Aquatic Macroinvertebrates as Indicators of Water Quality

GLOBE		*SDG Partners*	*Type of Activity*
Areas	*Associated Protocols*		
Hydrosphere	*Dissolved oxygen, Conductivity, pH, Temperature, Transparency.*	*6 (Clean water and sanitation)*	*Exploratory*

Overview

When talking about Biological Indicators of Water Quality, we observe that only a few organisms can satisfy these requirements. Aquatic macroinvertebrates are considered as the best bioindicators of water quality. Bioindicators are used in addition to physicochemical analyses; their advantages are that they are not limited to the time of taking the sample; They allow to discover of changes produced over time since living organisms present evolutionary adaptations to specific environmental conditions and have limits of tolerance to the different alterations of the same, which allows having a particular historical vision of the events that occurred in a period, depending on the dynamics of the biological communities present.

Time

2 classes

Prerequisites

Basic knowledge of ecosystems, food webs, populations, meteorology, and water quality.

School-level

High school students.

Purpose

Conduct a water quality assessment using aquatic macroinvertebrates as indicators of hydrobiological resources.

Student outcomes

✔ Identify the aquatic macroinvertebrates present in a body of water.
✔ Assess water quality using macroinvertebrates as bioindicators.

Background

Biological indices are used in addition to physicochemical analyses, although with their application, it is impossible to identify existing pollutants; their advantages are that they are not limited to the time of taking the sample; They allow to discover changes produced over time, since living organisms present evolutionary adaptations to specific environmental conditions and have limits of tolerance to the different alterations of the same, which allows having a particular historical vision of the events that occurred in a period, depending on the dynamics of the biological communities present.

Thus, for example, if in a given area of a river, there are high values of oxygen, low turbidity, low color, and low conductivity, but oligochaetes, mollusks, and chironomids dominate the fauna present, there is no doubt that in that site most of the time conditions of high pollution predominate and that the moments of cessation of this are so brief, which are insufficient to bring about significant changes in the structure of the community.

Numerous biological indices are based on communities of algae, macrophytes, bacteria, fish, and various groups of invertebrates. However, the most advanced and widespread natural methods among the specialized literature are those based on the composition of the benthic macroinvertebrate community, which are those organisms that have a size greater than 0.3 mm in length and lack a backbone, such as crabs, insects (larvae, pupae, and adults of some orders), mollusks, turbellarians, annelids, among others. With the presence/absence of these organisms, biotic indices can be calculated, which are systems for classifying water quality by giving a score. Biological methods, never excluding physicochemical quality, are relatively simple, fast, and inexpensive, making them ideal for monitoring, surveillance, and control of watersheds.

Guiding Research Questions

Scientific concepts

- Bioindication for water quality assessment
- Aquatic macroinvertebrates.
- Habitat types of aquatic macroinvertebrates.
- Lifestyles of aquatic macroinvertebrates

Materials and tools

1) Metal or plastic mesh net of about 1.0 m^2
2) Triangular or "D-net" type hand net
3) Bucket.
4) Plastic bags or containers.
5) 70% alcohol

6) Markers or markers.
7) White trays.
8) Fine-tipped tweezers.
9) Magnifying lenses (Magnifier)
10) Stereomicroscope (optional)

What to do and how to do it

1. ***Sampling***

To collect the most remarkable possible diversity of macroinvertebrates, it is essential to carefully explore the sampling site to cover all possible habitats, i.e., bottom substrate (sand, stones, mud, vegetation debris); aquatic plants (floating, emerging, and submerged); tree roots, etc. To obtain comparable results, the sampling effort should cover an area between 10 and 20 m² and be done for 20 or 30 min.

Sampling should not be carried out after heavy rains, as there may be a loss of local organisms or others being swept away by the current. Sampling should be done in large rivers on both banks, as the fauna may differ due to shade, meanders, bottom composition, and eventual contamination.

In the case of streams with stony substrates, the most used qualitative method is the screen network; that is, only the diversity of species is determined, but not their abundance per unit area. It consists of a metal or plastic mesh net of approximately 1.0 m^2 fastened on each side by two sticks of 1.5 m in length. While one person holds the mesh over the bottom of the river, another removes the bottom against the current; The removed organisms are trapped in the mesh with the substrate.

The vegetated shores are usually affluent in macroinvertebrate fauna. There live especially larvae of odonates, Hemiptera, mollusks, and crustaceans. Qualitative sampling with a triangular or "D-net" handset is the most commonly used for these sites. With the help of these nets, a sweep is made along the banks with vegetation, thus trapping the organisms existing there.

For all the above methods, it is recommended to take five aftershocks to cover different points of the cross-section of the water course.

The samples collected by the different methods are washed, preferably in a limnological bucket, with mesh at the bottom (less than 0.5 mm), and the organisms are then taken to the laboratory and stored in bags or plastic containers with 70% alcohol, adequately labeled, for separation, identification, and counting.

2. Treatment of samples

The samples are placed in white, well-lit trays, and with the help of fine-tipped tweezers, the organisms present are extracted, taking care not to mistreat them. The substrate is carefully removed from one end of the tray to the other until it is ensured that no organisms remain. It should be noted that when you do not have enough experience,

many organisms can go unnoticed, either because of their size or because they are camouflaged with the remains of vegetation or mineral substrates. This work must be performed or supervised by appropriately trained persons. The samples are stored in 70% alcohol in adequately labeled bottles.

3. Identification of aquatic macroinvertebrates

Macroinvertebrates are identified in a stereo microscope with the help of existing literature.

BMWP method

The Biological Monitoring Working Party (BMWP) index was created in England in 1970 as a simple and rapid method to assess water quality using macroinvertebrates as bioindicators; For the application of the index, it is only necessary to reach the family level and the data are qualitative, that is, it gives information on the presence or absence of organisms. The index allows estimating the quality of an aquatic ecosystem from the valuation of the aquatic species that inhabit it; Each species is assigned a specific value according to its tolerance to pollution ranging from 1 to 10 so that the most tolerant families obtain a lower score than those that require a better quality of the waters in which they live. The sum of the values obtained for each family at a sampling point shall give the degree of contamination of the same. The higher the sum, the lower the contamination of the point studied.

Scores assigned to the different families of aquatic macroinvertebrates to obtain the BMWP

Family	Score
Anomalopsychidae, Atriplectididae, Blephariceridae, Ptilodactylidae, Chordodidae, Gripopterygidae, Lampyridae, Odontoceridae, Perlidae, Polymitarcyidae, Polythoridae, Psephenidae	10
Coryphoridae, Ephemeridae, Euthyplociidae, Gomphidae, Hydrobiosidae, Leptophlebiidae, Limnephilidae, Oligoneuriidae, Philopotamidae, Platystictidae, Polycentropodidae, Xiphocentronidae	9
Atyidae, Calamoceratidae, Hebridae, Helicopsychidae, Hydraenidae, Hydroptilidae, Leptoceridae, Naucoridae, Palaemonidae, Pseudothelpusidae, Trichodactylidae, Saldidae, Sialidae, Sphaeriidae	8

Ancylidae, Baetidae, Calopterygidae, Coenagrionidae, Crambidae, Dicteriadidae, Dixidae, Elmidae, Glossosomatidae, Hyalellidae, Hydrobiidae, Hydropsychidae, Leptohyphidae, Lestidae, Ochteridae, Pyralidae	7
Aeshnidae, Ampullariidae, Caenidae, Corydalidae, Dryopidae, Dugesiidae, Hyriidae, Hydrochidae, Limnichidae, Lutrochidae, Lymnaeidae, Megapodagrionidae, Mycetopodidae, Pleidae, Staphylinidae	6
Ceratopogonidae, Corixidae, Gelastocoridae, Gyrinidae, Libellulidae, Mesoveliidae, Nepidae, Notonectidae, Planorbidae, Simuliidae, Tabanidae, Thiaridae	5
Belostomatidae, Chrysomelidae, Curculionidae, Ephydridae, Glossiphoniidae, Haliplidae, Hydridae, Muscidae Scirtidae, Empididae, Dolichopodidae, Hydrometridae, Noteridae, Sciomyzidae	4
Chaoboridae, Cyclobdellidae, Hydrophilidae, Physidae, Stratiomyidae, Tipulidae.	3
Chironomidae (cuando no es la familia dominante), Isotomidae, Culicidae, Psychodidae, Syrphidae	2
Haplotaxida, Tubificidae	1

Classification of waters and their ecological significance according to the BMWP index

Class	Quality	BMWP Value	Meaning	Colour
I	Good	≥150	Very clean waters	
		123-149	Unpolluted water	

II	Acceptable	71-122	Slightly contaminated: contamination effects are evident	
III	Doubtful	46-70	Moderately polluted water	
IV	Criticizes	21-45	Heavily polluted water	
V	Very critical	<20	Heavily polluted water, critical situation	

Suggested Resources

To learn more, the following resources are suggested:

Guide to the identification of aquatic invertebrates: http://www2.udec.cl/~lpalma/Palma2013_Guia_identificacion_Macroinvertebrados_preview.pdf

Aquatic macroinvertebrate identification booklet: Guide to participatory monitoring: https://www.researchgate.net/publication/342248615_Cartilla_de_identificacion_de_macroinvertebrados_acuaticos_Guia_para_el_monitoreo_participativo

Bibliography

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