

# ABUNDANCE AND DIVERSITY OF A MAYFLY TAXOCENE IN A SOUTH AMERICAN SUBTROPICAL MOUNTAIN STREAM

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## ABSTRACT

The structure of the Ephemeroptera taxocene was studied under adverse summer conditions. Our study examined eight stations in a South American mountain stream from moist temperate cloud forest to premontane subtropical forest including an altitudinal range of 950 m. To make them more comparable, the two samplings were carried out in the rainy season (1989 and 1990). We collected nymphs of nine mayfly species from four different families. The mayfly density ranged from 4 ind/m<sup>2</sup> to 1,214 ind/m<sup>2</sup>. Our data suggest some degree of persistence of the taxocene in the five lower stations, probably induced by the dominant *Baetodes* sp. This is attributed to invariable physical conditions in the channel. We did not observe any pattern in other species.

## INTRODUCTION

The subtropical mountain forest is a conspicuous biome in this part of South America. It is very important in the water production aspects and its regulation. The tree richness of this mountain forest and its variations along altitudinal levels has been documented (Morales et al., 1995).

The altitudinal gradient offers appropriate opportunities to investigate factors which control the diversity, composition and abundance of stream organisms (Ward and Berner, 1980) although little previous work on stream zonation have been conducted in Northwestern Argentina (Argañaraz, 1984, Domínguez and Ballesteros Valdez, 1992).

The Ephemeroptera taxocene were investigated within a major study on the macroinvertebrate benthic fauna of mountain streams.

## MATERIAL AND METHODS

The De los Reales River belongs to the Salí River drainage basin (Tucumán, Argentina). The stream begins at approximately 2,500 m.a.s.l (Fig. 1) and drains into Pueblo Viejo River (Tucumán, Argentina) at 800 m.a.s.l.

**Table 1.** Mayfly composition at the stations investigated and abundance (ind/0,27 m<sup>2</sup>) in two years.

Species	Station															
	1989								1990							
	a1	b1	c1	d1	e1	f1	g1	h1	a2	b2	c2	d2	e2	f2	g2	h2
Baetis sp. 1	14	0	1	13	8	28	60	5	0	0	0	2	24	4	1	0
Baetis sp. 2	0	5	1	1	10	7	6	1	0	0	0	0	13	0	2	0
Baetodes sp.	3	0	0	54	69	82	328	163	0	0	2	19	55	67	93	101
Camelobaetidius sp.	27	1	158	22	11	0	35	61	5	6	12	13	12	8	4	9
Thraulodes sp.	0	1	4	0	2	6	13	25	0	0	0	0	0	0	0	0
Meridialaris sp.	1	0	0	0	0	0	0	0	1	4	1	0	1	1	3	0
Leptohyphes sp.	3	16	16	12	15	15	28	6	18	0	8	12	4	15	23	0
Lachlania sp.	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0
Tricorythodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Total Ephemeroptera	48	23	180	102	115	138	47	261	24	10	23	46	109	95	127	110
Ephem. Richness	4	4	5	5	6	4	7	6	3	2	4	4	6	5	7	2
Total other taxa	67	407	143	170	236	379	282	197	528	60	102	48	63	171	279	177
Mean taxa/sample	5	6	6.6	6.3	7.6	6	7.6	8	6.6	4.6	5.3	6	7.3	7	8.3	6

The study area is situated in the «Yungas» phytogeographical province, typical of the mountainous subtropical region. We had two collections, in summer (January) 1989 and 1990. Samples were taken every 110 m change in elevation from 2,070 to 1,120 m.a.s.l. of elevation. Eight stations (Fig. 1) were sampled with three subsamples of Surber sampler (300 µm mesh) from cobble riffles at each site.

The structure of the mayfly community was studied under summer conditions (rainy season with 80-100% of the annual total) to differentiate from of the other authors (Argañaraz, 1984, Dominguez and Ballesteros Valdez, 1992, Fernández et al., 1995). On average, the summer monthly precipitation is near 120 mm (Villalba et al., 1992). In this season the faunal assemblage is variable, caused by synchronous transformation of nymphs into adults (Domínguez and Ballesteros Valdez, 1992) and disturbs caused by torrential rains. Floods with discharges ranging from 400 to 800 L/s (Hunzinger, 1997) are frequent.

### Analysis of Data

Heterogeneity from mayfly taxocene was calculated for each year using Shannon-Wiener index:

$$H' = - \sum_{i=1}^k p_i \log p_i \quad (\text{Zar, 1984}).$$

The Spearman rank correlation coefficient (Zar, 1984) was used in order to compare the taxocene between years. For this it was used the total number of individuals from 9 taxa in each year. A Correspondence Analysis (CA) was performed using CANOCO (Ter Braak, 1987), without transforming the data and including rare species

### RESULTS

Nine mayfly species from four different families were found (Table 1), and the density ranged from 4 ind/m<sup>2</sup> to 1,214 ind/m<sup>2</sup>.

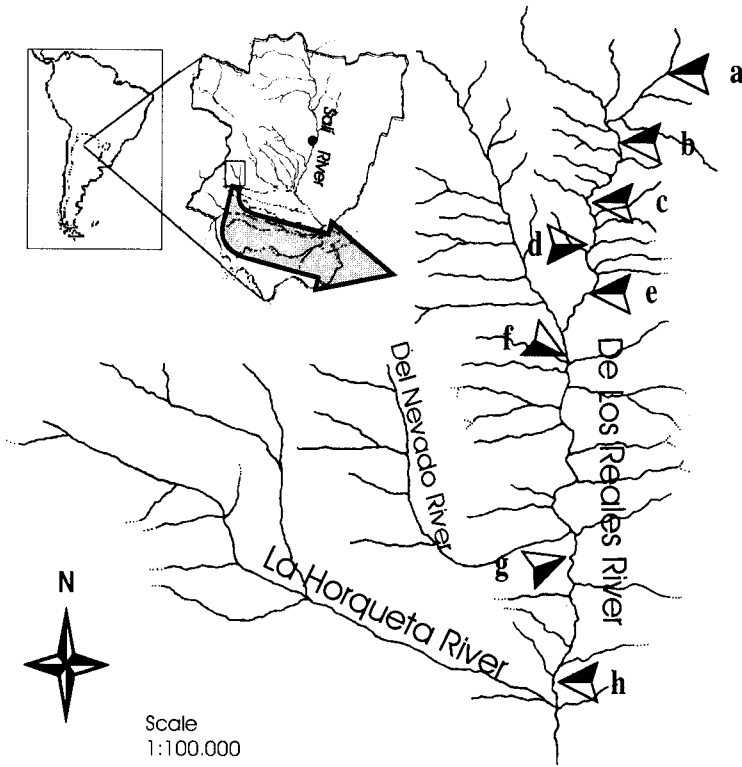


Fig. 1. Course of De los Reales River (Tucumán, Argentina) with sampling stations locations.

Among aquatic macroinvertebrates, the mayflies were important in 1989, with a percentage of total catches of 41%; however in 1990 the mayflies represented only 27.5%. Diversity measure ( $H'$ ) was 1.96 and 1.72 in each year respectively.

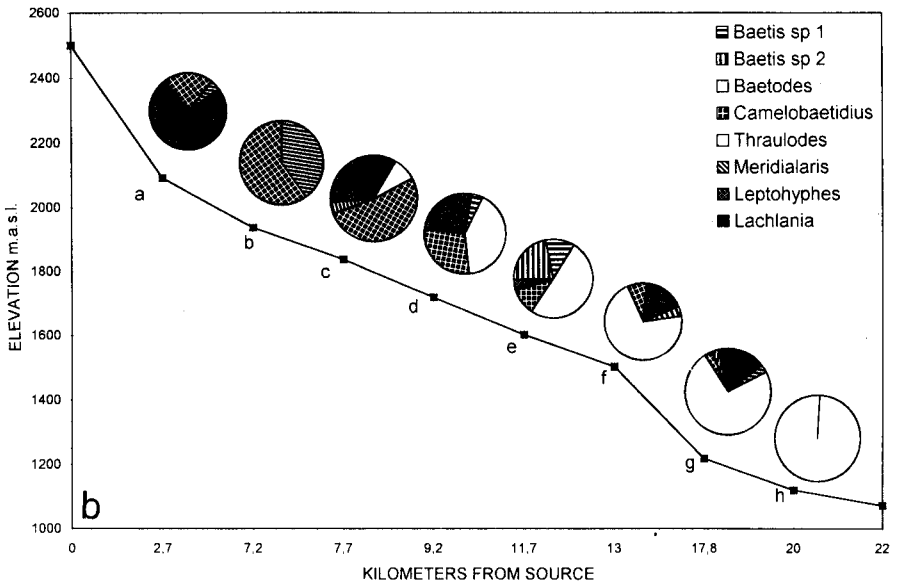
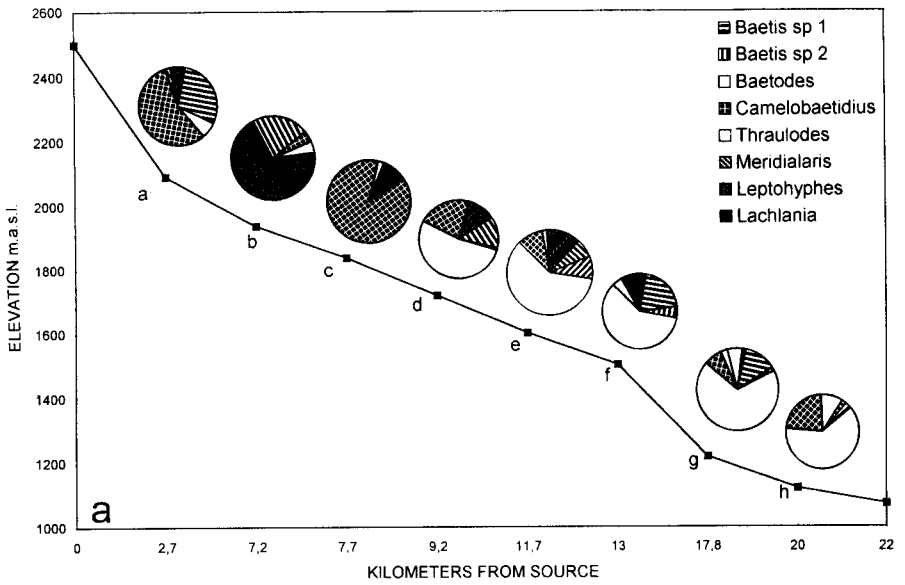
Baetidae, collectively constituted the majority of the mayfly fauna at sampled stations and *Baetodes* sp. is the species most important numerically, over the 50% in both years (Table 1).

Altitudinal distribution and abundance of the mayfly species along the profile of the De los Reales River is presented in both years (Figs. 2a and b). *Baetodes* sp. becomes more important downstream, while other species do not present a clear pattern. The abundance and richness exhibited a general increase downstream. There is a significant correlation between both years ( $r_s = 0.738$ ,  $p < 0.05$ ).

In the ordering (Fig. 3) can be noticed that stations  $d_1-h_1$  from 1989 and  $d_2-h_2$  from 1990 are grouped in one extreme of the axis II gradient ( $\lambda = 0.175$ ). This axis is inversely correlated with depth ( $r = -0.578$ ,  $p < 0.05$ ), these stations are depth  $\geq 30$  cm. Moreover both axis are significantly correlated ( $p < 0.05$ ) with the altitude ( $r = 0.50$  and  $r = 0.53$ , respectively).

## DISCUSSION

The results obtained under the summer conditions were interesting, especially because of adverse conditions for the benthic community and the coincidence with the emergence period for most of aquatic taxa.



**Figs. 2a-b.** Numerical percentages of different genera of mayfly nymphs as a function of altitude in De los Reales River in summer of each year. Sites locations are indicated by letters on the longitudinal profile (a:1989, b:1990).

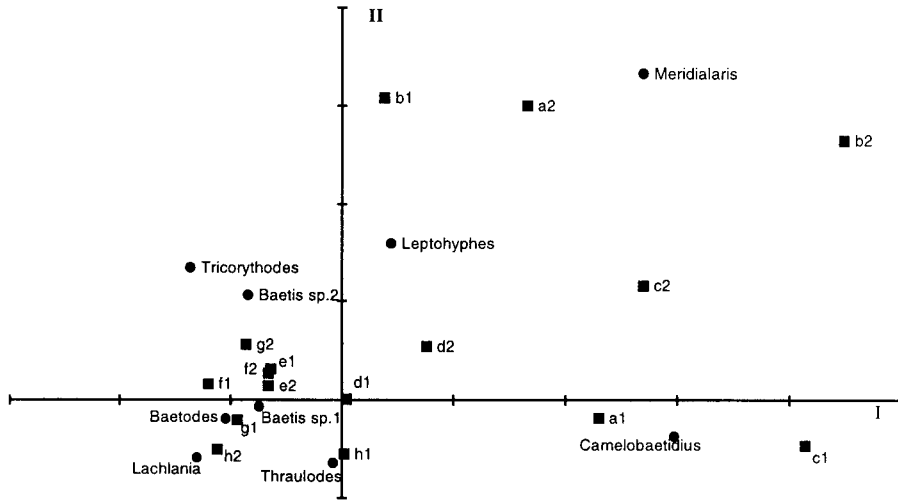


Fig. 3. Correspondence Analysis on the presence of the mayfly in De los Reales river. Distribution of the samples in the plane defined by the I and II components.

The diversity index was smaller than in some prealpine streams (Switzerland) from 1,030 m to 1,670 m.a.s.l. (Breitenmoser-Würsten and Sartori, 1995), which is in agreement with generalized concepts of a greatest richness and diversity in the benthic fauna in temperate regions.

The strong correlation between both years show some degree of persistence, in Townsend et al. (1987) sense, of the taxocene in the stations.

The ordering of stations *d-h* (Fig. 3) is probably induced by *Baetodes* sp., mostly because is more abundant downstream. These five stations are very similar especially in depth, displaying less variable conditions from year to year. The five upper stations are situated in the temperate cloud forest, a monoespecific forest of *Alnus acuminata* (Betulaceae). Within of these stations, the three upper ones (*a-c*) are situated in a very unstable area.

The station  $b_2$  is important on the first axis due to low richness and abundance. This localization in the ordination is also influenced by the presence of four individuals of *Meridialaris* sp., a negligible species. On the other hand, it is a rare species for the analysis (Ter Braak, 1987) in the previous year.

Domínguez and Ballesteros Valdez (1992) collected mayflies over the similar altitudinal range in a drainage system immediately to the north (24 Km) of our study area. They listed 10 species of nymphs in winter and they found a faunal break at an altitude of 770-670 m, however this range is not included in our study. Noticeably, the overall richness and the specific constitution were similar (60%). The altitudinal (1,700 - 1,100 m.a.s.l.) comparable stations showed lower richness (generally one species in each) Domínguez and Ballesteros Valdez (1992) with respect to data from 1989.

In this same river at lower elevations (450 m.a.s.l.) in winter, Fernández et al. (1995) collected six species of mayflies, with similar constitution and representing 31.2% of the benthic community; *Baetodes* sp. was also the dominant mayfly species.

Within the general pattern of altitudinal diversity, station *b* is very particular from the abundance and richness point of view, attributable to the conditions of this station, which as influencing CA.

The importance of altitude in the taxocenotic analysis, was also observed in the forest trees (Morales et al., 1995) leading other causes to a second place.

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