9 Altitudinal distribution of Ephemeroptera in the Farallones de Cali National Park, Colombia

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Introduction

The Farallones de Cali National Park is located southwest of Colombia on the Andes mountain system. The park, with the highest biodiversity in Colombia, contains lotic ecosystems and numerous waterfalls forming the drainage basins for the Cali, Meléndez, Pance and Anchicayá rivers, which are a source of drinking water and electric power for Cali, the third largest city of the country.

The ephemeropteran fauna of Colombia is poorly known, the first reports being given for the Antioquia Departament by Roldán et al. (1973), Pérez and Roldán (1978), Machado and Roldán (1981) and Hernández and Moreno (1982). Roldán (1980, 1985) prepared preliminary keys for identifying the mayflies. Very few studies have dealt exclusively with the Departament del Valle; only some records are scattered throughout the literature.

This research was undertaken to document the distribution of Ephemeroptera in the Farallones de Cali National Park, to do preliminary taxonomic work on the group in this area, to establish sampling stations at different altitudes above sea level for collecting biological and physico-chemical data and to predict the value of Ephemeroptera as water quality indicators.

Description of the Study Area

Four different drainage systems were selected for this study: the Cali, Meléndez, Pance and Anchicayá rivers, all located in the Departament del Valle, Colombia (Fig. 1). The ecological characteristics of each area are listed below.

Cali River: the Cali River Basin is located on the eastern watershed of the western cordillera at 3°30'N,76°25'W, including the basins of the Felidia and Pichindé rivers. Just below the town centre of Cali, the Cali River is joined by the Aguacatal River and becomes polluted (Fig. 1).

The Cali River Basin passes through several different Holdridge life zones along its course (Espinal 1968). The headwaters correspond to a premontane wet forest (bmh-MB), which has an annual rainfall of 2000-4000 mm, a temperature range of 12-17°C and elevations of 1900-2800 m. This zone has steep slopes and is difficult to reach.

The Cali River continues though a small area of subtropical wet forest (bmh-ST), at 1600-1800 m above sea level, characterized by mean air temperature of 20°C throughout the year and precipitation of 2000-4000 mm. The forest in this region is preserved and protected. The water level of the river is relatively stable and the river remains clear throughout the year.

Between elevations of 1000 and 1600 m with annual rainfall of 1000-2000 mm, the river flows through subtropical moist forest (bh-ST). The forest itself has been cut down and erosion has occurred. The river is affected by agricultural activities in the area and by local pollution sources.

The Cali River Basin includes small stony streams, stony rivers and sluggish rivers. The soil is made of undifferentiated basic igneous rocks.

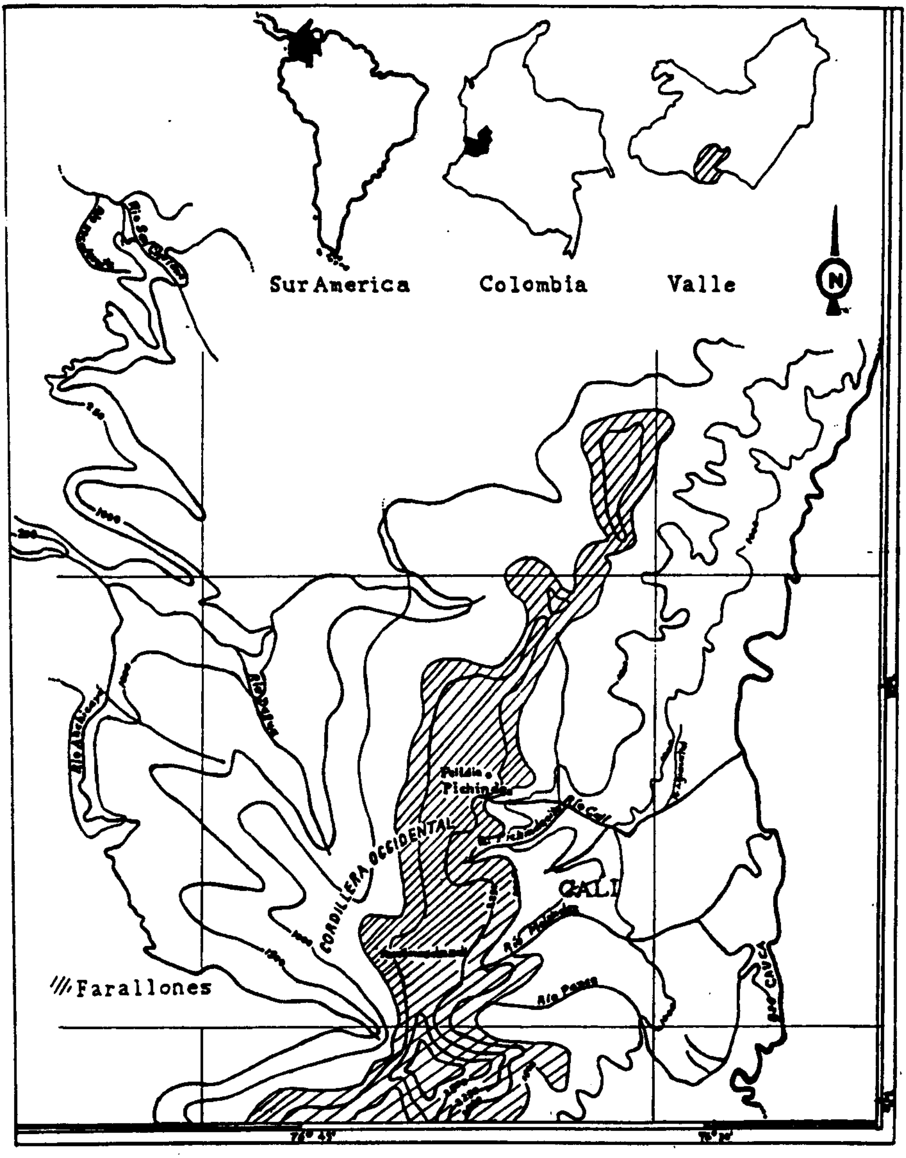
Meléndez and Pance rivers: the Meléndez and Pance river basins occupy 15,000 hectares. The basins consist of high and low zones. The high zone presents slopes greater than 75 per cent and are difficult to access. The low zone has lightly hilly topography.

These rivers pass through the same Holdridge life zones as the Cali River Basin (Fig. 1). The altitude of these basins ranges from 3900 to 950 m. The geological strata consist of intersegmental cretaceous rocks, tertiary igneous rocks and recent alluvial and colluvial sediments (Corporación Atónoma Regional del Cauca 1979).

There are coal, gold and industrial sediments near the half-basins. Thus, both debris and domestic effluents contribute to water pollution, especially in the Meléndez River.

The Anchicayá River drainage system is located in the western watershed of the western cordillera. This is an inaccessible region, craggy and wooded. Many rivers flow out to its basin. Due to the heavy rainfall, it is a tropical wet forest region (Bmh-T) with an annual rainfall of 4000-8000 mm and a mean annual temperature of 24°C.

Figure 1. **The study area: the Cali, Meléndez, Aguacatal, Pance and Anchicayá rivers, all located in the Department del Valle, Colombia, South America (taken and adapted from map published by Instituto Geográfico Agustin Codazzi).**



Methods

Twenty sampling locations were established in the Cali, Meléndez, Pance and Anchicayá rivers, between 50 and 2000 m above sea level, from January 1990 to June 1992. Physico-chemical data on water quality were collected and analyzed according to the U.S. National Sanitation Foundation Water Quality Index (Ott 1981). The collections upon which this paper is based include both nymphs and adult mayflies. Ephemeropteran nymphs were collected in each location at 30-day intervals. A hand screen or hand-picking of rocks and debris was employed for 90 minutes in an area of 2 m^2. The hand screen was held close to the stream bottom while stones and bottom material were dislodged by the collector scuffing the bottom with his boots.

Twenty-five per cent of the nymphs collected were transported alive to the laboratory to obtain adults and to confirm their identity. The remaining 75 per cent were placed in vials containing 70 per cent ethanol for identification. Aerial collections for adults were made using aerial nets or beating nets for sweeping stream-side vegetation.

Nymphs and adults were identified with the keys of Lehmkuhl (1979), Merritt and Cummins (1984), Berner and Pescador (1988) and others.

Distribution diagrams were constructed in order to correlate mayfly species with altitude and with water quality parameters.

Results and Discussion

Samples collected from 20 stations between 50 and 2000 m elevation from the Cali, Meléndez, Pance and Anchicayá rivers yielded over 1141 nymphs of 17 species of Ephemeroptera. Leptophlebiidae and Leptohyphidae were the predominant families, each family with 36 per cent of the total numbers. Euthyplociidae and Oligoneuriidae were the least represented (Fig. 2).

The genera *Thraulodes* (Leptophlebiidae) and *Lephohyphes* (Leptohyphidae) were broadly distributed from 50 to 2000 m elevation and represented the highest frequency of occurrence. *Baetis* (Baetidae) was found with minor frequency but with the same altitudinal distribution. *Euthyplocia* (Euthyplociidae) and *Moribaetis* (Baetidae) were present between 1600 and 2000 m but in small numbers (Fig. 3).

Thraulodes sp. A and *Thraulodes* sp. B (new species) were restricted to high altitudes. These water systems have high concentrations of dissolved oxygen and minimal water temperature fluctuations (Fig. 4). The families, Oligoneuriidae and Euthyplociidae, were each represented by a single genus, *Lachlania* and *Euthyplocia*, respectively.

When altitudinal variation of the different physical and chemical station parameters were compared to the Ephemeroptera community for the Cali, Meléndez,

Figure 2. Percentage distribution of Ephemeroptera families.

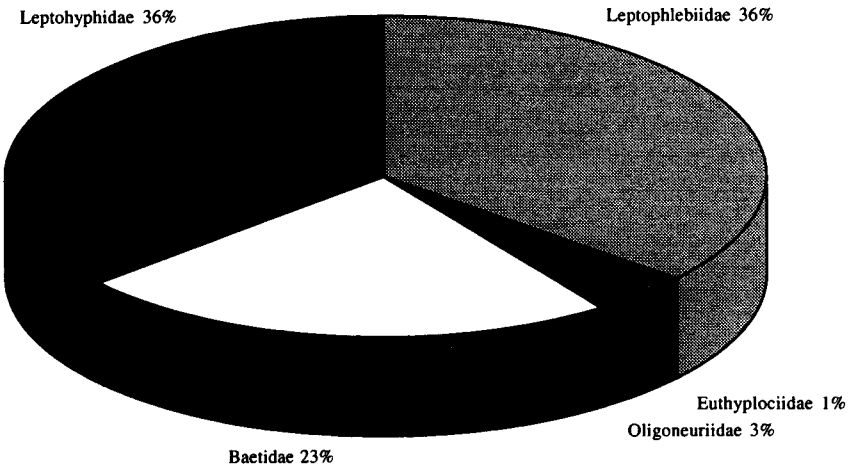


Figure 3. Percentage and altitudinal distribution of Ephemeroptera genera.

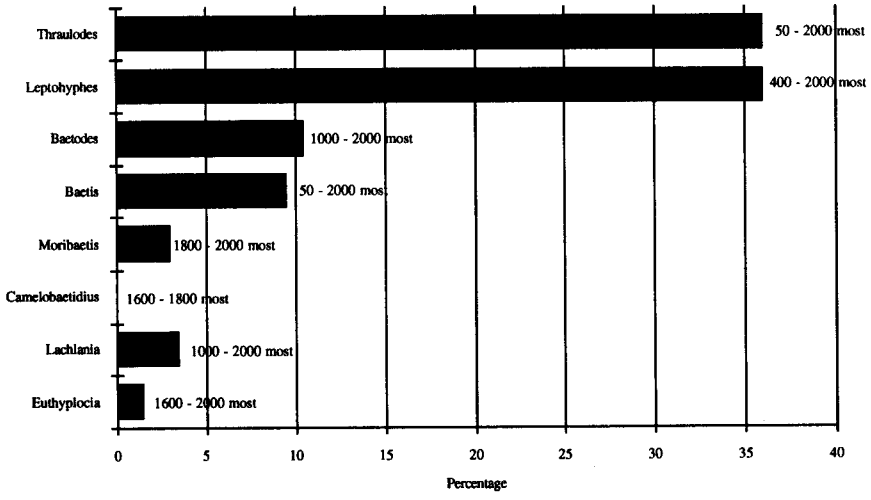


Figure 4. Altitudinal distribution of Ephemeroptera.

FAMILIES	SPECIES	METERS OVER SEA LEVEL								
		50	430	840	1000	1080	1200	1600	1800	2000
Leptophlebiidae	Thraulodes sp. A									
	Thraulodes sp. B									
	Thraulodes sp. C									
	Thraulodes spp.									
Baetidae	Baetis spp.									
	Baetodes sp. A									
	Baetodes sp. B									
	Baetodes sp. A									
	Camelobaetidius sp. A									
	Camelobaetidius sp. B									
	Moribaetis sp.									
Leptohyphidae	Leptohyphes sp. A									
	Leptohyphes sp. B									
	Leptohyphes sp.									
	Haplohyphes spp.									
Oligoneuriidae	Lachlania sp.									
Euthyplociidae	Euthyplocia sp.									

Anchicayá and Pance rivers, the highest percentage of individuals was observed between 1600 and 2000 m. Here, temperatures were between 16°C and 18°C, oxygen saturation was between 98.3 per cent and 99.9 per cent and Ott water quality index between 76 and 77.2 units.

The preliminary identification of principal Ephemeroptera species permitted establishment of correlations between the Ott water quality index for each station of the Cali and Meléndez rivers and faunistic diversity. The greatest Ephemeroptera numbers and diversity occurred in areas with a water quality index between 77.2 and 76.5 for both rivers (Figs. 5 and 6). The biological index showed the impact caused by water deterioration more clearly than any physical or chemical index for these rivers.

Conclusions

Leptophlebiidae, Leptohyphidae and Baetidae were the best represented families of Ephemeroptera, both with respect to species richness and abundance.

Figure 5. Water quality parameters in the Cali River.

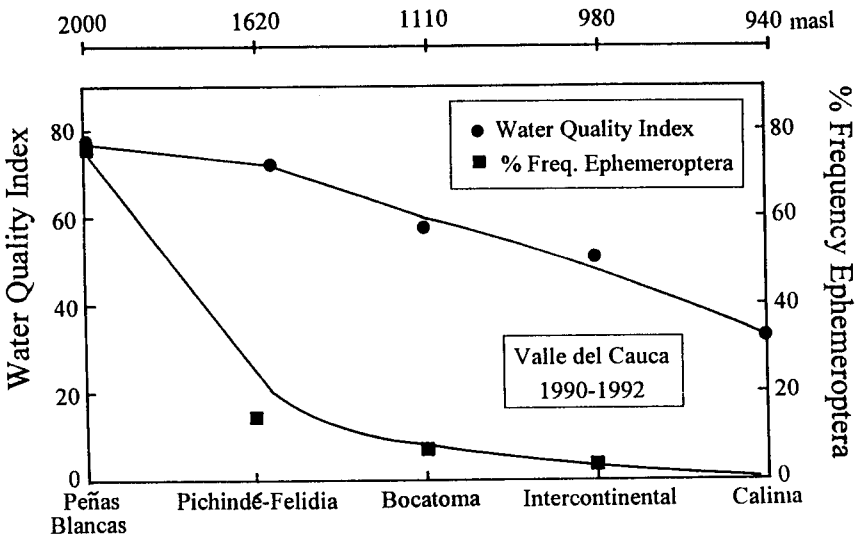
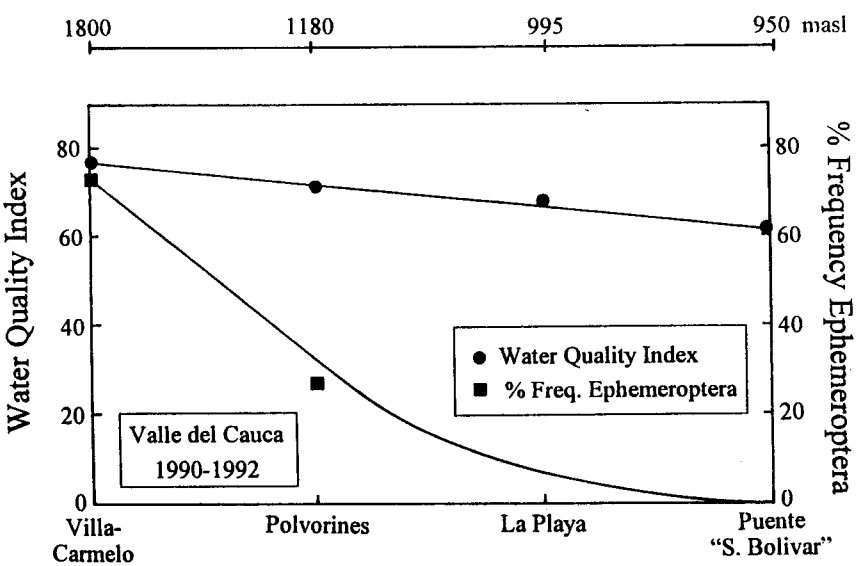


Figure 6. Water quality parameters in the Meléndez River.



Leptohyphes and *Baetis* showed a great capacity of adaptation to different ecosystems and pollution conditions. The presence of several species of *Thraulodes* means that this genus may have a wide range of distribution in altitude. However, *Thraulodes* is sensitive to polluted conditions. *Lachlania* sp. and *Euthyplocia* sp. can be regarded as indicators of cold and unpolluted areas.

The greatest number of genera of Ephemeroptera occurred in the upper basins of the Cali and Meléndez rivers, where the Ott water quality index was 77.2 and 76.3 units, respectively, and oxygen was 98.3-99.1 per cent saturated.

Acknowledgements

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