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Presence and abundance of Ephemeroptera and other sensitive macroinvertebrates in relation with habitat conditions in pampean streams (Buenos Aires, Argentina)*

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With 3 figures and 7 tables

Abstract: The objective of this work was to analyse the presence and abundance of Ephemeroptera and other sensitive invertebrates in two streams in the pampean area of Argentina, which have different ecological conditions. Juan Blanco stream is a pristine system and a reference site for the area while Buñirigo stream is affected by industrial effluents coming from food industries and tanneries. Biological and physico-chemical samples were taken seasonally from each stream over two years at two sites (upstream and downstream). DO, conductivity, pH, BOD, COD, heavy metals (Pb, Cr, Cu, Cd, Zn and Hg) and nutrients were measured and biotic indices were applied to determine water quality. Among the Ephemeroptera, *Caenis* cf. *argentina* (Caenidae) and *Callibaetis* cf. *fasciatus* (Baetidae) were the dominant species with the maximun densities in Juan Blanco stream. Other macroinvertebrates found in the study area and considered sensitive were *Magellomyia bruchina* (Trichoptera, Limnephilidae), *Campsurus major* (Ephemeroptera, Polymitarcyidae), *Aeshna bonariensis* and *Micrathyria dydima* (Odonata Anisoptera) and *Diplodon delodontus delodontus* (Pelecypoda, Hyriidae) recorded at low number in Buñirigo downstream. The abundance of individuals for each species can be correlated with water quality variations in the study sites. Certain parameters like pH can influence the distributions patterns of *C.* cf. *fasciatus*.

Key words: Ephemeroptera, macroinvertebrates, water quality, Pampean streams.

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Introduction

Benthic macroinvertebrates have been used extensively in water quality studies, because their community structure shows changes of physical and chemical parameters associated with anthropogenic perturbation and it can integrate environmental conditions over time.

According to MERRIT & CUMMINS (1996), the distribution patterns resulting from habitat selection by a given aquatic species reflect the optimal overlap between habit and environmental conditions that comprise the habitat (substrate, flow, turbulence, etc.). However, pollution and variations of physico-chemical parameters can restrict the presence of certain organisms such as several caddisflies, mayflies and cladocerans (CAIN et al. 1992, GREVE et al. 1998, VAN DER GEEST et al. 1998, 1999, LESLIE et al. 1999). Aquatic species that require stable environmental conditions because of their long life cycles, are not able to maintain populations in frequently disturbed rivers (VAN DER GEEST et al. 1998). Low concentrations of contaminants (e. g. heavy metals and pesticides) may induce adverse life cycles effects and behavioural responses in sensitive macroinvertebrates (SPHEAR et al. 1978, LESLIE et al. 1999). In the pampean plain in Argentina, TANGORRA et al. (2000), RODRIGUES CAPÍTULO et al. (2001, 2002) and GRAÇA et al. (2002) researched the application of biotic indices using macroinvertebrates to asses the ecological status in streams and rivers. Nevertheless, the information concerning the effects of pollutants and aquatic macroinvertebrates for this area is rather limited. The behavior of each species in relation with variation of environmental parameters has not been adequately studied, considering values of sensitivity reported in the literature. The preimaginal stages of Ephemeroptera, for example, are considered to be indicators of water quality, because they often inhabit unpolluted rivers and streams with high dissolved oxygen and oligotrophic conditions such as low organic matter and nutrients contents. However, the Baetidae and Caenidae can tolerate slightly to moderately disturbed environments (ROLDÁN PÉREZ 1988, DOMÍNGUEZ et al. 1994). These families (as well as the Polymitarcyidae) are the most representatives of the Order in the study area (DOMÍNGUEZ et al. 1994).

It would be expected that Ephemeropteran abundance in sites with low water quality should be lower or absent, because it is supposed that they are sensitive to disturbances. The aim of this study was to assess the presence and density of larval instars of the predominant species of Ephemeroptera in relation to environmental variables and water quality in streams of the pampean plain in Argentina, comparing their distribution with other sensitive macroinvertebrates in the studied systems.

Study site

The study sites (Fig. 1) are located in Magdalena, Buenos Aires province, Argentina (Río de La Plata basin). Pampean grassland is the typical biome of that area, being steppe composed of gramineous grasses (CABRERA 1971). The predominant activities are extensive agriculture and cattle raising. The climate is humid and temperature (mean 20 °C) with mean rainfall of 800 mm/year. Two streams were analysed because they present similar geomorphological characteristics but different water quality (according BAUER et al. 2002). The Juan Blanco stream (23 km long) flows through a UNESCO Biosphere Reservoir and thus could be considered a pristine stream and a reference site for the area. The other stream is the Buñirigo (22 km) which is affected by industrial effluents (tanning and food industries) mainly in its downstream section. These lotic systems (< 1%) and current (0.008-1.27 m/s), high turbidity (mean 73 NTU), abundant

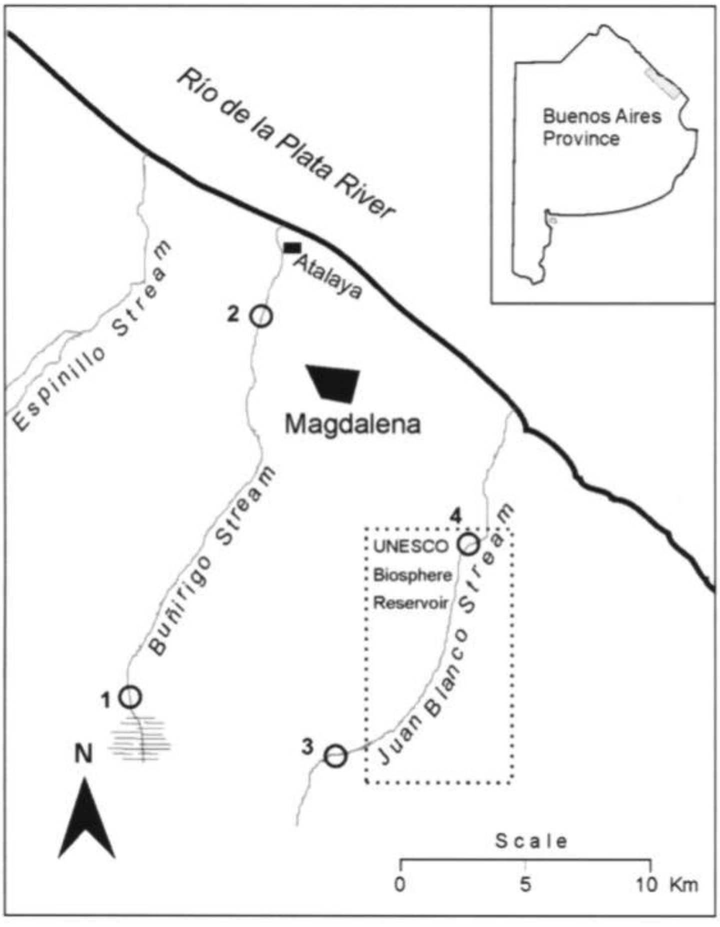

Fig. 1. Map of study area showing of Juan Blanco and Buñirigo streams.

organic matter (mean 5-18%) and suspended solids (mean 49 mg/l). The sediments are Cenozoic deposits of muddy loess (CAVALLOTTO 1995, RODRIGUES CAPÍTULO et al. 2001). The streams of this plain are usually semi-permanent or temporary headwater.

Material and methods

Biological data

Samples were taken seasonally from each stream over two years at two sites (upstream and downstream). The benthic macroinvertebrates were sampled with an Ekman grab (100 cm^2) at each sample site (three replicas) and complementary qualitative samples were always taken with sieves (150 µm) from macrophytes to examine the presence of other macroinvertebrates. The samples were fixed in situ with formaldehyde (5%) and the organisms were identified and counted under a stereoscopic microscope using the keys of DOMÍNGUEZ et al. (1992, 1994, 1995) and FERNANDEZ & DOMÍNGUEZ (2001). In order to characterize the macroinvertebrate community several variables were calculated: diversity indices (SHANNON & WEAVER 1963, MARGALEF 1955), richness (number of taxa), eveness, BMWP´ (modified by ALBA TERCEDOR et al. 1992) and IBPamp biotic index (RODRIGUES CAPÍTULO et al. 2001)

Physical and chemical data

Sediment samples were taken for analysis of heavy metals: Pb, Cr, Cu, Zn (Atomic absorption spectrophotometry 3500), Cd (Atomic absorption spectrophotometry EPA 3005 A-7130), Hg (GVF 7471 A). Detection limits were: Pb 0.002 µg/g, Cr 0.002 µg/g, Cu 1.0 µg/g, Zn 0.004 µg/g, Cd 0.0005 µg/g, and Hg 0.1 µg/g. Chemical and physical data were measured in the field with portable instruments: DO (oxymeter 600-ESD), conductivity (conductimeter Hanna), ph (pH meter Hanna Hi 8633) and T° (field thermometer). BOD_5 (dark incubation 5 days), COD (oxidation with $K_2Cr_2O_7$), NH_4^+ -N, NO_2^- -N and NO_3^- -N (spectrophotometry 635 nm), soluble reactive phosphorus (SRP) (spectrophotometry 885 nm) were measured according to APHA (1985)

Organic matter (OM) percentage in sediments was calculated by weight loss after ignition at 500 °C during 4 h from a subsample (50 g fresh weight) taken from an Ekman grab. All physico-chemical samples were taken seasonally on the same date as biological data.

Certain morphometric parameters of the streams such as depth and width for each sampling station were also considered.

Statistical analysis

Because comparisons should be made between reference and test sites with similar characteristics, (that in the absence of water quality impairments would be expected to yield equivalent macroinvertebrate communities) natural variability must be distinguished from perturbation-induced changes. With the aim to know variability, statistical analysis of differences (t-test) were applied to compare environmental and biological data between sample stations within each stream and between streams. This test was chosen because the variances were homogeneous and data followed normal distribution.

Canonical Correspondence Analyses (CCA) was used for the analysis of the data to evaluate the relationships between the presence of Ephemeropterans and other sensitive organisms and water quality. Environmental variables were automatically excluded from the analysis if multicolinearity was indicated by a variance inflation factor > 10 and were manually excluded when the p-value was > 0.05 according TER BRAAK (1986). Significance of relations inferred by CCA was tested using a Monte Carlo Test with 199 permutations.

All biological and physico-chemical variables (except pH) were log transformed previous to the analysis in order to reduce the effects of scale variation.

Results

Biological data

The macroinvertebrate fauna (Table 1) was dominated by Nematoda, Oligochaeta, Naitidae and certain Insecta (Diptera, Coleoptera and Hemiptera). Other important groups, although with lower density, were Mollusca (Gastropoda and Pelycipoda), Crustacea (Cladocera, Amphipoda and Decapoda) and other insects like Odonata, Ephemeroptera and Trichoptera. Among the species found in the study area those considered more sensitive were *Magellomyia bruchina* (Trichoptera, Limnephilidae), *Campsurus major* (Ephemeroptera, Polymitarcyidae), *Odonata Anisoptera* (*Aeshna bonariensis* and *Micrathyria dydima*) and *Diplodon delodontus delodontus* (Pelecypoda, Hyriidae) recorded a low number in Buñirigo downstream. The most common species of Ephemeroptera observed in the study sites were *Callibaetis* cf. *fasciatus* (PICTET) (Baetidae) and *Caenis* cf. *argentina* NAVAS (Caenidae). The highest density of these two species (Fig. 2) was determined in autumn in Juan Blanco stream but the Caenidae (3700 ind./m^2) were located mainly downstream while the Baetidae (600 ind./ m^2) were upstream. The cover of macrophyte species is shown in Table 2: minumum cover was recorded in Buñirigo downstream (20 %) where the dominant species was *Schoenoplectus californicus* while other species with lower importance were *Hydrochleys nymphoides* and *Azolla filiculoides*. In the other sampling sites *Hydrochleys nymphoides, Potamogeton striatus, Myriophyllum aquaticum, Sagittaria montevidensis, Ludwigia peploides, Lemna gibba, Egeria densa and Alternanthera philoxeroides* were also recorded. Filamentous algae were always present. Biotic Indices(BMWP´, IBPamp) showed higher values in Juan Blanco, corresponding with

Table 1. List of common macroinvertebrate taxa recorded in this study area.

TAXA	J. Blanco upstream	J. Blanco downstream	Buñirigo upstream	Buñirigo downstream
Hydra sp.	x	x	x	x
Cura sp.	x	x	x	x
Temnocephala sp.	x	x		x
NEMATODA	x	x	x	x
Naididae	x	x	x	x
Tubificidae	x	x	x	x
Helobdella sp.	x	x	x	x
Diplodon delodontus	x	x	x	x
Gundlachia concéntrica	x	x	x	x
Biomphalaria peregrina	x	x	x	x
Drepanotrema kermatoides	x		x	x
Heleobia parchappei	x		x	
Pomacea canaliculata	X	x	x	x
Tardigrada	x	x	x	x
Cyclopoida	x	x	x	x
Calanoida	x	x	x	x
Harpacticoida	x	x	x	x
Macrothricidae spp.	x	x	x	x
Chidoridae spp.	x	x	x	x
Ostracoda	x	x	x	x
Hyalella curvispina	x	x	x	x
Palaemonetes argentinus	x	x		
Macrobrachium borrelii		x		
Collembola	x	x	x	x
Caenis sp.	x	x		x
Callibaetis sp.	x	x	x	x
Campsurus major	x			
Coenagrionidae	x	x	x	x
Aeshna bonariensis	x	x	x	
Mycrathyria dydima	x	x		x
Chironomus sp.	x	x	x	x
Goeldichironumus sp.	x	x	x	x
Dicrotendipes sp.	x			
Paratanytarsus sp.	x	x		
Tanypus sp.		x		
Ceratopogonidae	x	x	x	x
Stratyomidae	x	x	x	x
Muscidae	x	x		x
Psychodidae		x		x
Tipulidae	x		x	x
Ephydridae	x	x	x	x
Culicidae	x		x	
Blephariceridae	x	x		
Hebrus sp.		x		x
Belostoma elegans	x	x	x	x

Table 1. Continued.

TAXA	J. Blanco upstream	J. Blanco downstream	Buñirigo upstream	Buñirigo downstream
Neoplea sp.	x	x	x	x
Corixidae	x	x	x	x
Mesoveliidae	x	x		x
Tropisternus sp.	x	x	x	x
Berosus sp.	x	x		
Elmidae	x	x	x	x
Staphylinidae	x	x		
Dytiscidae	x	x	x	x
Suphisellus sp.	x	x	x	x
Chrysomelidae	x	x		
Gyrinidae	x	x		x
Cyrnellus sp.		x		
Magellomyia bruchina	x	x	x	
Acari	x	x	x	x

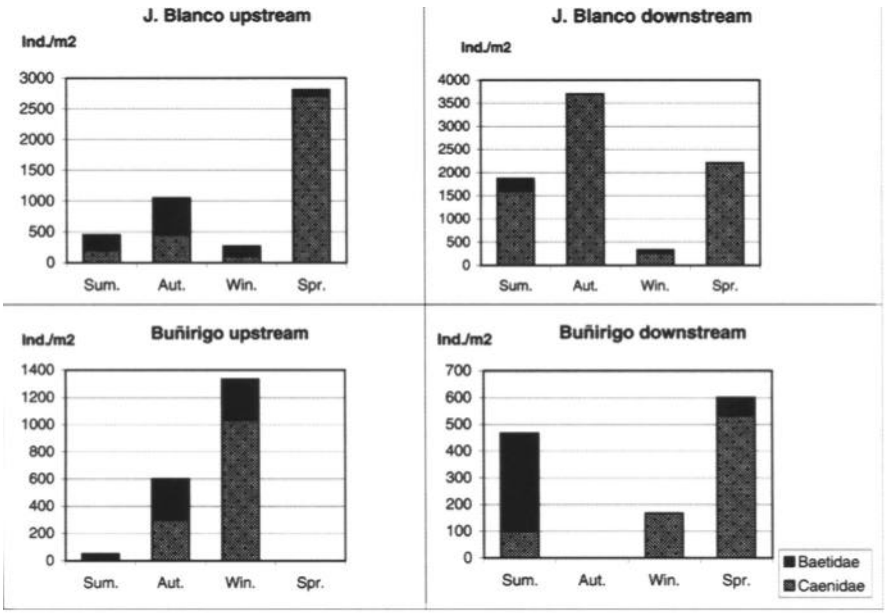

Fig. 2. Seasonal densities of *Callibaetis* cf. *fasciatus* and *Caenis* cf. *argentina* (Ephemeroptera) in the sampling sites. The value 0 in this graphics corresponds to absence of these organisms, in the case of Buñirigo upstream in spring due to this site was dry while the Buñirigo downstream in autumn this values was related to unfavourable conditions (pollution).

Table 2. Aquatic plants species and percentages of cover (maximum values) for each sampling site.

Sample stations	J. Blanco upstream	J. Blanco downstream	Buñirigo upstream	Buñirigo downstream
Aquatic plants	filamentous algae, Characeae, *Ludwigia peploides, Hydrocotyle ranunculoides, Sagittaria montevidensis*	filamentous algae, *Potamogeton striatus, Azolla filiculoides, Lemna gibba, Egeria densa, Myriophyllum elongatus, Hydrochleis nymphoides, Alternanthera filoxeroides*	filamentous algae, *Hydrochleis nymphoides, Potamogeton striatus, Myriophyllum elongatus, Sagittaria montevidensis*	filamentous algae, *Schaenoplectus californicus, Hydrocotyle ranunculoides, Azolla filiculoides*
% cover	35	40	60	20

sites unpolluted or slightly polluted while the other stream presented moderate to slight pollution. Diversity indices, richness and eveness varied seasonally with lower values in autumn and winter (Table 3). During the spring sampling Buñirigo uspstream site could not be sampled because it was dry.

Physical and chemical data

Heavy metal concentrations (Table 4) were lower than reference values for this area (MANASSERO et al. 1998), except Zn (≥ 35.25 µg/g). However, in Buñirigo downstream the recorded values were always higher than at the other sites, except Hg with its highest values (0.78 µg/g) in Juan Blanco downstream located in UNESCO reserve. The seasonal variations of physico-chemical parameters are summarised in Table 3. The high values of conductivity observed in Buñirigo downstream (3040 µS) were associated with industrial pollution. Juan Blanco stream showed the highest values of BOD (16 mg/l), COD (122 mg/l) and nutrient concentration: SRP (406 mg/l), NH_4^+ -N (0.252 mg/l), NO_2^- -N (0.028 mg/l) due to naturally eutrophic conditions while NO_3^- -N (0.619 mg/l) was recorded in Buñirigo upstream. Temperature showed variations related with seasonal changes, in coincidence pH increased gradually toward summer.

Table 5 shows OM contents in sediments: the maximum value was observed in Buñirigo downstream (17.81 %) due to food industry effluent output. The values for the other sites varied between 5 to 10 %, percentages similar to other lotic system of pampean area without industrial effects.

Statistical analyses

The results of analyses of differences applied to compare sampling stations can be observed in Table 6. There was no statiscally significant difference between Juan Blanco upstream

Table 3. Average values of physico-chemical data and biotic indices. DO= Dissolved oxygen (mg/l), T° = temperature (°C), Cond. = Conductivity (µS/cm), BOD = Biochemical oxygen demand (mg O_2/l), COD = Chemical oxygen demand (mg O_2/l), N = species richness, R1 = diversity index of Margalef, H´ = Diversity index of Shannon, E1 = Eveness, BMWP´ = Biological Monitoring Working Party modified, IBPamp = Biotic Index for Pampean streams.

	J. B. 1 Summer	J. B. 1 Autumn	J. B. 1. Winter	J. B. 1 Spring	J. B. 2 Summer	J. B. 2 Autumn	J. B. 2 Winter	J. B. 2 Spring	B.1 Summer	B.1 Autumn	B. 1 Winter	B. 2 Summer	B. 2 Autumn	B. 2 Winter	B. 2 Spring
DO	6.8	8.6	9	5.5	3.9	6.3	9	5.5	5.7	6.3	9.9	5.5	5.8	2.6	3.2
T °C	23.3	12.4	15.9	29	23.2	10.8	15.9	29	20.5	10.2	13.9	24.4	16	17.6	27
Conductivity	164	180	211	265	766	426	211	265	161	202	252	2079	3000	3040	2385
PH	8.7	6.9	7.8	7.8	8.1	6.3	7.8	7.8	8.4	7.3	7.6	8.1	6.6	7.5	7.8
BOD	5	9	7	16	2	13	7	16	7	6	4	3	10	2	11
COD	17	30	70	122	75	34	70	122	46	37	56	86	32	116	102
SRP	0.060	0.003	0.045	0.105	0.406	0.050	0.045	0.105	0.034	0.014	0.060	0.152	0.058	0.133	0.111
NH4+	0.011	0.004	0.061	0.227	0.040	0.252	0.061	0.227	0.052	0.115	0.042	0.051	0.018	0.028	0.049
NO2-	0.015	0.028	0.004	0.019	0.005	0.018	0.004	0.019	0.010	0.015	0.005	0.008	0.005	0.012	0.012
NO3-	0.063	0.046	0.086	0.250	0.064	0.021	0.086	0.250	0.070	0.619	0.023	0.111	0.316	0.043	0.043
R1	2.86	2.89	3.39	3.78	4.21	3.14	2.77	2.28	2.69	3.06	2.65	3.5	268	2.34	2.41
H´	2.73	1.57	1.57	2.04	2.26	2.15	2.34	2.65	1.76	1.84	1.62	2.08	1.79	2.1	2.37
E1	0.64	0.47	0.46	0.58	0.64	0.64	0.58	0.60	0.63	0.58	0.50	0.65	0.58	0.44	0.54
N	20	24	30	26	33	27	25	25	12	31	27	24	27	21	18
BMWP´	82	94	105	93	111	99	89	93	55	82	81	78	77	92	81
IBPamp	10	9	10	10	10	10	9	10	10	7	9	8	9	9	8

Table 4. Average values (µg/g) of heavy metals contents in sediments and reference values for the study area according MANNASERO et al. (1998).

Heavy metal	Reference value	J. Blanco upstream	J. Blanco downstream	Buñirigo upstream	Buñirigo downstream
Cu	29.2	16	12.25	21	30.75
Pb	19.6	11.25	8.5	10	16.75
Cr	129	7	11.75	6	15.25
Cd	0.34	0.125	0.125	0.125	0.125
Zn	40	41.5	46	35.25	89.25
Hg	15	0.19	0.78	0.1	0.32

Table 5. Organic matter contents in sediments (expressed in percentage)

Seasonal OM contents (%)	Juan Blanco upstream	Juan Blanco downstream	Buñirigo upstream	Buñirigo downstream
Summer	7.27	8.35	7.48	17.81
Autumn	5.03	6.47	6.84	16.54
Winter	10.83	5.16	8.31	11.54
Spring	5.96	8.1	dry stream	4.63

Table 6. Statistical analysis of differences (t-test) between studied sites. Statistically significant differences were indicated in bold font.

Compared sites	JB1-B1	JB2-B2	JB1-JB2	B1-B2
Conductivity	P = 0.42	**P = 0.000076**	**P = 0.000033**	**P = 0.000001**
DO	P = 0.42	P = 0.14	P = 0.001	**P = 0.03**
T°	P = 0.07	P = 0.32	P = 0.44	**P = 0.009**
BOD	**P = 0.02**	P = 0.33	**P = 0.008**	P = 0.38
COD	P = 0.42	**P = 0.01**	P = 0.34	P = 0.01
NO2	P = 0.10	P = 0.33	P = 0.21	P = 0.21
NO3	P = 0.49	P = 0.19	**P = 0.01**	P = 0.27
RSP	P = 0.26	P = 0.16	**P = 0.01**	**P = 0.006**
pH	P = 0.47	P = 0.38	P = 0.49	P = 0.34
H´	P = 0.42	P = 0.07	**P = 0.05**	P = 0.32
Baetidae larvae	P = 0.48	P = 0.2	P = 0.16	**P = 0.04**

and Buñirigo upstream sites when conductivity, DO, pH, T°, COD, NO_3^- -N, NO_2^- -N, SRP, larvae of Baetidae presence and H´ considered. There were statistically significant differences between Juan Blanco upstream and downstream sites when conductivity, DO. BOD, NO_3 and SRP were considered. Buñirigo upstream and downstream showed statistically significant differences for conductivity, DO, COD, T°, SRP and presence of Baetidae larvae. There were statistically significant differences between Juan Blanco down-

Table 7. Results of Canonical Correspondence Analysis.

Axes	1	2	3	4	Total inertia
Eigenvalues	0.267	0.212	0.158	0.105	0.718
Species-environment correlations	0.997	0.994	0.96	0.967	
Cumulative percentage variance					
of species data	32.3	57.9	77	89.7	
of species-environment relation	35.2	63.1	84	97.8	
	F-ratio = 0.010				
	P-value = 0.010				

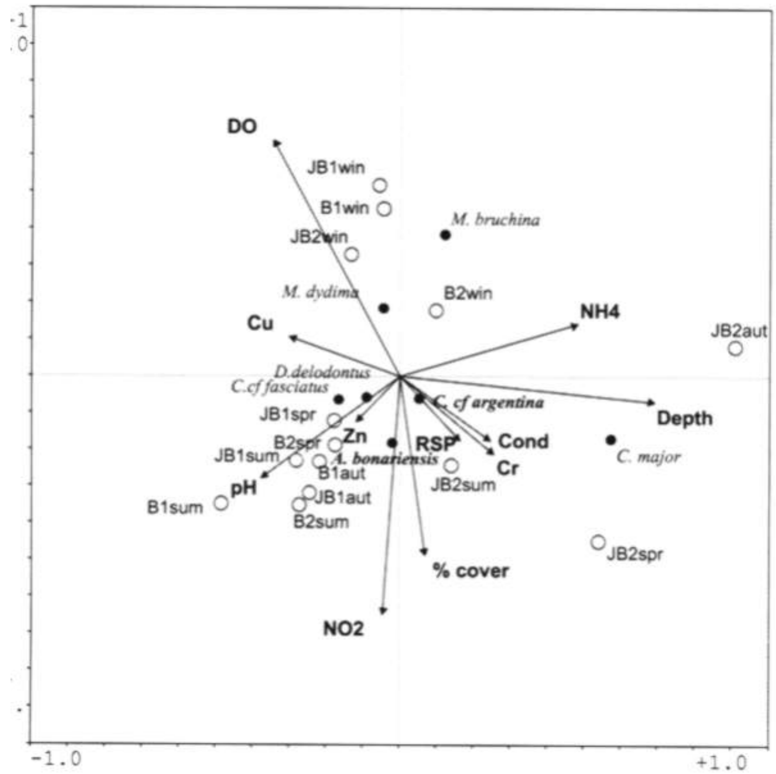

Fig. 3. Triplot of sampling sites, species and environmental variables in relation to the first two ordination axes of CCA. B1: Buñirigo upstream, B2: Buñirigo downstream, JB1: Juan Blanco upstream, JB2: Juan Blanco downstream, aut: autumn, win: winter, spr: spring, sum: summer.

stream and Buñirigo downstream sites when conductivity and COD were considered.

For the CCA analysis *C.* cf. *fasciatus*, *C.* cf. *argentina* and other sensitive macroinvertebrates such as *M. bruchina*, *C. major*, *A. bonariensis*, *M. dydima* and *D. delo-*

dontus were included. Thus. The correlation matrix consisted of 11 environmental variables, 14 samples and 7 cases (species). Six environmental variables were excluded from the analysis because their high inflation factor or their high p values (Pb, Hg, BOD, COD, T° and stream width). The eigenvalues obtained for the two first axes were 0.267 and 0.212, respectively (Table 7). Species-environment correlations were greater than 0.96 when the four main axes were considered and the Monte Carlo permutation test indicated that all axes were significant (F-ratio 3.329, P> 0.01). Axes 1 and 2 explained 57.9 % of the cumulative variance for the species data and 63.1 % for the species-environmental relation.

Fig. 3 shows the association between axis 1 with stream depth, pH, NH_4^+ -N, Cu and conductivity (mentioned in decreasing order of explanatory importance). Axis 2 was principally related with DO, vegetation cover and NO_2^- -N and with lower weight with RSP and Cr.

M. bruchina and *M. dydima* were correlated with the concentration of DO, furthermore this association is closely related during winter for all sites except Buñirigo downstream. The abundance of the Baetidae *C.* cf. *fasciatus* showed high concentration with pH, decreasing number of individuals/m^2 (or even disappearing) in coincidence with more acid conditions. A similar behaviour was observed for the mollusc *D. delodontus delodontus*. Juan Blanco downstream site was more correlated with vegetation cover than pH during spring and summer, however the behaviour of this parameter followed the general patterns in these sites.

A. bonariensis and the Caenidae *C.* cf. *argentina* were correlated with nutrients such as RSP and NO_2^- -N and vegetation cover. The last provides refuges and food sources and maybe microhabitats with locally high concentrations of DO. *C.* cf. *argentina* was located in halfway position with regard to both axes, therefore this species was also correlated with NH_4^+ -N, conductivity and Cr while *C. major* was more related with profundity (in relation to its burrowing habit). Heavy metals such as Cu, Cr and Zn would not cause apparent damages because of their lower concentrations and maybe due to the presence of humic compounds, higher percentages of OM and suspended solids which have the capacity to inmobilise them and inhibit their bioavailbility.

Therefore, it is possible to conclude that *M. dydima*, *M. bruchina*, *C.* cf. *fasciatus* and *D. delodontus* were the most sensitive species while *C.* cf. *argentina* and *A. bonariensis* were most tolerant. *C.* cf. *argentina* would be more resistant than *C.* cf. *fasciatus* in presence of environmental disturbances or temporally unfavourable conditions such as high conductivity, decreases in pH or high nutrient concentrations. However, for all species poor water quality did not exclude the presence of these organisms but modified their abundance (individuals/m^2).

Discussion

Density variations of Ephemeroptera were similar for all sites, with highest density in June and December. However, at the upstream site in Buñirigo the maximum numbers were recorded in September because in December this site was dry. However, there are several permanent wetlands with similar fauna in proximity of Buñirigo headwaters. This would favour the immigration of the macroinvertebrates toward our sampling site during the rainy period. The presence of ephemeropterans in the studied two streams would not be conditioned for variations in the physico-chemical parameters considered, because they were recorded in all the very distinct environmental situations. However, certain parameters like pH can influence the distribution pattems of *C.* cf. *fasciatus*, in coincidence with the conclusions of COURTNEY & CLEMENTS (2000) who found that sensitive mayflies were eliminated from streams with lower pH and/or metal pollution conditions in experimental studies. The abundance of individuals for each species can be correlated with water quality variations in the study sites. GRAÇA et al. (2002) conclude that invertebrates in the pampean area are tolerant to eutrophic conditions naturally prevalent on the local rivers. These conditions may be unfavourable for many organisms commonly considered sensitive according foreign literature. This coincides with the results obtained in Juan Blanco stream, where higher concentrations of nutrients were compatible with presence of sensitive fauna. From the tables and graphics it can be deduced that the high densities of there organisms coincided with the maximum values in the biotic indices such as IBPamp, BMWP', diversity, species richness, and evenness (in coincidence with RODRIGUES CAPÍTULO et al. 2001 and TANGORRA et al. 2000) and they had an opposed behaviour to physico-chemical parameters related with pollution. However, the registered scores of there parameters were generally lower than reference values of tolerance for the majority of aquatic invertebrates (EISLER 1985 a, 1985 b, 1987 and 1998).

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