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SCIENCE ON STAGE NETHERLANDS

Low budget marine investigation kit - Seawater experiments in your classroom

Students design an investigation unit with low budget materials. They monitor the water quality, grow phytoplankton, *Artemia* (brine shrimp), measure the filter capacity of shellfish or the feeding habit of bristle worms.

Keywords: Sea water, *Artemia*, bristle worms, low budget, aquarium, student research, algea

Discipline: Biology, chemistry

Age level of students: 14+

Conceptual introduction

The project offers a variety of research opportunities. With materials whose costs vary from 20 to 50 Euros, it is possible to build a research unit in which students conduct research at a marine system. The water quality can be monitored, and the growth rate of algae can be studied under the influence of various variables, such as light or nitrogen content.

What the students do

1. FARMING AT SEA

The main part of the earth is covered with salt water. The amount of available farmland is probably insufficient to feed the world population in the future. It is therefore obvious to investigate the potential of agriculture and livestock farming at sea.
With this in mind we developed a series of seawater experiments for our students.

Try to grow a maximum amount of phytoplankton with a minimum of nutrients, measure the filter capacity of clams or find the best food for bristle worms with a small ecological footprint. Let your students study brine shrimp (*Artemia salina*), bristle worms (*Nereis virens*) and mussels (*Mytilus edulis*).

Students can be assigned with concrete tasks but this setup is extremely useful for open assignments.

2. BASIC MATERIALS AND SEAWATER

For all experiments an aquarium approximately
40 x 25 x 20 cm is used.
For seawater, there are a number of alternatives.
We ourselves fetch water from the Oosterschelde (Easter Scheld). Preferably, do that at high water from a jetty. When you live too far from the sea to get the real deal, then make a good alternative with so-called synthetic sea salt. These boxes (or even buckets) contain, besides potasium chloride all trace elements which you need to get good quality seawater.
(Be aware that water with kitchen salt is salty water and not seawater.)
But you can also walk into the chemistry cabinet and try the recipe of Ciryll Bibby, from the book *Simple experiments in biology* :
Seawater (artificial). According to Kramer en Wiedemann.
276.5 g kitchen salt (NaCl)
69.2 g magnesium sulphate ($MgSO_4 . 7 H_2O$)
55.1 g magnesium chloride ($MgCl_2 . 6H_2O$)
6.5 g potassium chloride (KCl)
2.5 g sodium bicarbonate ($NaHCO_3$)
1.0 g sodium nitrate ($NaNO_3$)
1.0 g sodium bromide (NaBr)
0.5 g sodium phosphate (Na_2HPO_4)

Dissolve these compounds in 10 litres demineralised water and add 29 mL 50% calcium chloride solution.

3. COMMON MATERIALS USED

- microscopes
- beakers (50 – 250 – 500 – 1000 mL)
- pipettes
- stopwatch
- nitrite / nitrate / phosphate tests
- colorimeter
- burker counting chamber
- mussels / clams
- brine shrimp or brine shrimp eggs

4. RESEARCH IDEAS FOR THE LOW BUDGET MARINE INVESTIGATION KIT

- Try to grow phytoplankton, zooplankton (*Brachionus*) or brine shrimp (*Artemia salina*)
- Determine the effect of temperature (and/or salinity, nitrite, nitrate) on the growth of *Artemia*
- Determine the influence of light on the growth of algae or seaweed like *Ulva lactuca*
- Determine the influence of nitrate and phosphate on the growth of algae
- Determine the filter capacity of mussels, clams or other shellfish
- Study the feeding habit of bristle worms (*Nereis virens*)
- Compare the growth of bristle worms with different types of food (carp food, wheat or a combination)

5. AN EXAMPLE: DETERMINE THE FILTER CAPACITY OF MUSSELS

Materials used:

- low budget marine investigation kit
- 10 mussels (*Mytilus edulis*)
- phytoplankton
- 250 mL beakers

- colorimeter
- burker counting chamber
- mini flashlight (optional)

1. Mussels


To keep mussels you need 1 prepared plastic soda bottle with modified cap (0.5 L) and some cable wraps.
To keep the mussels or clams together and to make sure they can attach with their byssus you have to:

- Cut a plastic soda bottle in half, about one-third from the top.
- Heat the bottom part of a test tube with a Bunsen burner to make holes in the plastic bottle to ensure a water flow over the mussels. (Be aware of the fumes, it's best to use a fume hood.)
- Attach some cable wraps to the rim of the bottle to make it easy to collect the mussels.

If you want to keep the mussels alive a little longer you need a sand swirl filter and a protein skimmer. (see 6. and 7.) Make sure the mussels are acclimatized to the situation in your aquarium. This will take some days.

Take a sample of the phytoplankton and measure the extinction with the colorimeter. You can also make a calibration curve. Make a dilution series of your phytoplankton and measure the extinction of the samples.

Use the Burker counting chamber to estimate the number of cells per mL so you can quantify the extinction measured with the colorimeter.
Fill a 250 mL beaker with phytoplankton and add 1, 2 or 3 mussels.
Take samples every 15 minutes, during 1.5 hour.
Measure the extinction with the colorimeter.

Alternatively you can make a dilution series of your phytoplankton. Fill test tubes with 5 mL of each sample. Hold the test tubes about 2 cm above the table. Take your mini-flashlight and shine through the test tube from top to bottom. This will result in a green reflection on the table. The higher the concentration of phytoplankton, the greener the reflection will be. (Of course you can also quantify the resulting colour with the Burker counting chamber

6. BUILDING A SAND SWIRL FILTER

Materials used:

- 1 water pump for example Superfish Aquapower 650
- 2 prepared plastic soda bottles (1.5 L)
- 1 pierced bottle cap
- 1 connection tube
- 1 marble
- a cup full of sea sand (or sand from a sandpit)
- 20 cm garden hose
- connection materials like plastic coated wire

You can easily build your own sand swirl filter by following these instructions:

- At first, take a 1.5 litre plastic soda bottle and cut away the bottom.
- Drill a hole in the cap of the bottle so you can mount a PVC pipe on the bottle. Bend the PVC pipe in a ninety degree angle or use a ninety degree connection piece.
- Drill (or burn with a heated test tube) another hole just under the rim (where the bottom of the bottle was).

2. Sand swirl filter


- Use a second soda bottle to produce a stable base for your sand swirl filter.
- Again drill or burn a hole near the bottom of the bottle. Then cut away the upper, conical part.
- Mount the first bottle, upside down, into the second bottle and connect the PVC pipe. (It might be easier to

put the PVC pipe in the second bottle before attaching the first bottle.) Connect this system to the water pump.

- Add the marble to your filter to prevent sand entering your pump.
- Now finish it off by putting the sand into your sand swirl filter.
- Attach the filter to the aquarium. When you switch on the pump, water will be forced through the bottles. The sand will start swirling. Bacteria attached to the sand grains will add a significant contribution to the cleaning of the water.

3. PVC pipe with marble, attached to bottle cap

7. BUILDING A PROTEIN SKIMMER

Materials used:

- 1 air pump for example: Superfish Airflow mini
- 1 basswood/limewood (linden) air diffuser
- 0.75 m air hose (to fit the air diffuser)
- 0.75 m garden hose
- 1 prepared plastic soda bottle with modified cap (0.5 L)
- 1 extra soda bottle to collect waste (0.5 L)
- connection materials like plastic coated wire

It's recommended to make a protein skimmer to extract excesive nitrogen compounds. Proteins and polypeptides have the ability to attach to tiny air bubbles blown through the water. Thus creating a fine froth comparable to the froth you sometimes find on beaches. In doing so you remove the majority of redundant nitrogen compounds.

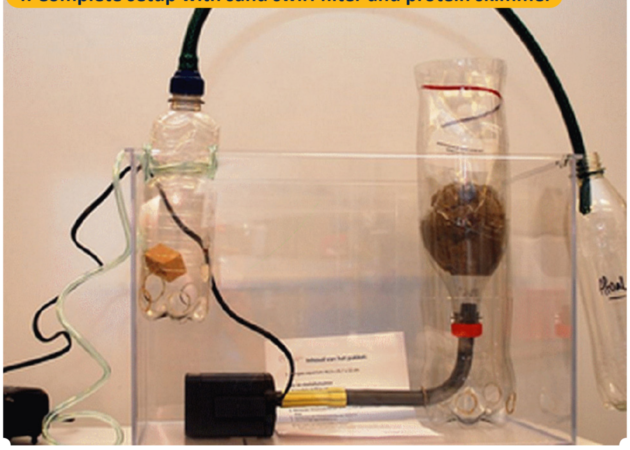
For the protein skimmer we use a 0.5 litre soda bottle.

Heat the bottom part of a test tube with a Bunsen burner to make holes in the lower part of the bottle to guarantee the water flow through the bottle. (Be aware of the fumes, it's best to use a fume hood)

Connect the basswood (linden) or lime wood air diffuser to the air hose and mount this air diffuser in the bottle. Because of the airflow, water will be passed through the bottle. The airflow will also add some extra oxygen to the water.

With a bottle cap, an extra piece of water hose and a beaker or extra bottle the froth will be removed from your system.

4. Complete setup with sand swirl filter and protein skimmer



Conclusion

WHAT THE STUDENTS ARE EXPECTED TO GET OUT OF THIS :

Students learn how to investigate a not so everyday organism. They access experiments with low budget materials.

PERSONAL EXPERIENCE - WHAT TO BE AWARE OF :

We have been working with sea water, shellfish and algae for over a decade. It is a question of perseverance to get the experiments right. But don't let failures disappoint you. Failures don't exist. It's only the outcome which is not what you expected. It's a continuing learning process. But it's good fun. Students will enjoy it!

If you need any help, please contact me, hmu@jtc-roosendaal, or my technical assistant Patrik, pvo@jtc-roosendaal.nl.

References

- Cyrill Bibby, "Simple experiments in biology", London: Heinemann, 1954

Science on Stage Europe

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A network of national steering committees in these member countries provides the interface to their science teaching communities. They organise national activities for teachers and select the teachers who represent each country at the European Science on Stage festivals.

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