Development of an ecosystem with Cobra SMARTsense

Students learn how ecosystems function and how various changes affect each ecosystem.

Biology | Ecology & environment | Water analysis

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	45+ minutes

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Teacher information

Application

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Experiment setup

Ecosystems are complex habitats in which everything contained within them acts and reacts with each other. This includes both the biotic (plants, animals, bacteria, ...) and abiotic (such as stones) factors. They are therefore in a direct relationship with each other.

An ecosystem can be, for example, a lake, a forest or a reef, but also a smaller system, such as an aquarium, can be described with the term "ecosystem".

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Other teacher information (1/6)

Prior knowledge

Students should already be familiar with the metabolic processes of organisms, material breakdown and photosynthesis.

Scientific Principle

Different environmental environments are created in the three chambers, which are connected to each other. This is a long-term experiment that can be continuously monitored and measurements can be taken.

Other teacher information (1/6)

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Other teacher information (2/6)

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Learning objective

Students learn how ecosystems function and how various changes affect each ecosystem.

Tasks

1. Students create different environments in the three chambers.
2. In a second step, the students observe the ecosystem they have created and measure various relevant environmental factors.
3. In a third step, the students change some factors in their ecosystem (light, temperature, ...) and observe the resulting changes.

Other teacher information (3/6)

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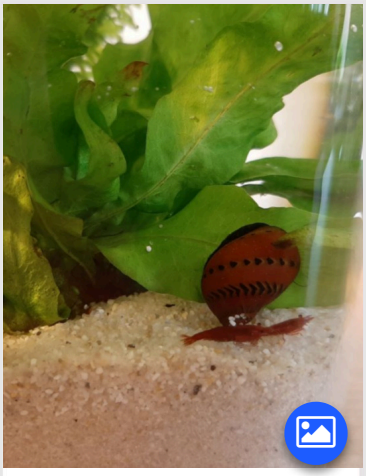

Snails and shrimps in the aquatic environment

Notes on structure and implementation

In all environments in which living organisms are used, special attention must be paid to the needs of the organisms used. Suitable observation animals for the **terrestrial environment** Feeding animals from reptile supplies (grasshoppers, crickets, ...). For the **aquatic environment** some freshwater snails of the genus *Neritina* or else shrimps of the genus *Neocaraidina* from the aquarium trade can be used. In the **mining environment** the best thing to do is to use earthworms.

Especially when changing the conditions, care should be taken to remove the animals from the system if in doubt. While a temperature difference of two degrees is not a problem, the introduction of a limestone or citric acid into the aquatic environment is a severe disruption to the habitat.

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Other teacher information (4/6)

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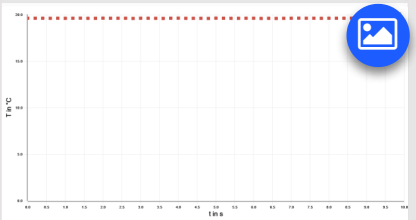
Results and observations

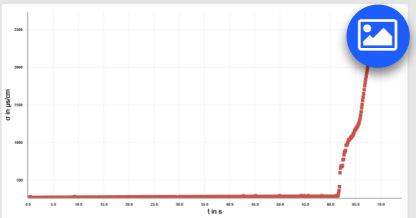
The pictures show exemplary measurements with the measureAPP. The temperature in °C was recorded once. In this case, nothing was changed in the temperature.

The other image shows the conductivity of the water in the aquatic environment in µS/cm. The steep rise of the curve marks the point at which a teaspoon of a commercial NPK fertilizer (nitrate, phosphate, potassium) was added to the water and simulates the input of fertilizers from agriculture.

The same can be done with the pH value: For example, if you add a few splashes of citric acid to the water, you simulate the input of acid rain. The limestone, on the other hand, causes the pH value of the water to rise over time.



Temperature measurement in °C



Conductivity in µS/cm

Other teacher information (5/6)

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Ideas for parameter changes

It is recommended to always closely observe the changes in the parameters. Especially large temperature fluctuations or long periods of darkness should be carried out without animal inhabitants.

- Change in temperature
- Change in lighting
- introduction of calcareous rocks into the aquatic environment
- Introduction of fertilizer (NPK) into the aquatic environment
- Addition of sugar to the degrading environment
- Addition of carbon dioxide in gaseous form

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Other teacher information (6/6)

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Terrestrial environment
In the terrestrial environment, measurements should be taken in light and also in darkness to detect photosynthetic activity. Here the O_2content of the air with the CO_2content of the air in order to demonstrate the differences between day and night.

Aquatic environment
In addition to photosynthesis, the influences of excessive (agricultural) fertilization and, for example, acid rain can be represented in the aquatic environment via the conductivity and the pH value. **For these changes should be removed.**

Degrading environment
Here, if compost from a compost heap has been used, the microbiological activity can be detected via the temperature. The more compost has been used and the more active it is, the higher the temperature will be. In addition, the O_2content and the CO_2content can be measured and compared with the normal values in order to detect aerobic or anaerobic degradation processes.

Safety instructions

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- The greatest possible care must be taken when dealing with living creatures.
- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student Information

Motivation

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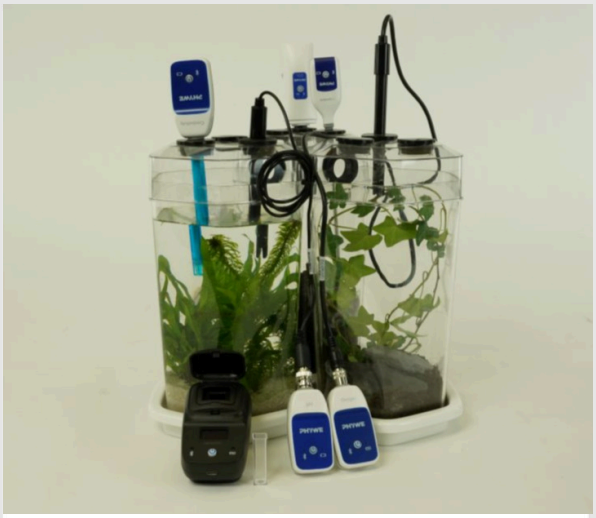

Experiment setup

You know ecosystems from your environment and the news:

The lake you jog around on weekends and go swimming in the summer, your neighbor's pond, or the forest just outside of town. These ecosystems are complex connections of living things and the environment that are sensitive to change.

To better understand these ecosystems, create your own small ecosystem in the following experiment.

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Equipment

Position	Material	Item No.	Quantity
1	Modular Ecosystem fitting the Cobra SMARTsense Sensors	64839-00	1
2	Cobra SMARTsense - CO2, 0 ... 100000 ppm (Bluetooth + USB)	12932-01	1
3	Cobra SMARTsense - Oxygen, 0 ... 20 mg/l (Bluetooth + USB)	12933-01	1
4	Cobra SMARTsense - pH, 0 ... 14 (Bluetooth)	12921-00	1
5	Cobra SMARTsense - Colorimeter, 0 ... 100 % (Bluetooth + USB)	12924-01	1
6	Cobra SMARTsense - Conductivity, 0...20000 µS/cm, 0...100°C (Bluetooth)	12922-00	1
7	Cobra SMARTsense - Temperature, - 40 ... 120 °C (Bluetooth)	12903-00	1
8	measureAPP - the free measurement software for all devices and operating systems	14581-61	1
9	Button Cell CR2032, 3V (2 pieces)	07922-17	2
10	USB quick charger with 8 USB ports	07934-99	1
11	Macro-cuvettes, PS, 4ml,100 pcs	35663-10	1

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Additional equipment

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Additionally needed are the materials for the formation of the ecosystem (soil, stones, plants, possibly animals, and so on).

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Set-up (1/6)

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The Cobra SMARTsense environmental sensors and measureAPP are required to measure the parameters. Check if "Bluetooth" is activated on your device (tablet, smartphone) (the app can be downloaded for free from the App Store - QR codes below). Now open the measureAPP on your device.

measureAPP for

Android operating systems

measureAPP for

iOS operating systems

measureAPP for

Tablets and PCs with Windows 10

Set-up (2/6)

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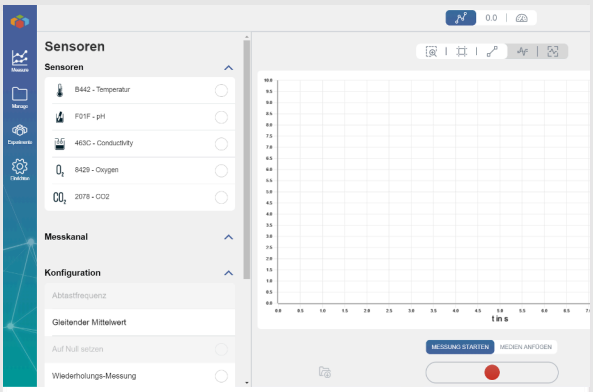

User interface measureApp

in the Windows 10 version

- Turn on the corresponding SMARTsense sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the item "Measure" with the device as shown in the figure on the left.
- The SMARTSense sensor is now displayed in the app.
- The other sensors are connected in the same way.
- Calibration of the CO_2sensor: Press the power button for 7 seconds. This will automatically calibrate the sensor to 400 ppm (roughly equivalent to the CO_2concentration of fresh air).

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Set-up (3/6)

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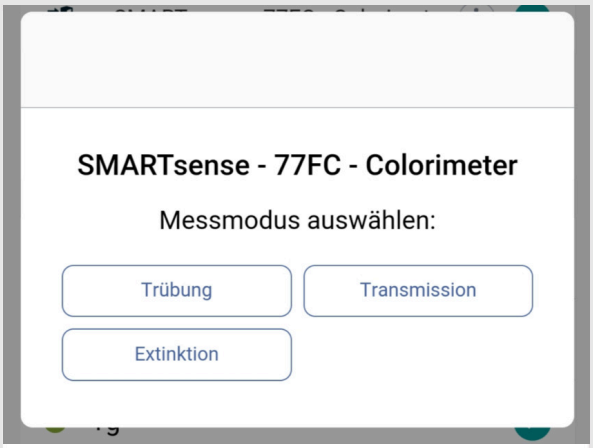

Select "Exercise".

- The SMARTsense Colorimeter measures the turbidity of the water. It is operated slightly differently than the other sensors:
- Pour some water into the supplied envelope.
- Turn on the SMARTsense colorimeter and connect it to the measureAPP.
- The SMARTSense sensor is now displayed and selected in the app.
- In the window that opens, select the tab "Trübung" (picture on the left).

Set-up (4/6)

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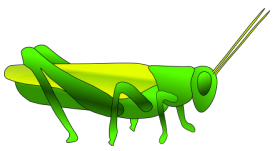
Terrestrial chamber

Terrestrial environment

- Fill one of the chambers with about 5-10 cm of potting soil or topsoil.
- Plant a plant - for example, ivy (*Hedera helix*), ivy (*Epipremnum pinnatum*) or similar, easy to keep plant - in the ground.
- If possible, add some stones or a piece of wood.
- Feeding insects from reptile supplies, for example, which can be used here, are suitable as living creatures.
- If the soil is very dry, it should be moistened.



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Set-up (5/6)

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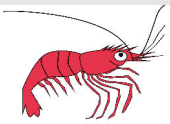
Aquatic environment

Aquatic environment



- Fill one of the chambers with tap water.
- Add sand or gravel as substrate. Since the soil is a colonization site for pollutant-degrading bacteria, it is a good idea to use sand from a biotope, e.g. from an aquarium, pond or river.
- Plant aquatic plants in the substrate (water plant (*Elodea spec.*) or similar).
- Add some aquatic inhabitants (water snails, shrimps or possibly small fish for a short-term experiment are suitable here).

Set-up (6/6)

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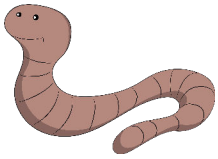
Degrading environment

Degrading environment

- Fill the last chamber with some compost so that the soil has a layer about 10 cm high.
- If possible, add some earthworms. If these are not to be found in the compost, they can be procured, for example, in the fishing supply.
- If no compost is available, the humus layer from the forest, for example, is also suitable. In this case, however, the parameters to be measured are significantly less pronounced (temperature).



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Procedure (1/2)

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- Close unused lid openings with the plugs provided (top left picture).
- Now the chambers are equipped with the supplied sensors, which are inserted into the lid holders (picture below left):
  - Terrestrial environment: SMARTsense Oxygen
  - Aquatic environment: SMARTsense pH, Conductivity, Colorimeter
  - Degrading environment: SMARTsense CO_2, temperature
- These can of course be changed between the chambers.
- Record the values and write down your observations.

Procedure (2/2)

Now try to make some changes that you think will have an impact on the environment. Always remember that you are responsible for the animals living in the environments.

Here are some suggestions:

- install lighting above the chambers
- darken the chambers
- add some limestone, citric acid or fertilizer to the aquatic environment
- add some sugar to the degrading environment
- raise the temperature by a few degrees (if there are animals in the environment, they should be removed first)

Write down your observations and compare them with the normal conditions.

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Report

Task 1

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Write down your observations.

Terrestrial environment	Aquatic environment	Degrading environment

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Task 2

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What changes did you notice after you changed individual parameters?

	Changed component	Observation
Terretrie milieu		
Aquatic environment		
Degrading environment		

Task 3

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In the terrestrial environment, you can see that the carbon dioxide content is higher at night than during the day. Also, the oxygen content is lower at night. How do you explain that?

- ○ The content of carbon dioxide and oxygen is the same during the day and at night.
- ○ During the day, plants carry out photosynthesis. In the process, they consume carbon dioxide and produce oxygen. Daylight serves as the energy source.
- ○ It is the other way round, at night the oxygen content is higher and the carbon dioxide content lower than during the day.

Check

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Task 4

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Again and again we hear about acid rain and the fertilizer input of agriculture into water bodies. How can you prove that in this experiment?

- [ ] Acid rain is detectable by adding an acid, such as citric acid, to the water. The pH value rises as a result.
- [ ] Acid rain is detectable by adding an acid, such as citric acid, to the water. The pH value then drops.
- [ ] The fertilizer input from agriculture can be detected via the conductivity of the water: If you add some fertilizer during the measurement, it increases.

Check

Task 5

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Drag the words into the correct boxes!

In a compost pile, the temperatures in the middle are quite _____, and can quickly reach 60°C. These indicate the _____ degradation activity inside. In addition to _____, various minerals (including nitrate, phosphate and potassium) are released, making compost an excellent _____.

microbiological
energy
fertiliser
high

Check

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