Water quality assessment using invertebrates – field study

Macroinvertebrates are animals without a backbone that are large enough to be seen with the naked eye. Freshwater macroinvertebrates spend part or all of their life cycle in flowing or standing waters. They include insects (fly nymphs and larvae, beetles and bugs), snails, mussels, leeches, worms, flatworms, slaters and shrimps. Fly nymphs and larvae leave water when they metamorphose and reach maturity, spending their adult life on "land" (or in the air). In many cases, their adult life stage is short and lasts only from several hours to a few days. In contrast, to their immature stage spent in water can last for one or two years.

Macroinvertebrates play an important role in the aquatic food web - they feed on algae and plant material, such as leaves, helping to break down organic matter. They also provide a source of food for other animals, such as fish, birds and mammals. Macroinvertebrates are also good indicators of water quality because different species have different levels of tolerance to pollution. They also show integrated responses to pollution over time, rather than just at the time of sampling (like spot water samples analysed for the pollutant chemicals), and as such, they are useful for assessing the health of freshwater ecosystems.

Eutrophication (over-enrichment with plant nutrients such as phosphorus and nitrogen) is a significant problem that affects the quality of fresh waters, leading to decreased levels of dissolved oxygen in the water and lower levels of biodiversity. The main sources of nutrients are discharges from wastewater treatment systems and run-off from agricultural land. Some freshwater macroinvertebrate species are more sensitive to this form of pollution than others and, therefore, investigating which macroinvertebrate groups are present or absent, and comparing abundance of these groups, allows us to assess water quality.

Water quality assessment

Introduction

In this practical you will investigate the sensitivity of different groups of macroinvertebrates to water pollution, specifically over-enrichment with organic matter and the nutrient phosphorus, and learn how water quality can be assessed using macroinvertebrates. You will do this by:

- Collecting macroinvertebrate samples upstream and downstream of a wastewater (sewage) treatment works using the kick-sampling method.
- Identifying and quantifying the macroinvertebrates in the samples using a macroinvertebrate identification key and a microscope.
- Comparing macroinvertebrate communities at the upstream and downstream sites.
- Comparing macroinvertebrate results with water quality data from the two sampling sites.

Macroinvertebrates will be assessed at two sampling sites on the North Queich – one upstream and one downstream of the Milnathort waste water treatment works.

The production of this resource was funded by the William Grant Foundation

Materials for macroinvertebrate sampling

- A 25 cm^2 pond net with a 900 µm mesh net
- Sample bags/pots
- Tweezers
- Waterproof boots (wellies)
- Life jackets
- Shoulder length gloves
- Hand gloves

Materials for macroinvertebrate identification

- Small sample tubes
- 5 x plastic pipettes
- 5 x plastic spoons
- Microscope (up to 40 times magnification)
- 2 x plastic petri dishes
- Lens tissue
- Macroinvertebrate identification key

Materials for water quality assessment

- Pens/pencils
- Notebooks
- White board/ notice board and sticky notes

Method

Macroinvertebrate sample collection

USE PROTECTIVE GLOVES WHEN SAMPLING

1. Choose a shallow stretch of a stream that includes different habitats, for example riffles, runs, slow or standing water, to increase the variety of macroinvertebrates captured.
2. In flowing water, place the kick net in the water with its open mouth facing upstream.
3. Collect a sample by kicking the stream bed upstream of the net for three minutes, whilst moving upstream. Keep a short distance between the place your kick and the net - this will allow you to collect macroinvertebrates while reducing the amount of dislodged sediment and vegetation that will flow into the net.
4. In slow-flowing or standing water, kick the river bed and catch dislodged animals by sweeping the net through the water above the disturbed substrate.
5. Conduct a one minute hand search. For example, lift stones in shallow waters or along stream margins to examine what is attached or clinging to them. Try to cover a range of habitats where water depth allows.

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6. Transfer the sample into a pot or sample bag and cover with water to keep the macroinvertebrates alive. Ensure that there are no animals left on the net; if there are, use hands or tweezers to move them to the sample pot or bag.
7. Collected samples should, ideally, be analysed on the day that they are collected. If this is not possible, store them in a cold environment (1-5^{o}C) and analyse them within two days of collection.

Macroinvertebrate sample analysis

1. Divide each sample among groups of pupils by placing the collected material into a few bottles and adding water.
2. To sort the material, use plastic spoons and tweezers to pick animals out of the sample and transfer them to Petri dishes.
3. Using a microscope, identify the macroinvertebrates collected by following the steps in a suitable identification key. Use a microscope to help with the identification. Record groups and numbers of animals in each group.

Water quality assessment

1. Using the results from your analyses, identify the differences between the samples collected upstream and downstream of the waste water treatment works. Which macroinvertebrate groups are the most to least abundant at each site?

2. Based on what you have learned about the pollution tolerances of the macroinvertebrate groups in Activity 1, discuss what the results indicate in terms of the water quality in the North Queich. Is the water quality affected by the waste water treatment works?

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