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Lentic water quality characterization using macroinvertebrates as bioindicators: An adapted BMWP index

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ABSTRACT

Water quality in lowland lentic system was evaluated through the use of aquatic macroinvertebrates as bioindicators, and their relationship with basic physicochemical factors was considered; thus, two biotopes were established for identifying both groups of macroinvertebrates, one being the population associated with macrophytes (AM) and the other being benthic (B). As a result, 46 families of macroinvertebrates were collected, with Hydrobiidae, Chironomidae, Thiaridae and Polymitarcyidae being the most abundant in the system. In addition, families with high tolerance to extreme conditions, such as Ceratopogonidae, Chironomidae and Syrphidae, were found, as well as some families with low tolerance to these conditions, such as Caenidae and Leptoceridae. The first biotope presented 7.189 individuals (50.42%) and the second 7.056 (49.5%), for a total of 14.259 individuals. Biotope AM presented 100% of the richness, while biotope B was significantly less rich, with 15 families, which represent 32,06%. In order to evaluate the families found in the lowland lentic system, their distribution in the ranges of variation of the physicochemical factors and tolerance levels was taken into account. As a consequence, a new score table was established, where this system obtained a total score of 207 with an average of 166 per sampling station, suggesting signs of contamination. Finally, these results allow an adaptation of the *BMWP* (Biological Monitoring Working Party) index to be proposed, including the lowland lentic systems.

1. Introduction

Until the last century, the methodologies to study and monitor water resources were almost exclusively based on physicochemical analysis (Alba-Tercedor, 1996; Hawkes, 1998). Nevertheless, the increase in new contaminant products, as well as the fact that polluting effluents are usually specific in time, encourages the use of unusual methodologies (Zamora-Muñoz et al., 1995). Amongst them is included bioindication by using aquatic macroinvertebrates, a methodology that shows efficacy in the detection and mapping of alteration in water quality (Prat et al., 2006; Duran and Suicmez, 2007; Abarca, 2007). Besides, its use is cheap, fast and accurate, reflecting the conditions that existed long ago, while conventional analytical methods offer a momentary assessment of the system. The implementation of these methodologies does not necessarily involve the elimination of the analytical methods, which could be useful for further analysis in conflicting sections, such as specific waste dumping (MacNeil et al., 2010; Colpo et al.,

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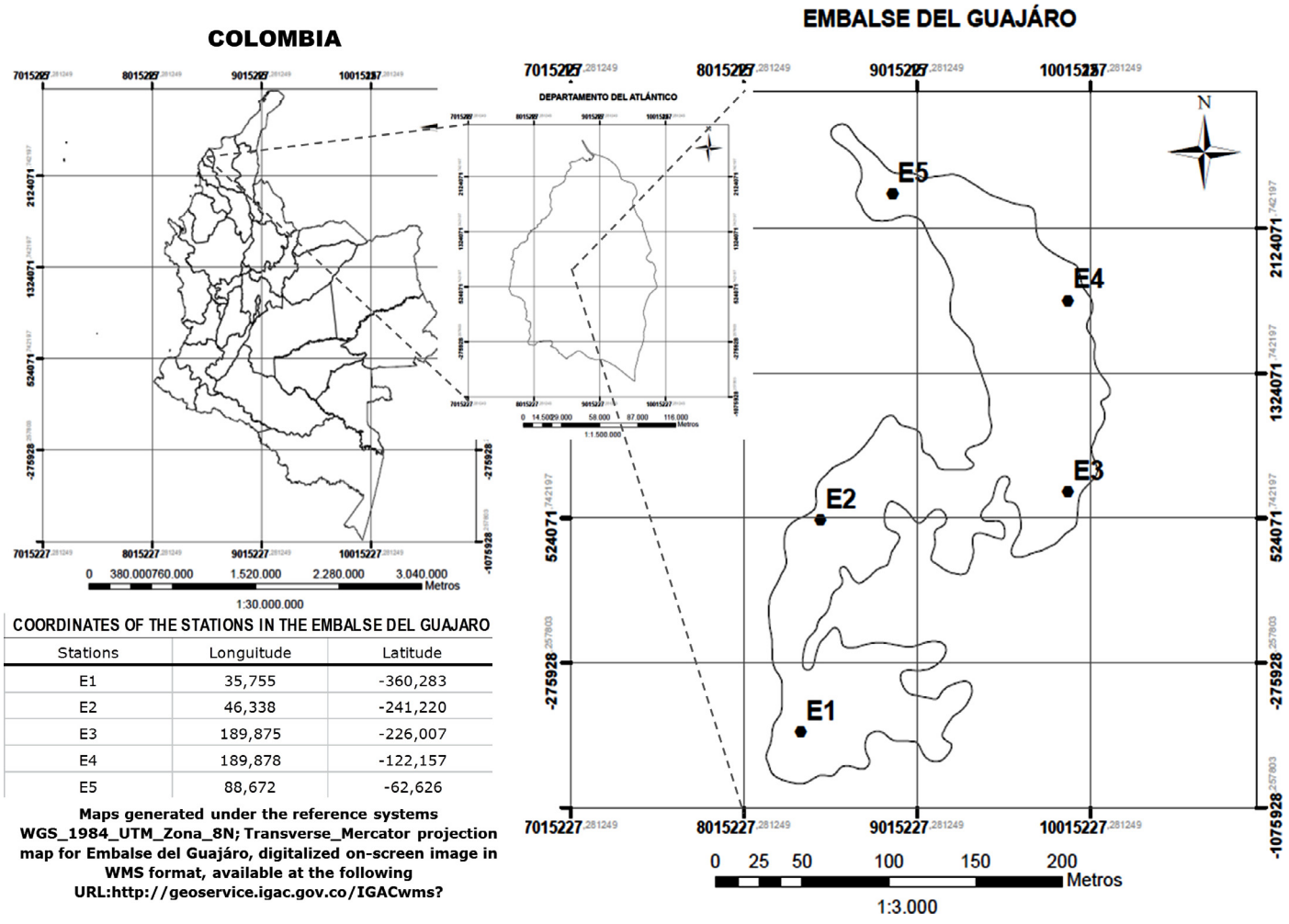

Fig. 1. Study area location showing stations E1. E2. E3. E4 and E5 used in the sampling area.

Table 1
Methods for physicochemical analysis used in this study.

Variable	Convention	Method (APHA AWWA-WPCF 2012)
Physicochemical		
Depth (cm)	Dep	SM Bathymetric 2130 B
Transparency (cm)	Tran	SM Bathymetric 2130 B
pH (Und. de pH)	pH	SM Electrometric 4500 H + B
Temperature (°C)	T	SM Electrometric 2550B
Dissolved Oxygen (mg/L)	DO	SM Azido Modification 4500-O C
Alkalinity (mg/L CaCO3)	Alk	SM Titration 2320 B
Hardness (mg/L Ca + 2 + Mg + 2)	Hn	SM EDTA Titrimetric 3500-Mg B
Conductivity (uS/cm) (*in situ*)	Cdv	SM Electrometric 2510 B
Biochemical oxygen demand (mgO2/L)	BOD5	SM Test BOD 5210 B
Suspended solids (mg/L)	SS	SM Gravimetric 2540 D
Sulphates (mg SO4-2/L)	SOx	SM Acetic acid Turbidity 4500 SO4-E
Nitrates (mg NO3/L)	NOx	SM Spect. Uv 4500 NO3-B
Ammonia nitrogen (mg NH3-N/L)	NHx	SM NH3-N 4500C
Phosphates (mg P-PO4/L)	POx	SM Spect. 4500 P – E
Hydrobiological		
Macrophytes Associated Macroinvertebrates	AM	SM 10500 A–D
Benthic Macroinvertebrates	B	SM 10500 A–D

2009; Nubia et al., 2009). All these aspects have been considered in the implementation of this methodology in many countries around the world (Czerniawska-Kusza, 2005; Królak and Korycińska, 2008; Varnosfaderany et al., 2010; Suleiman and Abdullahi, 2012). However, its use has been concentrated in lotic and lentic systems from high and low latitudes as well as at high altitude in the Neotropic (Pinilla, 2010; Trama and Marcacuzco, 2013; Ramírez and Gutiérrez-Fonseca, 2014).

Around the world, there are many researchers working on the setting of the most common index that uses aquatic macroinvertebrates, called BMWP (Biological Monitoring Working Party). This index is modified according to the present biodiversity settings present in these places (Mustow, 2002; Roche et al.,