Verh. Internat. Verein. Limnol. | 28 | 1229–1235 | Stuttgart, October 2002

Chironomid composition from drift and bottom samples in a regulated north-Patagonian river (Rio Limay, Argentina)

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Introduction

The Limay River is an effluent of the Nahuel Huapi Lake, located at 71° 72' W and 56° 75' S in Rio Negro Province, and draining an area of 36,400 km^2. Together with the Neuquen River, it forms a vast catchment area with the Rio Negro in northern Patagonia and discharges into the Atlantic Ocean. It receives important discharge flows as a consequence of the glacial Andean regime (mean value 726 m^3/s) (BONETTO & WAIS 1995). Along its west–northeast course (Neuquen Province), many dams and reservoirs have been constructed for the purpose of hydroelectric power generation.

The aim of this study was to examine the faunistic composition and spatio–temporal distribution of the Chironomidae along the study area during 1996–1998. The Chironomidae were frequently abundant among the benthic macroinvertebrate communities monitored (RODRIGUES CAPÍTULO & PAGGI 1998). The research was carried out at the Limay River section located between Piedra del Aguila Dam (40° 20' S and 70° 10' W) and El Chocon Dam (39° 30' S and 69° 00' W) as part of the Biomonitoring Program initiated as a result of the Study of Environmental Impact performed following the implementation of the Water Managements Flexibilization Rules of Piedra del Aguila Hydroelectric Power Station (GABELLONE & SARANDON 1996).

This research was supported by the Catchment Interjurisdictional Authority (AIC) Rio Negro, Neuquen Provinces.

Material and methods

Study area

The selected section of the Limay River (Fig. 1) is characterized by having a well-defined main river bed with steeply sloping right margins, and left margins with a gradual slope and flow. Many secondary branches anastomose and some of them may be isolated under low water discharge conditions, becoming temporary lentic environments. The alluvial valley was approximately 800 km^2.

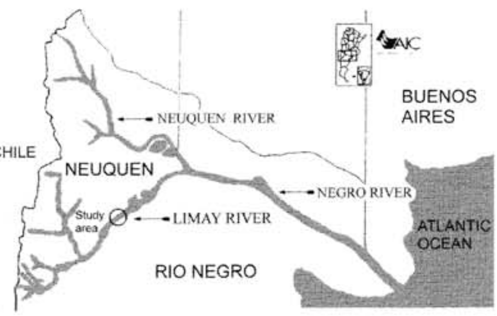

Fig. 1. The study area in the Limay River and the Rio Negro catchment.

The physico-chemical water characteristics were defined by a low degree of mineralization, low conductivity (<60 μS/cm), a predominance of bicarbonates and calcium ions and a total alkalinity below 30 mg/L, and chlorophyll *a* <1 mg/m^3. These characteristics, together with the snow–pluvial water source, are oligotrophic (CONZONNO 1981). The river is located in a desert area with xerophile vegetation and shrubby bushes.

Sample collection and general procedures

Seven sample sites were selected as follows: four sites in the Taux zone, 70 km downstream of the Piedra del Aguila Dam: (1) Taux main channel (TP); (2) Taux intermittent (TI) – a river branch (700–800 m^3/s flow capacity when active) with an island (35–40 m in width) mid-stream; (3) Taux separate (TS) isolated at low water levels with a riverbed >1 m in width colonized by macrophytes in summer and containing low levels of organic matter; and (4) Taux ford (TV) distant from the main river bed, with unique physico–chemical features, such as conductivity (487 μS/cm). Three sites at the Picasa zone, 82 km downstream of Piedra del Aguila Dam, with diversified river beds and many secondary branches:

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(5) Picasa main channel (PP); (6) Picasa intermittent (PI) deeper (1–1.2 m in February 1997) and narrower (20 m) than TI; and (7) Picasa separate (PS) shallower and narrower than TS, active at low discharges but dries up easily when disconnected, with low slopes and a flat bottom (SARANDON & GAVIÑO NOVILLO 1997).

The samples were taken with an Ekman dredge (225 cm^2) at locations with fine sediments, and with an active and passive Surber sampler operated for 15 min at locations with coarse substrates. Larvae were cleared in 10% KOH and mounted on chloral hydrate or Euparal slides (also pupal exuviae) for OM observations; all of the material was identified following the methods of BRUNDIN (1966) and WIEDERHOLM (1983, 1986).

Density (ind./m^2), Shannon diversity (H'), richness (R_1) and evenness (E_1) were calculated at each sample site, in addition to the mean values over the sampling period (Table 1). Sites, physico-chemical features, (BASSANI & TAMBUSSI 1997) (Table 2) and species ordination were performed by means of PCA analysis to examine the ecological interrelationships between the sites.

Results and discussion

Eighteen chironomid species belonging to five subfamilies were collected. Orthocladiinae and Chironominae showed the greatest species richness (six taxa), followed by Tanypodinae (four), Diamesinae and Prodiamesinae (recorded for the first time in Argentina) (one). Orthocladiinae were present in all sampling sites as were Chironominae (except in PS); Tanypodinae

Table 1. Spatial distribution (mean values) of density, richness (R_1), Shannon diversity (H') and evenness (E_1) of the species.

	Sample sites						
Taxa	TP	TI	TS	TV	PP	PI	PS
Tanypodinae							
Apsectrotanypus sp.		60		3			
Ablabesmyia reissi		297	244	35			
Djalmabatista lacustris		239	127	90			
Pentaneura sp.					2		
Diamesinae							
Limaya cf. *longitarsis*	3	5		3	13		9
Prodiamesinae							
Monodiamesa sp.		146		108			
Orthocladiinae							
Cricotopus sp. 1	118	67	287	72	165	63	105
Cricotopus patagonicus	5		129	3	1	0	53
Eukiefferiella sp.	19	5	125	57	55	46	105
Lopescladius sp.	6	3					
Thienemanniella desertica			19	15	28	37	39
Thienemanniella sp. 1					0		
Chironominae							
Cryptochironomus sp.			83	100			
Dicrotendipes embalsensis			192	2	7		
Paralauterborniella sp.				2			
Pseudochironomus sp.						3	
Rheotanytarsus sp.	11	29	76	26	30		
Tanytarsus sp.		60		29			
Total density	159	911	1282	544	301	149	311
R_1	0.79	1.17	1.12	1.90	1.23	0.6	0.7
H'	0.84	1.73	2.03	2.12	1.37	1.15	1.4
E_1	0.52	0.79	0.92	0.83	0.66	0.83	0.87

Table 2. Physico–chemical features of the sampling sites in the Limay River.

	Sampling sites						
Parameters	TP	TI	TS	TV	PP	PI	PS
pH	7.72	7.61	7.93	7.79	7.83	7.63	7.74
T (°C)	11.83	11.99	11.23	11.95	11.33	11.23	11.29
Conductivity (µS/cm)	21.29	22.33	22.63	169.62	20.78	21.27	21.93
OD	10.66	10.08	11.19	9.96	10.21	9.82	9.45
Turbidity	6.51	10.5	8.78	9.46	5.73	9.99	7.46
Flow (m/s)	2.1	0.74	0.45	0.7	2.29	0.72	0.7
Dominant substrate	boulder + sand	sand	boulder + sand	gravel + sand	sand	gravel + sand	gravel + sand

were mainly found in TI, TS and TV; Prodiamesinae were found in TI and TV; and Diamesinae were present in all sampling sites (except in TS and PI) (Table 1). The presence of these species varied throughout the sampling period.

The mean values of richness (R_1) ranged from 0.6 to 1.90, evenness (E_1) from 0.52 to 0.92, and Shannon diversity (H') from 0.84 to 2.12. TP showed the lowest values of H' (November 1997) and E_1, and PI showed the lowest values of R_1. The highest values of H' and R_1 were found at TV, and TS exhibited the highest values of total density and E_1 (Table 1).

The water discharges varied from a minimum in February–May 1997 (230–500 m^3/s) to a maximum in August 1997 (1000–1400 m^3/s), with small variations of water discharge (700 m^3/s) between November–December 1997 and February–April 1998, (Figs. 2 and 3).

TS had the greatest species abundance, with *Ablabesmyia reissi* (2074 ind./m^2), *Cricotopus* sp.1 and *Dicrotendipes embalsensis* (1555 ind./m^2) in December 1997, followed by TI with *Ablabesmyia reissi* and *Djalmabatista lacustris* (1620 ind./m^2) in February 1998, and *Ablabesmyia reissi* (1050 ind./m^2) and *Monodiamesa* sp. (1316 ind./m^2) in April 1998.

Species abundance (*Monodiamesa* sp., 900 ind./m^2 and *Cryptochironomus* sp., 743 ind./m^2) was lower in TV, but it had the highest diversity (H', 1.86) and richness (R_1, 1.08) (number of taxa, eight) in August 1997.

TP showed low species abundance compared with the other Taux sample sites during the same sampling period except for *Cricotopus* sp.1 (634 ind./m^2) in June 1997. Only six species (*Cricotopus* sp.1, *Cricotopus patagonicus, Eukiefferiella* sp., *Limaya* cf. *longitarsis, Rheotanytarsus* sp., *Lopescladius* sp.) were common throughout the sampling period. H' ranged from 0.23 to 1.09.

PS recorded the highest species abundance, with *Cricotopus* sp. 1 dominating (444 ind./m^2), followed by *Eukiefferiella* sp. (443 ind./m^2), *Cricotopus patagonicus* (287 ind./m^2) and *Thienemanniella desertica* (130 ind./m^2) in February 1997. *Limaya* cf. *longitarsis* was present in low densities (25–59 ind./m^2) in June and December 1997. The lowest values of diversity and density, recorded in May 1997, coincided with the lowest water discharge and the disconnection of the branch from the main channel. The absence of flow seemed to be the determinant for the rheophile species; nevertheless, the site could be connected at low discharge flows (700 cm^3/s).

PI recorded the same number of species and similar abundances as PS, with the presence of *Pseudochironomus* sp. in February 1997 and in April 1998, instead of *Limaya* cf. *longitarsis*. The branch was disconnected and then reconnected after May 1997. The highest discharge flow (August 1997) disturbed the sediments and diversity declined dramatically. By November–December 1997 its diversity had increased, with an evenness of almost 1.

PP recorded major densities of *Cricotopus* sp. 1 (552 ind./m^2), followed by *Eukiefferiella* sp. (275 ind./m^2) in June 1997, *Rheotanytarsus* sp. (273 ind./m^2), *Thienemanniella desertica* (175

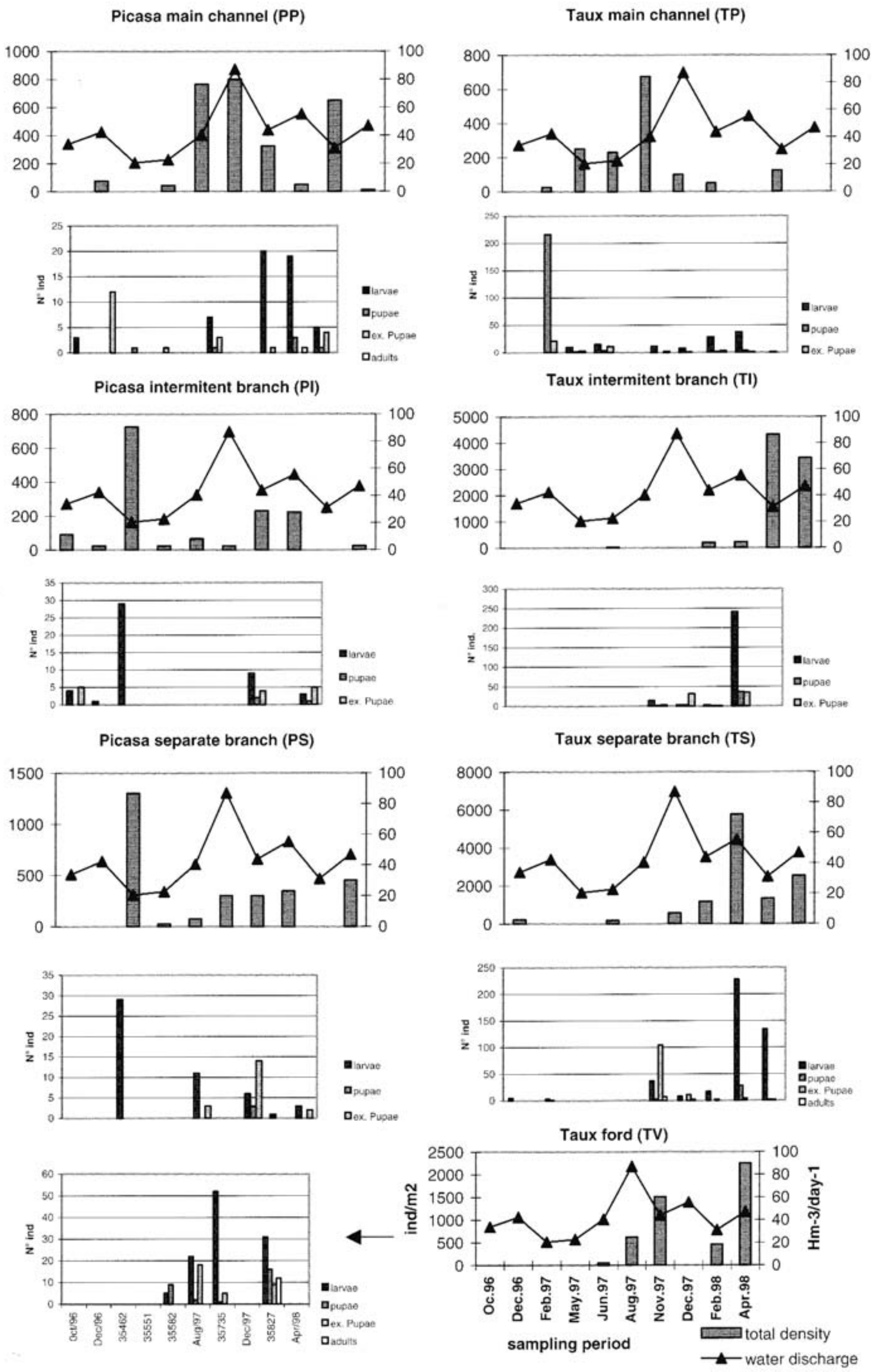

Fig. 2. Relationship between temporal–spatial fluctuations in densities of chironomids and water discharge rates from the Piedra del Aguila Dam (mean values). Records of the stages obtained from a Surber sampler showing the emergence periods in the respective sites.

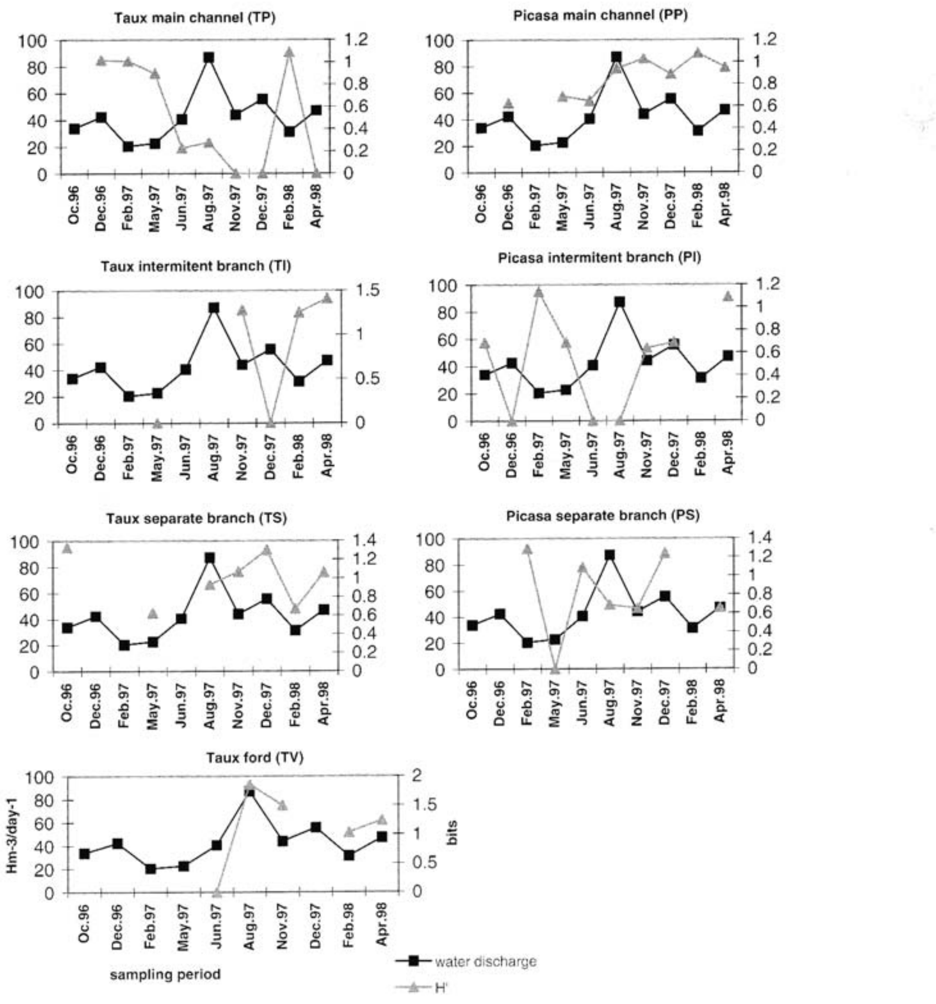

Fig. 3. Relationship between temporal–spatial fluctuations in diversity (H') of chironomids and water discharge rates from the Piedra del Aguila Dam (mean values).

ind./m^2) in February 1998 and *Limaya* cf. *longitarsis* (120 ind./m^2) in August 1997. This section of the river always had high water volumes and flow, and the increase in water discharge did not affect the presence of the rheophile species, which exhibited regular abundances and diversity throughout the sampling period. A different situation was found in Taux in the main channel (Figs. 2 and 3).

The emergence periods (Fig. 2) occurred mainly during spring, at the beginning of the summer and at the end of the summer and beginning of autumn, when the river sections had a regular water volume (400 hm^3 of daily discharge) from December 1997 to April 1998. In the Taux main channel (TP) the emergence periods were less evident due to the important drift after the high water discharges of August 1997.

The distribution of the seven sample sites, following PCA of 18 taxa, is shown in Fig. 4. Three distinct groups could be observed: TP, PP, PS and PI showed closer affinities with rheophile species, related to flow, volume and

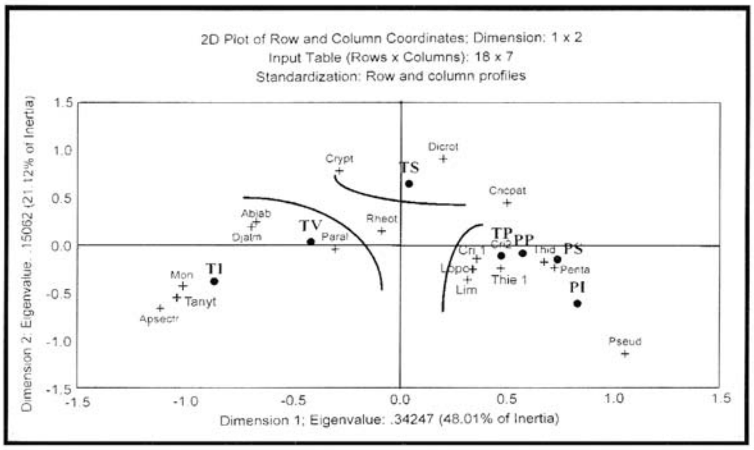

Fig. 4. PCA biplot showing the grouping of the seven sample sites into three distinct groups based on the mean density of species during the sampling period.

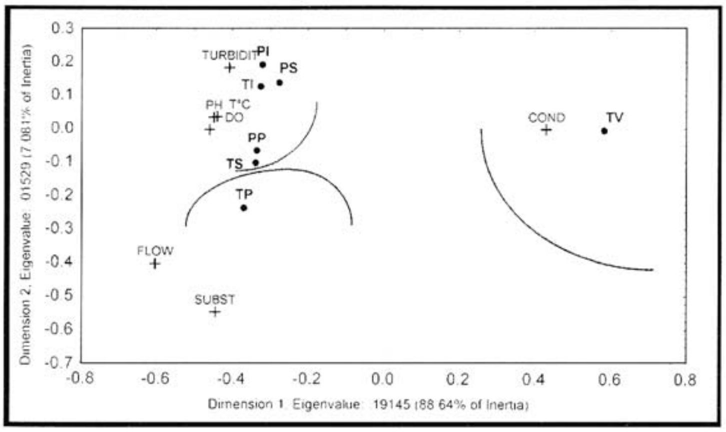

Fig. 5. PCA biplot showing the grouping of the sites based on physico–chemical features (see Table 2).

distance from the PDA dam. The second group, composed of TV and TI, was characterized by areas of low discharge that were becoming lentic environments, and contained mostly Tanypodinae species. The third group was represented by TS, which displayed lentic characteristics at low discharges. It was a long distance from the main channel and remained isolated after discharge was restored; Chironominae species dominated.

Figure 5 displays the results of the PCA in relation to the physico–chemical features of the sites. TV lay to the right because of its fluctuating conductivity and its isolation from the main channel. TP was directly influenced by flow changes and the nature of the substrate, predominated by the erosive conditions. The remainder of the sample sites grouped together sharing other common features (Table 2).

Conclusions

The river section examined in the present study displayed a longitudinal and transverse ecological complexity caused by fluctuations in the water discharge of an anastomosed area of the river, with intermittent and separate branches from water flow, where the changes in chironomid composition were evidenced by overlapping and return from lotic environments with typical species (*Cricotopus, Thienemanniella, Limaya*) to more lentic species (*Ablabesmyia, Dicrotendipes*).

Based on the PCA, the TV and TI sites were distinguished by temporarily becoming lentic environments at low water discharges. These sites were characterized mainly by the Tanypodinae and Prodiamesinae species, in terms of abundance and diversity. TS was the farthest site from the main channel, isolated for long periods, and containing mainly Chironominae and Tanypodinae species, in terms of abundance. The sites on the main channel (TP, PP) and the nearest (PS, PI) contained the major Orthocladiinae species. This middle section of the Limay River had a total richness of 18 taxa, and similar data were recorded for South African streams at the same latitude (Lindegaard & Brodersen 1995) and an Argentinean semi-arid stream (Medina & Paggi 2000).

Acknowledgements

The authors thank Lic. S. Bassani (AIC) for permission to publish data from the Study of Environmental Impact at Limay River section downstream Piedra del Aguila Dam. ILPLA, Cient. Cont. No. 720.

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