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**EVALUATION OF WATER QUALITY THROUGH
BENTHIC MACROINVERTEBRATES IN THE SARDINAS
RIVER AND LA DELICIA STREAM IN ECUADOR**

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**ОЦЕНКА КАЧЕСТВА ВОДЫ С ИСПОЛЬЗОВАНИЕМ ДАННЫХ
О ДОННЫХ МАКРОБЕСПОЗВОНОЧНЫХ В РЕКЕ САРДИНАС
И РУЧЬЕ ЛА ДЕЛИСИЯ В ЭКВАДОРЕ**

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Abstract. The present study characterized the macrobenthic entomofauna of the Sardinas river and the La Delicia stream. Their environmental quality water was determined by applying the BMWP/Col (Biological Monitoring Working Party for Colombia) index in two sampling points, distributed in the Sardinas river and La Delicia stream, during the months of May and June 2017. For its collection, a Surber net was used. In the laboratory, they were classified and identified in class, order and family levels. The specimens were analyzed by calculating the richness (S), abundance (N) and relative abundance (%). A total of 90 individuals belonging to 16 morphospecies were collected. The Hemiptera order with the Veliidae family was the most abundant, encompassing most of the organisms collected 33.33%. The less represented group was the order Diptera with the family Tipulidae with 1.52% of the individuals collected. The water quality was Moderate for the river Sardinas (BMWP/Col 59) and Good for the La Delicia stream (BMWP/Col 75). The present study characterized the community of macroinvertebrates in the study area and the ecological quality of the studied bodies of water.

Аннотация. В настоящем исследовании характеризуется донная энтомофауна реки Сардинас и ручья Ла Делисия и определяется качество окружающей среды путем применения индекса BMWP/Col (Рабочая группа по биологическому мониторингу для Колумбии) в двух пунктах отбора проб, расположенных на реке Сардинас и ручье Ла Делисия и выполненных в течение мая и июня 2017 года. При отборе проб использовалась сеть Surber. В лаборатории была проведена классификация и идентификация по уровням класса, отряда и семейства. Образцы анализировались путем расчета богатства видов (S), численности (N) и относительной численности (%). Было собрано в общей сложности 90 морфологических образцов, принадлежащих к 16 морфологическим разновидностям. Семейство Велии (Veliidae) из отряда Полужесткокрылых (Hemiptera) оказалось самым распространенным, представленным большинством отобранных в пробах организмов (33,33%). Наименее представленной группой было семейство Караморы (Tipulidae) из отряда Двукрылые (Diptera) составляющей 1,52% от числа отобранных особей. Качество воды

оказалось удовлетворительным для реки Сардинас (59 по BMWP/Col) и хорошим в ручье Ла Делисия (75 по BMWP/Col). В данном исследовании была определена динамика популяций макробеспозвоночных в исследуемой зоне и экологическое качество исследуемых водоемов.

Keywords: aquatic entomofauna, environmental quality, richness and abundance.

Ключевые слова: водная этномофауна, качество окружающей среды, богатство видов, численность.

Introduction

The accelerated growth of the human population, industrialization and urbanization are causes directly associated with water pollution [1]. Initially, water quality was evaluated only by physical-chemical data, which analyzed the effects of short-term pollution. However, in the 1950 s, biological methods for determining water quality developed extensively in Europe and it was found that water quality indicator organisms determine the long-term effects of impacts on the aquatic ecosystem [2].

The parish of Pacto is located at the Northwestern end of the Metropolitan District of Quito at a distance of 84 km from the city. Its weather is humid and temperate. Temperatures oscillate between 17° and 20°C. It has a surface area of 346.14 km². It is a mountainous region with an altitude ranging from 500 to 1,800 meters above sea level. It is crossed by the rivers: Guayllabamba, Mashpi, Sahuagal, Sardinias, San Jose, Pachijal, Anope, Chulupe, Gualcuyacu, Piripe, Pishashi, Chontal, San Francisco and Santana [3]. This area is considered agricultural with a great potential for eco-tourism, nature tourism, and as a conservation area [4].

The native vegetation of the Parish of Pacto is part of the montane forests of Ecuador, considered worldwide as zones of high diversity and endemism [5-9]. However, there are no studies that describe the community of macroinvertebrates and their degree of conservation. Therefore, in the present study the macrobenthic entomofauna of the Sardinias river and the La Delicia stream were characterized, and their environmental quality was determined through the application of the BMWP/Col Index (Biological Monitoring Working Party for Colombia) [10], in two sampling points, distributed in the river Sardinias and La Delicia stream, during the months of May and June 2017.

Material and research methods

Study Site: The Sardinias river and the La Delicia stream are located in the Province of Pichincha, Quito Canton, Pacto Parish. The inhabitants use them as a source of water for their pipe systems, for which there is uptake infrastructure. The Sardinias river has a strong current and a rocky substrate. The riparian vegetation corresponds to a secondary forest with little human activity. Sampling was carried out at the coordinates: 17N 074844S — UTM 0016926.

The La Delicia stream is a source of water of sloping topographic surface, which is between high points. According to erosion and lithology it could be characterized as regular. The water is colorless. It was possible to observe the presence of amphibians at the sample sites. The stream has a native vegetation cover, of a secondary forest type. The samples were taken at the coordinates: 17N0742530 — UTM 0016243.

Field Phase: The field work was carried out in two sampling points that were determined taking into account the use of water for human consumption. The samples were taken in the months of May and June 2017. Coordinates were recorded with a GPS (Garmin, Oregon 550). A 50m long transect parallel to the riverbank was established where 10 macro invertebrate sampling points were

chosen randomly. In each selected point, during the course of a minute, the sampling technique with the Surber net was applied [11-12]. The collected organisms were placed in Ziplock-type bags [13] properly labeled and preserved in ethanol at 70% [14].

At each point pH, turbidity and conductivity were measured with a multi-parameter HACH device model HQ40d.

Laboratory Phase: In the laboratory, the organisms were separated from the substrate, using a sieve, watchmaker's tweezers, a white plastic tray, water, 95% ethanol, 3 ml. vacutainer tubes, and 100 ml. plastic jars for the larger individuals. The macroinvertebrates collected were identified at the class, order and family level with the help of a technical level stereoscopic microscope with a binocular zoom Model ZMAB-ST2, with 10x eyepieces and 1x and 4x lenses. The identification of the specimens was made through dichotomous keys: [9, 15-20].

Data Analysis: The following parameters of the aquatic macro invertebrate community were evaluated:

Richness of Species (S): Total number of species in each sampling point. [21]

Abundance (N): Total number of individuals recorded in each sampling point. [21].

Relative Abundance (%): Number of individuals of each morphospecies multiplied by one hundred and divided by the total recorded abundance in each body of water [21].

BMWP/Col (Biological Monitoring Working Party for Colombia): To determine water quality the BMWP/Col index was used [16].

Results and discussion

Aquatic Habitat Conditions: Table 1 details the environmental conditions of the Sardinas river and the La Delicia stream at the time of macro invertebrate sample collection (Table 1).

Table 1.
 ENVIRONMENTAL PARAMETERS OF THE SARDINAS RIVER AND LA DELICIA STREAM

<i>Las Delicias stream</i>				<i>Sardinas river</i>				
<i>T°C</i>	<i>pH</i>	<i>Turbidity NTU</i>	<i>Conductivity μS/cm</i>	<i>T°C</i>	<i>pH</i>	<i>Turbidity NTU</i>	<i>Conductivity μS/cm</i>	
23,40	6,00	14,90	158,00	21,00	5,80	3,92	25,70	
18,80	6,80	6,20	45,00	25,20	7,50	4,94	130,70	
18,70	7,70	4,80	46,00	21,00	7,50	3,92	130,70	
\bar{X}	20,30	6,83	8,63	83,00	22,40	6,93	4,26	95,70

Richness, Abundance and Relative Abundance: A total of 90 individuals were collected, belonging to 16 morphospecies. The Hemiptera order with the Veliidae family, was the most abundant. It encompassed most of the collected organisms 33.33%. The least represented group was the order Diptera with the Tipulidae family with 1.52% of collected individuals.

La Delicia stream ranked 5 out of 10 and the Sardinas river got 9. Abundance in La Delicia was of 24 collected individuals, and in the Sardinas river 66 collected individuals. Regarding relative abundance it can be said that in the La Delicia stream the dominant morphospecies was Veliidae which belongs to the Hemiptera order, with 8% of individuals, while the least abundant morpho-species belong to the Coleoptera orders (Notonectidae, Dytiscidae and Hydrophilidae), Ephemeroptera (Leptophlebiidae and Baetidae), Diptera (Simulidae) and Odonata (Coenagrionidae) with 1% of collected individuals (Figure 1).

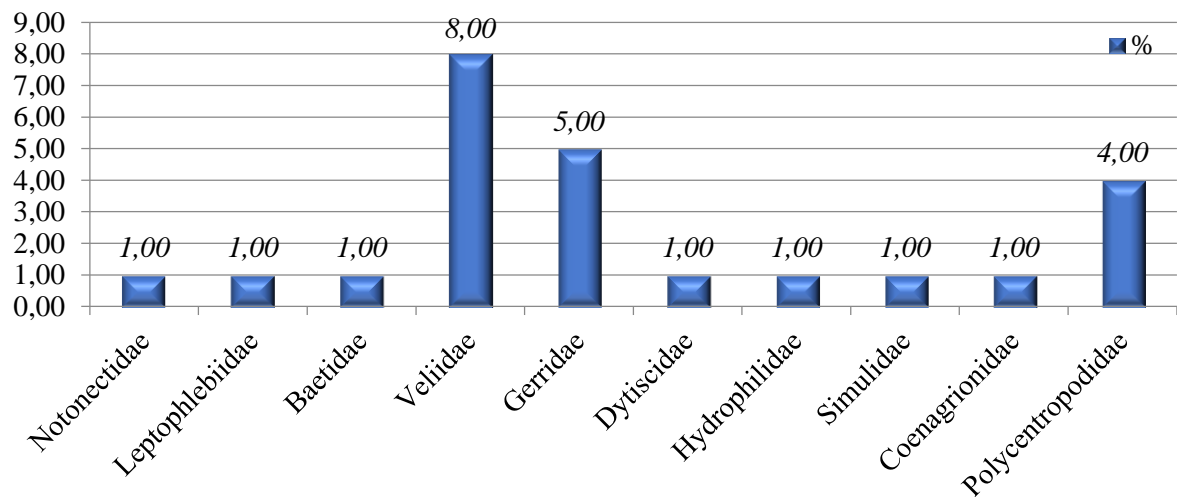


Figure 1. Relative Abundance of Delicias Stream.

In the Sardinias river the most abundant morphospecies was Baetidae with 22.73% of collected individuals and the least abundant was Tipulidae with 1.52% of collected individuals. Regarding the distribution of the morphospecies, it can be said that it was much more heterogeneous in the Sardinias river than in the La Delicia stream (Figure 2).

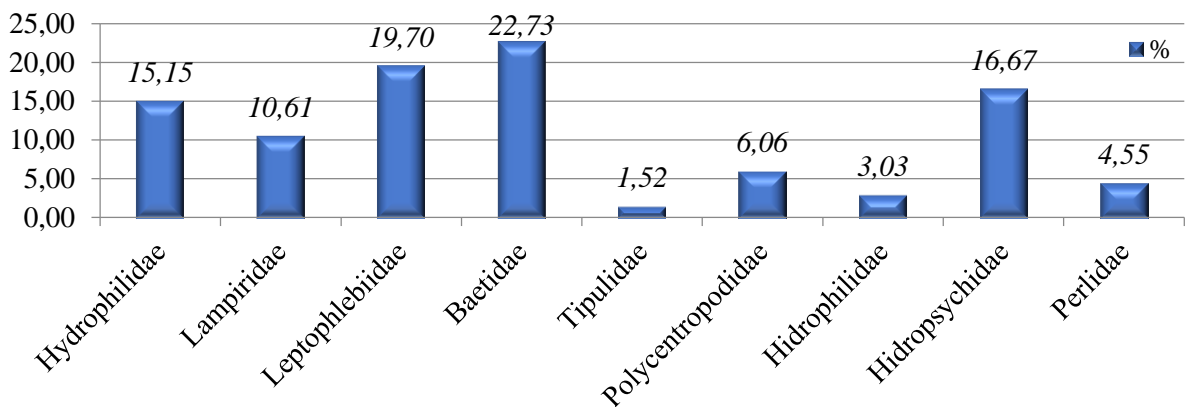


Figure 2. Relative Abundance of Sardinias River.

BMWP/Col Index: Through the analysis of the BMWP/Col index it was determined that the quality of water in the La Delicia stream is Class II Good, slightly polluted water. (Figure 3).

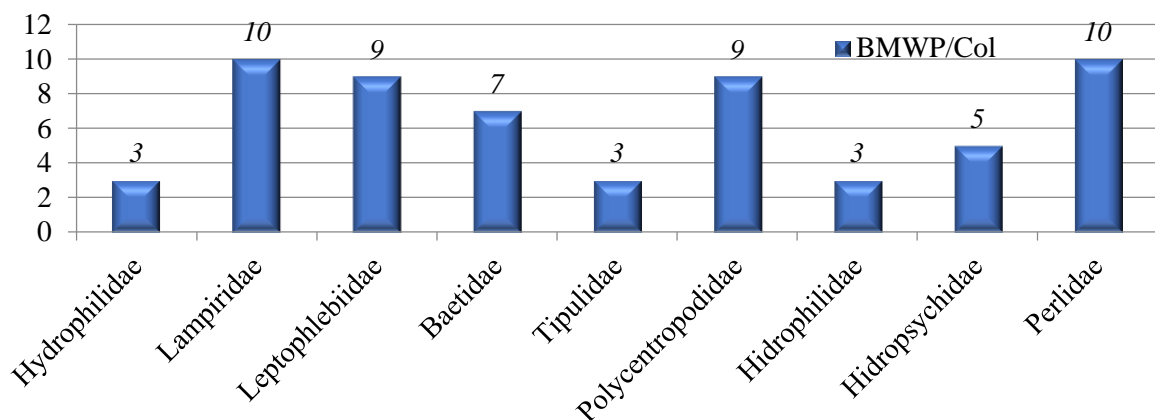


Figure 3. BMWP/Col index of La Delicia Stream.

The two sampled sites have different water quality. The La Delicia stream has better quality according to the BMWP / Col index. On the other hand, the Sardinas River has lower water quality. This is consistent with the information obtained from [21], who states the existence of a mining conflict in Pacto that is contaminating the Sardinas River in said community.

According to [22], the BMWP / Col is the ideal index to determine the water quality in the mountain ecosystem, because more than 97% of registered macroinvertebrate families are included in this quality index. Moreover, it is the most used index to evaluate the integrity of aquatic systems in Latin America [23]. Therefore the use of the index in the area would be the most appropriate methodology for determining water quality.

On the other hand the Sardinas river is a Class III Moderate, moderately polluted water (Figure 4).

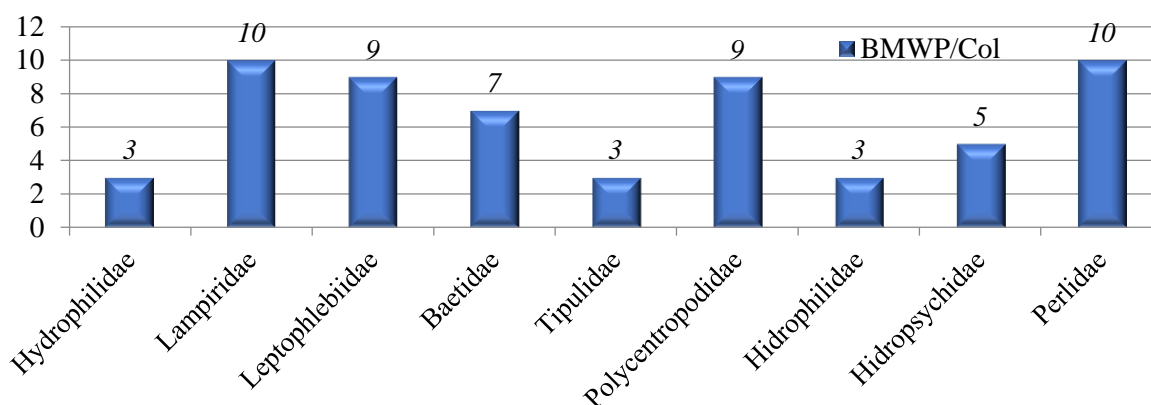


Figure 4. BMWP/Col index of Sardinas River.

Although the BMWP/Col index indicates that the Sardinas river has a Moderate quality, the presence of the Perlidae group that is observed constitutes a bioindicator of good water quality. The presence of this group may be due to the drift phenomenon [24] that could have dragged the group from other less contaminated bodies of water.

Conclusions

The water quality of La Delicia stream is Good according to macroinvertebrate community described instead the Sardinas River has a regular quality.

Although during the present study the community of macroinvertebrates was well characterized it is necessary to carry out interannual sampling campaigns to understand natural fluctuations caused by variations in the ecological flow and anthropic impacts that occur in this lotic system [25-27].

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