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Aquatic Macroinvertebrate Diversity and Water Quality, La Gallega-Morropón Creek, Piura, Peru

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ABSTRACT

Freshwater systems are one of the most important natural resources for life. Despite their value, these ecosystems have suffered great impacts caused by human activities, which directly affect the aquatic biota and the quality of water sources. Considering the value of aquatic macroinvertebrates as bioindicators of water quality, the richness, composition, and water quality of La Gallega-Morropón stream, Piura-Peru, were compared. Two field trips were conducted between November 2018 and May 2019 (contemplated wet and dry periods, respectively), performing 4 sampling stations. A total of 1772 individuals of macroinvertebrates were recorded, distributed in 22 families. Psychodidae had an abundance of 670 individuals, followed by morphospecies (Gasteropoda) with 379 individuals, Chironomidae with 275 individuals, and Elmidae with 136 individuals (all indicators of water quality). Finally, the water quality index method: 1) BMWP/Col, presented one station with good (HB1), acceptable (HB2), and critical (HB3 and HB4) quality, while 2) EPT exhibited two stations with good quality (HB3 and HB4), HB1 regular quality and HB2 poor (HB3 and HB4), HB1 regular quality and HB2 poor quality.

INTRODUCTION

The biological component has always been used as an alternative to understanding the quality of aquatic environments; throughout history, algae, protozoa, bacteria (perhaps the most used group), fish, macrophytes, fungi, and aquatic macroinvertebrates have been used (Roldán 2003, Coayla-Peñaloza et al. 2023).

For example, temperate regions were among the first to use these indices, and if they want to use them in tropical areas, they need to analyze the general processes and disturbances that exist (Álvarez & Pérez 2007, Bonada et al. 2006). Likewise, these must be flexible, selective, and broad to be used to indicate not only water quality but also human economic impacts (de la Lanza et al. 2000), furthermore, they constitute the animal biomass in rivers playing a vital role in the transfer of energy from primary resources to the main consumers in food webs (Medina & Yasmy 2011, Custodio & Chávez 2019).

The advantages are ease of sampling, rapid changes in trophic structure, and composition and occurrence of some groups due to various types of natural and anthropogenic disturbances and their sedentary character, giving a good idea of what happens in each sampled habitat (Bailey et al. 2003), these communities are sensitive to small increases in temperature, variations in hydrogen potential (Bergkamp & Orlando 1999, Durance & Ormerod 2007, Roldán 2003).

Freshwater bodies are always subject to various changes related to agriculture (pesticides, herbicides, fertilizers that settle in the water), livestock, or deforestation (Martínez et al. 2022). Fernández et al. (2004) stated that these compounds can be released into water from sewers and industrial effluents if they are close to the human population.

The pollution of the Piura River in recent years, is increasingly serious, which is due to discharges of domestic and hospital wastewater discharged without or poor treatment, agriculture, solid waste, and heavy metals due to illegal mining.

Aware of the essential role played by macroinvertebrates in freshwater aquaculture systems, the objective was to analyze the richness, composition, and water quality of the La Gallega-Morropón stream, Piura.

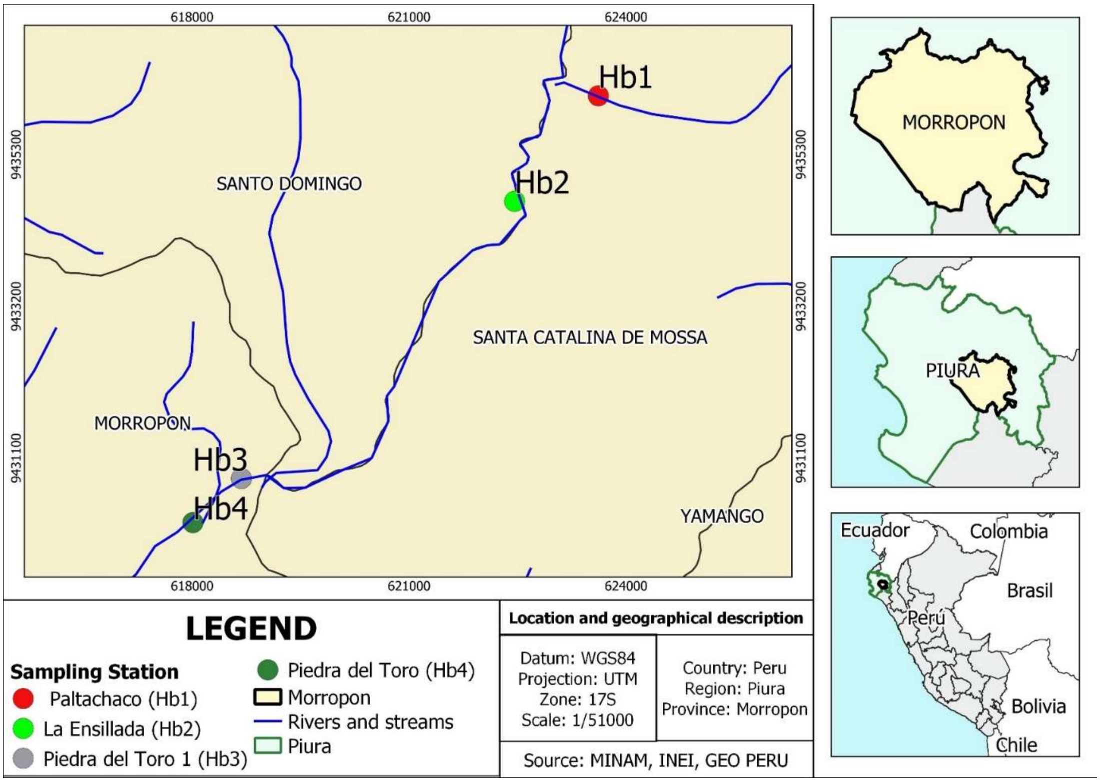

Fig. 1: Location of the study area, La Gallega-Morropón stream, Piura-Peru.

MATERIALS AND METHODS

The La Gallega sub-basin, with 142 km^2, includes the districts of Santo Domingo, Santa Catalina de Mossa, part of Chalaco and Morropón. The main course of the river begins at the confluence of the Santo Domingo and Ñoma streams; before flowing into the Piura River, it joins the Corral de Medio tributary. El Cerezo Creek has been integrated into this sub-basin. Its average annual discharge averages 1.68 m^3/s, with the highest discharges occurring in March. In the February-May period, 79 % of the total annual volume is produced (average 53 million m^3). The Corral del Medio River forms the Las Juntas River, which is very short until it joins the Piura River (Rojas & Ibáñez 2003).

Four sampling stations were established along the La Gallega stream (Fig. 1). For the collection of aquatic macroinvertebrates, two samplings were conducted during November 2018 and May 2019 (Fig.1), in the rainy and dry periods, respectively. For the collection, a Surber net of 30.5 × 30.5 × 8 cm, 500 µm mesh opening, with 3 replicates per substrate (leaf litter, rock and fine sediment) was used (MINAN 2017), Pinheiro et al. 2004). Samples were labeled with the sampling station preserved in 70% alcohol and separated for later identification at the Zoology Research Laboratory, Faculty of Sciences, Universidad Nacional de Piura.

For the identification of the taxa, taxonomic keys of Domínguez & Fernández (2001), Dominguez et al. (2006), Domínguez & Fernández (2009), Posada & Roldán (2003), Roldán (1988) and Springer (2006) were used.

Simpson's dominance, Margalef diversity, and Shannon-Wienner equity indices were used to estimate diversity (MINAM 2017, Moreno 2001).

For each sampling station, the EPT (Ephemeroptera, Plecoptera, Trichoptera) (Carrera & Fierro 2001) and BMWP/Col (Biological Monitoring Working Party, modified for Colombia) indices were estimated (modified from Roldán 2003).

RESULTS

A total of 1,772 macroinvertebrates were captured, distributed in 10 orders and 22 families. Psychodidae had the highest number of individuals with 670 individuals, followed by Chironomidae with 275 individuals, and Elmidae with 136 individuals. Fig. 2 shows the richness of the aquatic

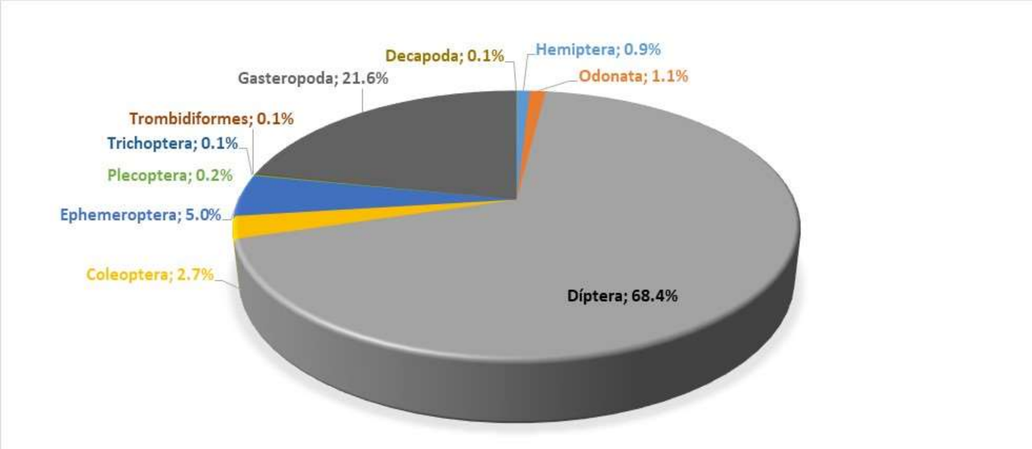

Fig. 2: Richness of aquatic macroinvertebrate taxa, La Gallega-Morropón stream, Piura-Peru.

Table 1: Alpha diversity indices of the sampling stations, La Gallega-Morropón stream, Piura-Peru.

Diversity indexes	Sampling stations			
	HB_1	HB_2	HB_3	HB_4
Simpson_1-D	0,526	0,549	0,132	0,695
Shannon_H	1,560	1,499	0,538	2,124
Margalef	1,864	1,573	1,165	1,669

macroinvertebrate taxa present in the La Gallega-Morropón stream, Piura-Peru.

As for the alpha diversity indexes, they show that there is no dominance of a specific group of taxa, due to the low diversity of species present in the sampling stations, the station that stands out with the highest value for Simpson's index is HB_4, while in the Margalef index, the highest value was HB_1, in terms of the value obtained from Shannon, HB_4 presented the highest value (Table 1).

Simultaneously for the water quality variable, the rating is varied for BMWP/Col in all stations, probably because this water quality index is calculated through the presence or absence of aquatic macroinvertebrate families, which may produce imprecision in the ratings (Table 2). In contrast, the EPT index calculates water quality based on the richness of the Ephemeroptera, Plecoptera, and Trichoptera orders (Table 2), which makes this index useful in the detection of more sensitive disturbances, as well as evidenced (Álvarez & Pérez 2007). Finally, the water quality index method, such as BMWP/Col, presented one station with good (HB_1), acceptable (HB_2), and critical (HB_3 and HB_4) quality; while EPT exhibited two stations with good quality (HB_3 and HB_4), HB_1 regular quality and HB_2 poor quality.

For the physicochemical parameters, Figs. 3 and 4 evaluated in the development of the monitoring comply with the ECAs for natural body category, established in the Peruvian regulations (MINAM 2017).

DISCUSSION

Rivera et al. (2008), state that contamination increases when there are low oxygen levels and the distribution of macroinvertebrates is related to water quality. It was possible to verify the presence of Chirinomidae in the La Gallega stream, which was found in the sampling stations ranging from good, acceptable, and critical waters; where the oxygen level in HB_1 and HB_2 is high and low in HB_3 and HB_4; in the case of Ephemeroptera, Custodio & Chaname (2016), comment that they live in sites with good oxygenation, in

Table 2: EPT and BMWP/Col indices for each sampling station, La Gallega-Morropón stream, Piura-Peru.

Sampling station	Station name	Water Quality Index	
		BMWP/Col	EPT
HB_1	Paltashaco	Good (blue)	Regular (yellow)
HB_2	La Ensillada	Acceptable (green)	Mala (red)
HB_3	Piedra del toro	Critique (orange)	Good (green)
HB_4	Piedra del toro 2	Critique (orange)	Good (green)

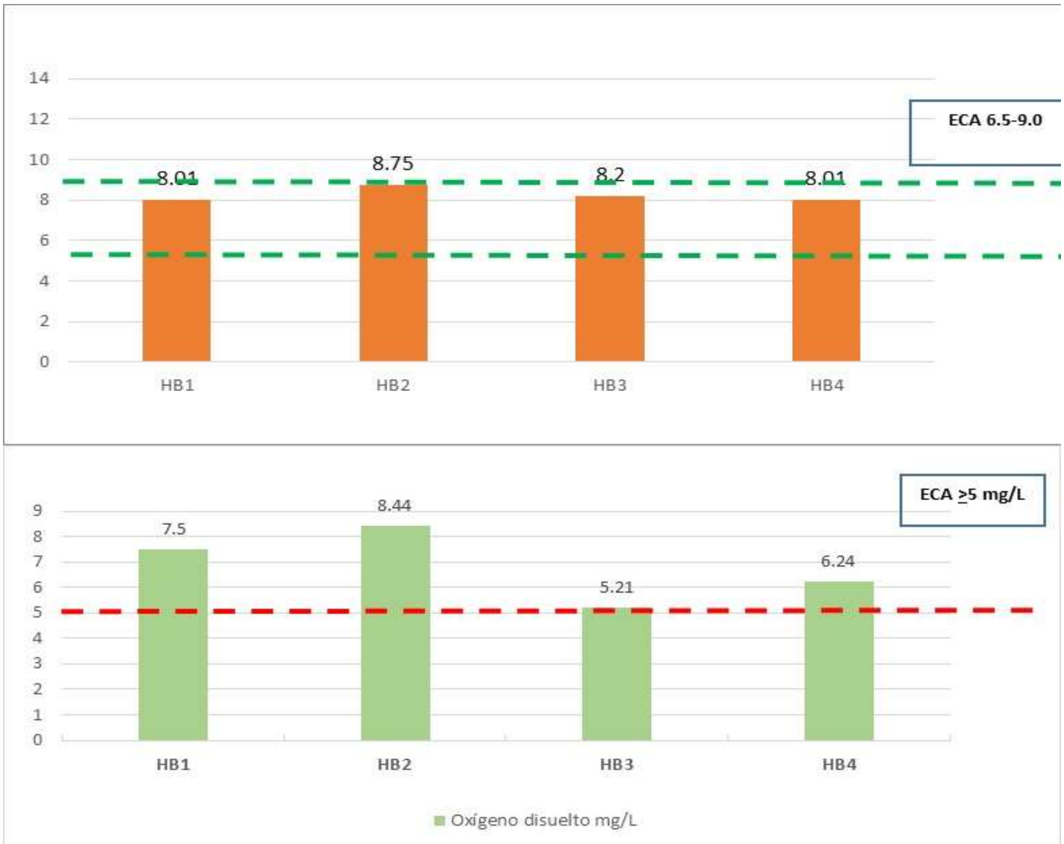

Fig. 3: Hydrogen potential (pH) and dissolved oxygen (mg/L) values of the sampling stations, La Gallega-Morropón stream, Piura-Peru.

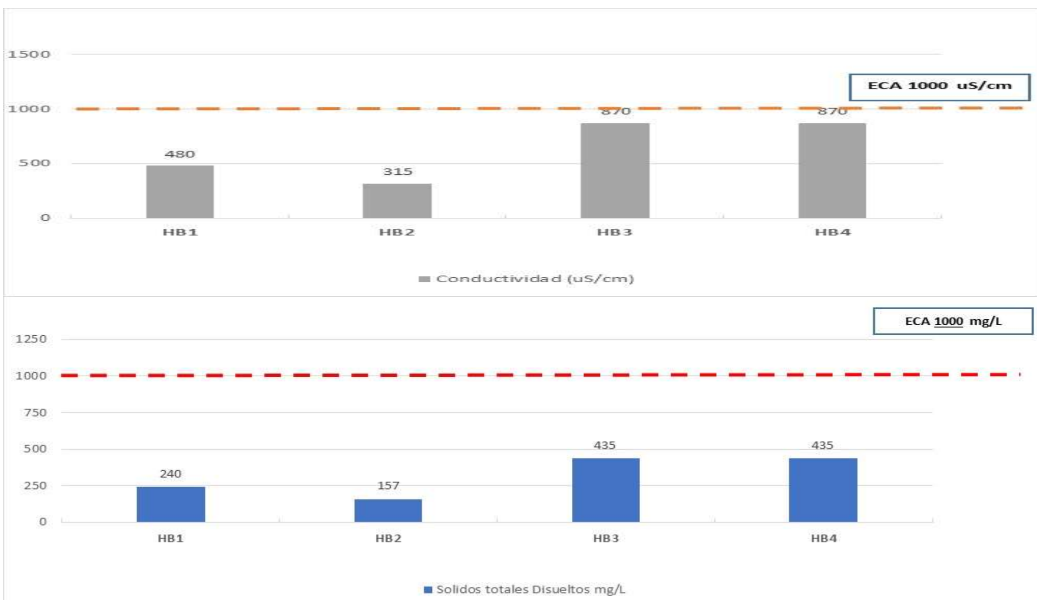

Fig. 4: Potential values of electrical conductivity (uS/cm) and Total Dissolved Solids (mg/L) of the sampling stations, La Gallega-Morropón stream, Piura-Peru.

substrates of sand, stone, that is, they live in water bodies with good quality, we can verify this in the HB1 station, here the water quality gave us acceptable with 118 scores (BMWP/Col) the highest in all sampling stations.

Burdet & Watts (2009), argue that substrates dominated by leaf litter provide a greater availability of resources derived from biodegradation, so that in addition to presenting a high species richness, they allow sustaining a higher density of organisms. It was possible to identify that in the sampling stations in the La Gallega stream, all of them presented substrates with leaf litter, thus favoring some groups of macroinvertebrates such as Libellulidae, Zygoptera, Psychodidae, Chironomidae, Elmidae, Leptophlebiidae, Leptophlebiidae, and Leptophlebiidae.

Villamarín (2008), points out that, in rivers, the higher the altitude the water quality is good, but the availability of habitat is lower; the opposite happens when the altitude is lower and even the availability of water is higher; in the stations of La Gallega stream, the composition of the taxa was homogeneous, so there was no evidence of the influence of the altitudinal gradient. In addition, Giacometti & Bersosa (2006) comment that the diversity of macroinvertebrate species is influenced by the variables temperature and oxygen, while in La Gallega stream, dissolved oxygen obtained values >5mg/L in all sampling stations, complying with what is established in ECA (MINAM 2017) for natural water bodies.

Alburqueque (2018), details that the water quality of the confluence of Corrales, Medio, and Alto Piura sub-basins using the BMWP/Col index, reported 37 families belonging to 5 classes, with a predominance of Hemiptera, Diptera, Coleoptera, and Ephemeroptera, it was identified that the water quality is acceptable and regular in different sampling points; In La Gallega stream a total of 22 families were obtained, being Psychodidae the one with the highest number of individuals with 670, followed by Chironomidae with 306 and Elmidae with 228, this difference of decrease in the number of families is because the water body has been suffering alterations caused by anthropological effects (different livestock and agricultural activities). Domínguez & Fernández (2009), Quinn & Hickey (1990), and Roldán (1988) refer that physicochemical factors influence the aquatic macroinvertebrate community. They emphasize that water velocity, temperature, and oxygen availability are determining factors in the distribution of these organisms. In the results obtained, the physicochemical parameters (oxygen, temperature, pH, conductivity, turbidity) are within the range of values established in the ECA (MINAM 2017) for natural water bodies.

CONCLUSIONS

The diversity of aquatic macroinvertebrates is low, due to the anthropogenic factor along the La Gallega-Morropón stream, Piura-Peru.

The water quality indexes, BMWP/Col, presented one station with good (HB_1), acceptable (HB_2), and critical (HB_3 and HB_4) quality, while 2) EPT exhibited two stations with good quality (HB_3 and HB_4), HB1 regular quality and HB_2 poor quality.

The values of the physicochemical parameters evaluated all comply with the values established in the Peruvian regulations.

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