

Benthic macroinvertebrates as biological indicators of water quality in the Lombaryo River in Ecuador

Morales Corozo, Juan Pablo*

Universidad Nacional Experimental de los Llanos Ezequiel Zamora, San Carlos, Venezuela

*Corresponding author.

E-mail address: j.p.shevarajo@gmail.com

Abstract: Macroinvertebrates provide signals about water source conditions and are used for monitoring, as they require water to be in good condition for survival. When water is polluted, slight changes in their habitat conditions can cause them to disappear. This study was conducted on the Lombaryo River, located in the diocese of the same name in Gonzalo Pizarro canton, which is in the province of Sucumbíos, with a total length of 24 kilometers and running through the entire diocese. The purpose of this study is to determine water quality by identifying five points in specific areas where the abundance of each species is collected and counted, using large invertebrates as bioindicators. This study finds strong evidence of the presence of Ephemeroptera, Plecoptera, and Trichoptera in the aquatic ecosystem of the Lombaryo River, and insect diversity indicates a clear connection with the protection of ecosystem services in this water body.

Key words: Macroinvertebrates; water quality index; environmental bioindicators; conservation

1 Introduction

Rivers are one of the main sources of nutrients for the entire food chain that allows life to exist on Earth. They are also crucial for the development of human communities, making them a cultural and natural heritage [1]. At the ecosystem level, they stand out for their complexity and dynamism where flora and fauna develop [2]. In the world, there is great concern for the conservation of these ecosystems in order to maintain their natural processes and allow the reproduction of the life of various species.

Aquatic ecosystems present in rivers have a high degree of sensitivity to variations in their conditions, which alter water quality and quantity, making it necessary to carry out comparative studies [3]. Recent developments in the field of conservation have prompted people to pay attention to biological indicators to assess the impact of pollutants on water sources, allowing the search for biological criteria to estimate the effects of anthropogenic activities [4].

Water quality bioindicators are groups of biological communities whose tolerance and biotic response are used as measures or parameters to evaluate and monitor the quality of a water body and whether they are altered due to the presence of pollutants [5]. Biological information reinforces the results provided by physicochemical analyses, allowing a comprehensive analysis to be obtained. Biological information also makes it possible to evaluate aspects such as the level of exposure and response of ecosystems to environmental changes.

Benthic macroinvertebrates are invertebrate animals such as crustaceans, mollusks, and insects that inhabit in fluvial ecosystems at least for one stage of their life cycle, with sizes exceeding 0.50 millimeters. They are sensitive to variations in hydraulic dynamics, having a potential use for analyzing disturbances of aquatic ecosystems [6]. According to Alomía et al. (2017), environmental damages generate variations in the amount of macroinvertebrate population, which is largely due to changes in physicochemical conditions, as some of them require good water condition to survive and a slight alteration causes their absence [7].

Studies on bioindicators show the importance of benthic macroinvertebrates in environmental health, leading to an understanding of the functional responses of these organisms to pollutants [8]. According to several scientific studies, benthic macroinvertebrates have been classified according to their sensitivity to the presence of pollutants in rivers into three groups: those sensitive to pollution; those tolerant to some degree of pollution; and those tolerant to pollution (Table 1).

Table 1. Category of benthic macroinvertebrates

Group 1 Sensitive to pollution	Group 2 Tolerates a certain degree of pollution	Group 3 Tolerates pollution
Ephemeroptera	Odonata	Hemiptera
Plecoptera	Amphipod	Oligochaeta
Trichoptera	Megaloptera	
	Coleoptera	

Source: Arevalo and Lema, (2020) [9].

Macroinvertebrates sensitive to pollution are those belonging to group 1 where the orders Ephemeroptera, Plecoptera and Trichoptera are found; their abundance enables us to understand the water quality [9]. Macroinvertebrates belonging to the order Ephemeroptera known as mayflies, have a special behavior, with a very short life span and are sensitive to changes in water [9]. Those belonging to the order Plecoptera are rare neopteran insects characterized by incomplete metamorphosis, in their nymphal stage they are aquatic and as adults they fly [10]. Those belonging to the order Trichoptera are endopterygote insects whose larvae are aquatic and fly as adults; they are related to the Lepidoptera [11].

The Lombaryo River, located in the parish of the same name in the Gonzalo Pizarro canton in the province of Sucumbíos, has an extension of 24 km and crosses the entire parish. For this research, the methodology established by Carrera and Fierro (2001) was adopted, which consisted of analysis on the three groups of macroinvertebrates: Ephemeroptera, Plecoptera and Trichoptera (EPT). The technicians of the Environmental Management Directorate of the Decentralized Autonomous Government identified five points in a specific area within the Lombaryo River where the macroinvertebrates were collected. Specialized taxonomic characters were used to identify the macroinvertebrates, and the abundance of individuals was quantified to later add up the total amount, obtaining the amount of EPT present using the following equation:

$$ICA = \frac{C_{EPT}}{C_T} * 100\%$$

Where:

ICA : Water quality index

C_{EPT} : Number of EPT collected

C_T : Total number of individuals

Table 2. EFA analysis

Description	Item 1	Item 2	Item 3	Item 4	Item 5	Total
Ephemeroptera	8	8	3	2	5	26
Plecoptera	5	11	9	8	11	44
Trichoptera	3	6	10	5	11	35
Abundance						105
Percentage						68.63%
Range						50% - 74%
Water quality						Good

Source: Cumbicus, (2023)

As can be seen in Table 2 with respect to the abundance of the EPTs analyzed, the water quality index has a value of 68.63%, which is within the category of good, so this criterion can be taken as a reference to establish local norms for the restriction in the execution of anthropic activities within the riverbanks based on the exclusive municipal competencies established in Article 430 of the *Organic Code of Territorial Ordering, Autonomy and Decentralization of Ecuador*.

Benthic macroinvertebrates are fundamental in aquatic ecosystems and show us the state of the rivers. Local governments play a fundamental role in Ecuador's institutional framework. In the case of the Lombaryo River, the autonomous decentralized municipal government of the Gonzalo Pizarro canton is called upon to carry out an integrated management plan for this water basin, including water quality records and taking the pertinent actions for the responsible use and conservation of this body of water, in coordination with the central government and in collaboration with the citizens.

A comparative analysis of the benthic macroinvertebrates in several nearby rivers will make it possible to create a register of bioindicators to verify water quality in order to take measures to prevent contamination, considering the parameters of temperature, humidity, altitude and precipitation to verify if they influence its behavior. This methodology provides a little-known recommendation for the management of water bodies in Ecuador.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- [1] Ramírez, A. y Gutiérrez, P. Estudios sobre macroinvertebrados acuáticos en América Latina: avances recientes y direcciones futuras. *Revista de Biología Tropical*, vol. 62, pp. 9-20, abr. 2014.
- [2] Fernández, R. L. Los macroinvertebrados acuáticos como indicadores del estado ecológico de los ríos. *Páginas de información ambiental*, n.o 39, pp. 24-29, 2012.
- [3] Oscoz, J.; Gomà, L.; Ector, J.; Cambra, M.; Pardos y Durán, C. Estudio comparativo del estado ecológico de los ríos de la cuenca del Ebro mediante macroinvertebrados y diatomeas. *Limnética*, pp. 143-158, 2007.
- [4] Cárdenas, A. Y.; Reyes, B.; López, M.; Woo, A.; Ramírez, E. y Ibrahim, M. Biodiversidad de macroinvertebrados acuáticos y la calidad del agua en la subcuenca de los ríos Bul Bul y Paiwas, Matiguás, Nicaragua. *Encuentro*, No 77, Art. n.o 77, sep. 2007, doi: 10.5377/encuentro.v0i77.3678.
- [5] Arroyo, C. y Encalada, A. C. Evaluación de la calidad de agua a través de macroinvertebrados bentónicos e índices biológicos en ríos tropicales en bosque de neblina montano. *ACI Avances en Ciencias e Ingenierías*, vol. 1, n.o 1, Art. n.o 1, abr. 2009, doi: 10.18272/aci.v1i1.4.

[6] Flores, D. y Huamantínco, A. Desarrollo de una herramienta de vigilancia ambiental ciudadana basada en macroinvertebrados bentónicos en la Cuenca del Jequetepeque (Cajamarca, Perú). *Ecología Aplicada*, vol. 16, n.o 2, pp. 105-114, jul. 2017, doi: 10.21704/rea.v16i2.1014.

[7] Giacometti, J. y Bersosa, F. Macroinvertebrados acuáticos y su importancia como bioindicadores de calidad del agua en el río Alambi. *Boletín Técnico, Serie Zoológica*, vol. 6, n.o 2, Art. n.o 2, 2006 (Acceso: Mayo 7, 2023). <https://journal.espe.edu.ec/ojs/index.php/revista-serie-zoologica/article/view/1394>.

[8] Solís, J. L. Utilización de macroinvertebrados como bioindicadores de la calidad del agua de la parte céntrica del río Jipijapa.», bachelorThesis, JIPIJAPA-UNESUM, 2017. (Acceso: Junio 17, 2023). Accedido:17 de junio de 2023. <http://repositorio.unesum.edu.ec/handle/53000/942>.

[9] Arévalo, M. L. C. y Lema, G. E. T. Relación entre la calidad del agua del Río Daule y la población de macroinvertebrados en los órdenes Ephemeroptera, Plecóptera y Trichoptera, como Bioindicadores. *Biblioteca Colloquium*, ene. 2020. (Acceso: Junio 17, 2023). <https://colloquiumbiblioteca.com/index.php/web/article/view/24>.

[10] Gutiérrez, P. E. Capítulo 6: Plecoptera. *Revista de Biología Tropical*, vol. 58, pp. 139-148, dic. 2010.

[11] Springer, M. Capítulo 7: Trichoptera. *Revista de Biología Tropical*, vol. 58, pp. 151-198, dic. 2010.

[12] Domínguez, E. y Fernández, H. R. Macroinvertebrados bentónicos sudamericanos, *Sistemática y biología*. Fundación Miguel Lillo, Tucumán, Argentina, vol. 656, 2009.

[13] Paredes, C.; Lannacone, J. y Alvaríño, L. Macroinvertebrados bentónicos como indicadores biológicos de la calidad de agua en dos ríos de Cajamarca y Amazonas, Perú | *Revista Peruana de Entomología*. 2019. Accedido: (Acceso: Mayo 7, 2023). <https://www.revperuentomol.com.pe/index.php/rev-peru-entomol/article/view/189>.