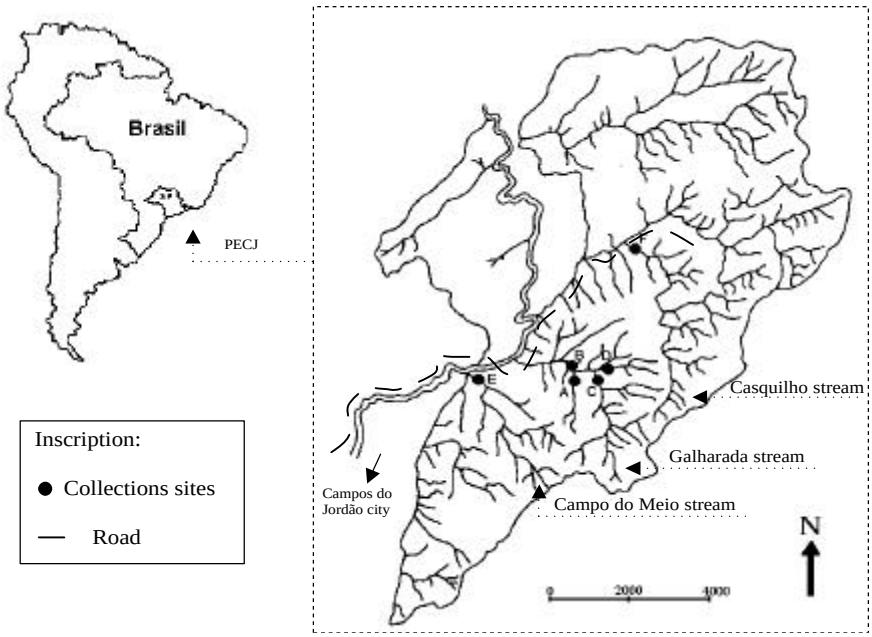

Figure 1: Hidrology map of Parque Estadual de Campos do Jordão, São Paulo State, Brazil, showing the location of the sites: A – tributary of Galharda stream; B, C, D – Galharada stream; E - Campo do Meio stream; and F - Casquilho stream (modified from Schoeder-Araujo et al., 1986).

Environmental Variables

In each site measures were taken of dissolved oxygen, pH, turbidity, electric conductivity, and water and air temperature, by means of a U10 Horiba multissensor.

The water column depth was measured by means of a centimeter-graded ruler. The water velocity and discharge were estimated according Lind (1979).

Fauna sampling and taxonomic identification

The fauna was collected on three occasions (September and November 2002, and February 2003) by means of a Surber sampler (0.1m² area and 500mm mesh size). The collected material was fixed in the field with 98% ethanol. In the laboratory, larvae were handpicked using a stereomicroscope and preserved in vials with 70% ethanol. The larvae were identified to at least genus or morphotypes: "type" to genus and "sp" to species.

Data analysis

The specimens collected on the three occasions were analyzed together, but the results were submitted to quantitative analyses separated by sampling site. The analyses were: density; taxonomic richness; Shannon-Wiener diversity (H') and evenness (E) indexes (Margurran, 1988). Differences in community structure between the 2 sites were explored using multivariate statistics. Were used Statistica for Windows – 4.2 version (Statsoft, Inc., 2000) to do a cluster analysis using the unweighted pair-group method using arithmetic averages (UPGMA) and the Bray-Curtis similarity applying the Multiple Grouping Analysis. An exploratory analysis was also carried out so as to detect possible faunal distribution patterns by using the multivariate Correspondence Analysis (Jongman et al., 1995). This analysis considered only the 23 taxa presenting at least 10 specimens.

Results

The streams are protected by riparian vegetation and characterized by rocky beds and clear water, high current velocity (0.4-0.6m/s), temperature between 15 and 16°C, low turbidity (1.6 to 7.7NTU), low electric conductivity (11.0 to 14.0mS.cm^{-1}), pH ranging from 5.0 to 6.0, and high dissolved oxygen concentrations over 9.1mg.L^{-1} (Tab. I).

Table I: Environmental variables of sites in Galharada, Campo do Meio e Casquilho streams of Parque Estadual de Campos do Jordão, São Paulo State, Brazil.

Variables	Tributary of Galharada stream	Galharada stream			Campo do Meio stream	Casquilho stream
	site A	site B	site C	site D	site E	site F
Elevation (m)	1554	1554	› 1584	1584	1500	1535
Latitude South	22°41'33"	22°41'33"	22°41'34"	22°41'29"	22°41'35"	22°39'49"
Longitude West	45°27'55"	45°27'55"	45°27'38"	45°27'42"	45°29'23"	45°27'04"
Stream Order	1	3	3	3	2	4
Vegetation	riparian zone	riparian zone	riparian zone	riparian zone	riparian zone	riparian zone
Width (m)	1.5	3.0	3.4	3.3	3.0	3.0
Water depths (m)	0.1	0.4	0.3	0.3	0.3	0.4
Air temperature (°C)	17.0	17.0	11.0	20.0	18.0	17.0
Water temperature (°C)	16.0	16.0	15.0	15.0	16.0	16.0
Conductivity (mS.cm^{-1})	12.0	11.0	14.0	11.0	13.0	11.0
Oxygen (mg.L^{-1})	9.2	9.1	9.6	9.8	9.1	9.1
Turbidity (NTU)	4.1	7.7	12.0	1.8	1.6	7.7
pH	5.2	6.0	5.0	5.5	5.2	6.0
Current velocity (m/s)	0.4	0.6	0.5	0.4	0.4	0.6
Minimum discharge (m^3/s)	0.05	0.4	0.3	0.2	0.2	0.4

The analysis of the 1,523 Chironomidae larvae collected at the six sampling sites showed 43 taxa (Tab. II). The Campo do Meio stream (site E) presented the highest richness (33 taxa), followed by the Galharada stream (sites B, C and D; 26, 25 and 25 taxa, respectively), the Casquilho stream (site F; 22 taxa), and the tributary of the Galharada stream (site A; 17 taxa).

The diversity and evenness indexes (Tab. II) were higher at site B (3.82; 0.81), site C (3.92; 0.84) and site D (4.12; 0.88). At site E, although the richness value was higher, the diversity and evenness indexes were lower (H'= 3.11; E = 0.61) due to the high density of aff. Pseudochironomus sp_1 (301 specimens out of 655).

Table II: Taxonomy composition, density values, taxonomic richness, Shannon's diversity and evenness indexes of the Chironomidae larvae in sites: A – tributary of Galharda stream; B, C, D – Galharada stream; E - Campo do Meio stream; and F – Casquilho stream of Parque Estadual de Campos do Jordão, São Paulo State, Brazil.

Variable	Tributary Galharada stream	Galharada stream			Campo do Meio stream	Casquilho stream
	site A	site B	site C	site D	site E	site F
Chironominae						
Beardius		6	1		2	2
Chironomini tipo1		3	11		5	
aff. Cryptochironomus			1		2	
Cryptochironomus sp_1					3	
Cryptochironomus sp_2					2	
aff. Endotribelos		1		1		
Nilotanypus					1	1
Nilothauma				1	7	
Nimbocera sp	13	13	4	21	15	5
aff. Omisus	43	40	32	9	9	10
Oukuriella				1		
Parachironomus					2	
Paratendipes						1
Phaenopsectra			4			1
Polypedilum	1	3	11	13	27	9
aff. Pseudochironomus sp_1	3	17	15	21	301	31
aff. Pseudochironomus sp_2		3	2	4	1	3
Rheotanytarsus	13	9	20	11	41	4
Saetheria					4	
Stempellinella			3	2	1	
Stenochironomus	3	3	2	1	2	
Tanytarsini type1	7	2		6	4	1
Tanytarsini type2	1	9	6	6	8	2
Tanytarsini type3		2			2	
Tanytarsini type4					1	19
Tanytarsini type5		3	2		1	3
Tanytarsini type6	1					
Tanytarsini type7		1				
Tanytarsus	2	1	1			
Xestochironomus			1	1		1
Zavreliella		6	1	14		
Orthocladiinae						
Corynoneura	34	37	20	10	28	21
Cricotopus				1	1	
Gymnometriocnemus				1		
Lopescladius					9	2
Nanocladius	10	2	14	4	2	
Parametriocnemus	9	5	12	4	43	7
aff.Thienemanniella		5		2	12	4
Thienemanniella	17	3	12		72	
Tanypodinae						
Ablabesmyia	2	1	1	12	3	
Djalmabatista	1	3	1	10	35	9
Larsia	1	20	1	8	5	2
Pentaneura		2	18	8	4	1
Density of larvae	161	200	196	172	655	139
Taxonomy Richness	17	26	25	25	33	22
Shannon's Diversity (H')	3.19	3.82	3.92	4.12	3.11	3.65
Evenness (E)	0.78	0.81	0.84	0.88	0.61	0.82

Aff. Omisus (26.7%) and Corynoneura (21%) were dominant at site A; aff. Omisus (20%) and Corynoneura (18.5%) at site B; aff. Omisus (16.3%), Corynoneura and Rheotanytarsus (both 10.2%) at site C; Nimbocera sp and aff. Pseudochironomus sp_1 (both 12.2%) at site D; and aff. Pseudochironomus sp_1 at site E (46%) and site F (22.3%) (Tab. II).

The multivariate cluster analysis using Bray-Curtis similarity (Fig. 2) showed three groups: Group I is constituted of sites A, B and C; Group II comprises sites D and F; and Group III is represented by site E.

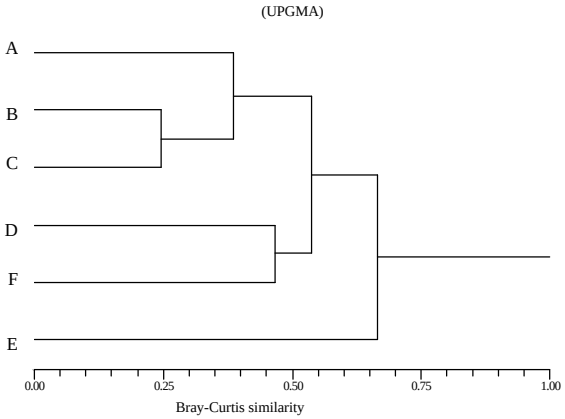

Figure 2: The multivariate cluster analysis by Bray-Curtis similarity between Galharada stream (sites B, C and D) and its tributary (site A), Campo do Meio stream (site E) and Casquilho stream (site F) of Parque Estadual de Campos do Jordão, São Paulo State, Brazil.

The multivariate Correspondence Analysis shows the spatial distribution of Chironomidae larvae in the PECJ streams (Fig. 3), whose dimensions 1 and 2 explain 57.88% and 15.74% of the total data variability, respectively. This analysis allows the association of the more dominant taxa with the sites, grouping sites A, B and C because of the predominance of aff. Omisus and Corynoneura. Ablabesmyia, Pentaneura and Zavreliella were associated with site D. Sites E and F fall in the same quadrant due to the density of aff. Pseudochironous sp1. This analysis shows the anthropic influence on the Casquilho and Campo do Meio streams.

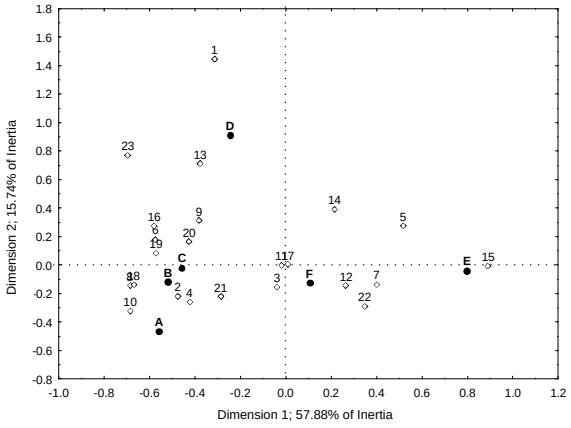

Figure 3: The multivariate Correspondence Analysis (Dimension 1 and 2) - Galharada stream (sites B, C e D) and tributary (site A), Campo do Meio stream (site E) and Casquilho stream (site F) of Parque Estadual de Campos do Jordão, São Paulo State, Brazil. Taxa: 1-Ablabesmyia; 2-Beardius; 3-Chironomini tipo1; 4-Corynoneura; 5-Djalmabatista; 6-Larsia; 7-Lopescladius; 8-Nanocladius; 9-Nimbocera sp; 10-aff.Omisus; 11- aff.Thienemanniella; 12- Parametriocnemus; 13-Pentaneura; 14-Polypedilum; 15-aff.Pseudochironomus sp_1; 16-aff.Pseudochironomus sp_2; 17-Rheotanytarsus; 18-Stenochironomus; 19-Tanytarsini tipo1; 20-Tanytarsini tipo2; 21-Tanytarsini tipo4; 22-hienemanniella; 23-Zavreliella.

Discussion

This work shows that Chironominae larvae are dominant (in specimen density and taxa richness) at the sampled sites on the PECJ streams, which have rhithral characteristics (high altitude, high current velocity and cool water with high dissolved oxygen concentration, and coarse substratum), differing from Pinder's (1995) observations that indicate that Orthocladiinae predominate in streams with these characteristics. The dominance of Chironominae is also reported by other studies about Brazilian lotic systems, such as Roque & Trivinho-Strixino (2000) in streams of the Parque Estadual do Jaraguá, and Sanseverino & Nessimian (2001) in the streams of Mata Atlântica, Rio de Janeiro.

A high taxonomic richness was observed in the three streams studied as compared to other data in the literature, which confirms the hypothesis that conserved forest areas support more environmental heterogeneity and, consequently, a high taxonomic diversity. Roque & Trivinho-Strixino (2000) investigated the Chironomidae fauna in the Parque Estadual do Jaraguá (São Paulo State) and observed that higher taxonomic richness occurred in areas with riparian vegetation, showing its importance in maintaining species diversity.

Although riparian vegetation protects the PEJC streams, two phenomena were observed. The sites of Galharada stream are located in a more central area of the park and the anthropic influences are minimized. Thus, the results showed high diversity and evenness indexes at the sites of this stream, which reflects higher stability of the community structure. On the other hand, the Campo do Meio and Casquilho sites, located near roads, are exposed to more disturbances. In addition, the Campo do Meio site is near the park border and a cluster of houses are located by its banks upstream, so less protected by riparian vegetation, and close to its mouth into the Sapucaí-Guaçu river, which is burdened with organic and inorganic pollutants from the town of Campos de Jordão. Hence, the diversity and evenness index values in these streams are lower due to the dominance of aff. Pseudochironomus sp_1, in spite of the fact that the values obtained may be considered as good when compared to the data presented by other authors (Henriques-Oliveira et al., 1999) in studies also carried out in preserved areas protected by riparian vegetation.

Spatial analysis results show higher similarity between sites A, B and C, where aff. Omisus, Corynoneura and Nimbocera prevailed. Site D falls apart from the remaining ones because Polypedium and aff. Pseudochironomus sp_1 were predominant. All these sites are protected by exuberant vegetation, despite site D being located near a former camping site so its vegetation is still recovering.

Sites E and F were characterized by the dominance of aff. Pseudochironomus sp_1 and Rheotanytarsus. They constituted a group apart from the Galharada sites indicating they are more exposed to anthropic interferences.

The fact that the streams are located in a forested area (PECJ) provides more spatial heterogeneity (e.g., in terms of water current velocity, substratum particle size and quality), and favour less variation in the amplitude of environmental factors (e.g., water temperature, dissolved oxygen). According Coffman (1995), the maximally heterogeneous streams for the greatest number of variables are likely to be associated with the greatest species richness. However, the results showed during all the collections, more faunistic heterogeneity in streams with preserved riparian vegetation instead than in streams situated near roads or the edge of the park. Its important emphasize the necessity of a conservation strategy to minimize anthropic influences.

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