THE OCEAN SENSES ACTIVITIES BOOK

SMELL

LIFE FROM BAD SMELLS

Focus:

To understand that hydrogen sulphide indicates that there is life at the bottom of the deep-sea.

Learning objectives:

With this activity, we create a nasty smell similar to hydrogen sulphide from rotting organic matter. We use that smell as a foundation for a discussion/lesson on interesting life, animals and food webs from the deep sea floor.

Key words:

Deep-sea, hydrogen sulphide, chemosynthesis, nematodes, tube worms, food webs.

This specific lesson plan was developed in a close collaboration with:
Mathew Stiller-Reeve, Erling Rosnes, Mari Eiliertsen, Sofia Ramalho, Victor Poddevin and Giuliana Panieri.

Edited by: *Giuliana Panieri and Mathew Stiller-Reeve*
Layout and Graphics: *Heike Jane Zimmermann*

Stiller-Reeve, M., Rosnes, E., Eiliertsen, M., Ramalho, S., Poddevin, V., & Panieri, G. (2023). Life from bad smells. In G. Panieri & M. Stiller-Reeve (Eds.), The Ocean Senses Activity Book (pp. 27-33). Septentrio Educational, 2023(1). https://doi.org/10.7557/8.7049

IN SHORT (FOR THE TEACHER):

The class will produce a smell like a hydrogen sulphide by rotting some organic matter in a bottle (basically like making compost), which will take a couple of weeks. They will smell the resulting odor. You can use the experience of this smell to frame a lesson/discussion about creatures at the bottom of the sea using the background information and the photo resources below.

Materials:

The total amount of materials will depend on whether pupils will work individually, in pairs or larger groups. Each group should have:

- A large plastic soda bottle.
- Leaves or grass cuttings (or other organic waste)
- Soil and sand.
- A large balloon.
- The teacher will have one bottle as a control with nothing inside and a balloon on top.

Audio/visual materials:

PowerPoint slides from AKMA to help tell the story of the animals introduced in the background story below.

Teaching Time:

- 30 minutes for the pupils to fill their bottles (if they go outside and look in nature/parks/ fields themselves).

- 30-45 minutes (1-2 weeks later) for the pupils to smell the gas (OUTSIDE!) and then to tell the story of the animal communities that are dependent on hydrogen sulphide. The teacher can use much more time if there are other elements of the curriculum that connect to this story.

Classroom organization:

One suggestion is to have groups of 2-3 to fill the bottles. Normal discussion format for the follow-up lesson/discussion.

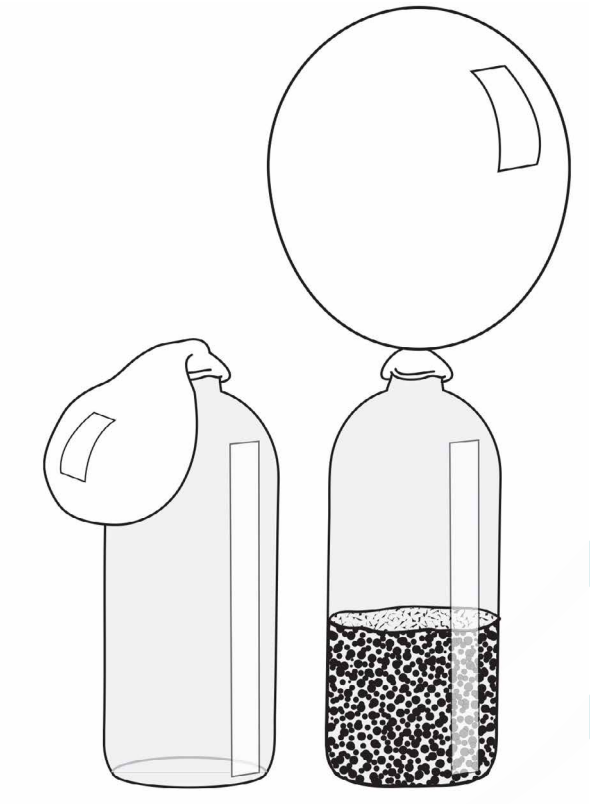
Practical:

Cover the top of one empty bottle with a balloon. This container will be the “control” of the experiment.

Fill second bottle 1/3 with plant pieces (torn into pieces). Drop sand and soil on top of plant pieces to create a thin layer. Cover top with balloon. You can also get the pupils to fill more bottles with different organic and food waste, but make sure you label the bottles clearly. It can be interesting to compare the different amounts of gas that are emitted from the different decomposition processes. Place the bottles in a warm sunny location for 1 week or more. Have pupils observe and compare any gas collection in balloons. Discuss their observations and ideas. Do all the balloons fill up, or do some deflate further?

With the filled balloons, go outside. Make sure the pupils let out a small amount of gas at a time and smell lightly. Ask your pupils what the smell reminds them of.

Tell them that the chemical in the smell is an important part of processes that support life in some extreme locations on the planet: at the bottom of the deep-sea!



BACKGROUND STORY:

This background story gives you, the teacher, interesting information to link the deep-sea to the smell your pupils have made in the bottles. Most of the information comes from Dr. Sofia Ramalho (University of Aveiro) and Dr. Mari Eilertsen (University of Bergen) whilst on board the AKMA Ocean Senses expedition.

Life on Earth is most often dependent on the energy from the sun. This energy is first captured via photosynthesis, and then distributed to others in the ecosystem via food webs. In the deep ocean, where light does not penetrate, life is built on different sources of energy.

At the bottom of the deep sea, there are many places where methane gas bubbles up into the sea water. This methane does not smell of anything. However, we can find bacteria on the sea floor which eat this methane.

When the bacteria eat the methane, a chemical reaction happens, and the methane is converted into ENERGY and hydrogen sulphide (and a couple of other chemicals). This process is like photosynthesis, but it is called

CHEMOSYNTHESIS, since the energy comes from a chemical rather than the sun light. The bacteria use the energy to live and grow, and the hydrogen sulphide (H2S) is a waste product.

Just like waste products we are used to on land, hydrogen sulphide (H2S) smells of sewers and rotting organic matter. It's stinky, but this stink means that life is being supported!

Even though H2S is poisonous for most animals, bacteria can carry out chemosynthesis and live in areas where the H2S builds up. The bacteria are often whitish or blueish and can gather to create what we call "bacterial mats" on the sea- floor.

Example of bacterial mats found at the sea floor in the Arctic Ocean. (Image: AKMA)

The bacteria grow and are what we call organic. This means that other things can eat them. Most of the time they are quite safe since they live in patches that are poisonous to other animals (because of the H2S). However, some small animals manage to roam around on the bacterial mats and feed off the bacteria that live there.

One such animal is a Halomonhystera which is a type of roundworm known as NEMATODE. This nematode can eat the bacteria and is not affected by the poisonous H2S. But its babies are not safe. They are not hardened to cope with the poison, and if they were on the bacterial mat they would die. To protect the babies, the mother Halomonhystera hatches the eggs inside her, and let's the babies grow until they are old enough and tough enough. Then the mother dies and the young Halomonhystera that are left escape and continue to live safely on the bacterial mats.

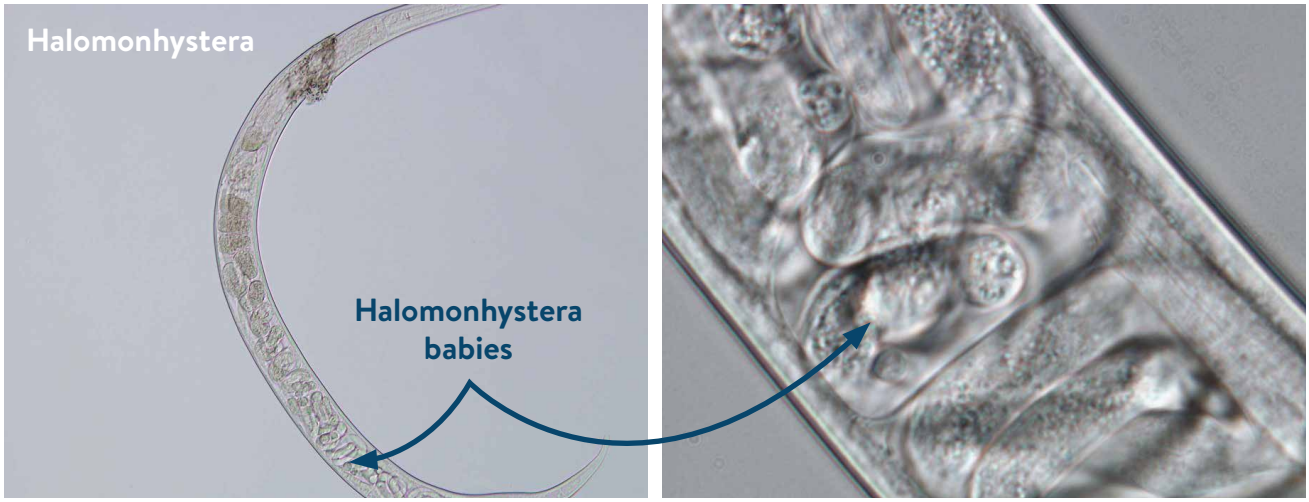


Image left: A Halomonhystera worm with babies nestled inside. Image right: A close of the baby Halomonhystera babies.

There are many other animals that live on or close to the bacterial mats and near to the smell of H2S. Very often, we find “forests” of worms close to the bacterial mats. These “forests” look like bushy coverings and are full of tube worms. Usually, they cannot stand the poisonous H2S, but they need to live nearby to find food. One such tube worm is a Oligobrachia who has an interesting collaboration with bacteria.

A «worm forest» of Oligobrachia at the bottom of the Arctic Sea near Svalbard. The white strands are the tubes that the worms have built that
they live inside (Image: AKMA, University of Tromsø, Havforskningsinstituttet)

Oligobrachia are a type of worm called a tube worm. An Oligobrachia lives in a hard tube the sticks up from the sea floor which it makes itself using a hard substance called chitin. We do not fully know what Oligobrachia eats. But we do know that bacteria live inside them. These bacteria eat the hydrogen sulphide that other bacteria have excreted, so they can grow. It is likely the Oligobrachia "eats" what the bacteria excrete, then they eat the bacteria themselves. All-in-all the bacteria need a tube worm to survive, and the tube worm need the bacteria to survive. A collaboration like this is what we call SYMBIOSIS.

Discussion:

We know a lot about the food webs on the Earth's surface, but we still have much to discover about food webs at the bottom of the deep-sea (over 1500m deep). When researchers like Mari and Sofia don't know for sure, they make hypotheses and test them. Maybe you and your class can make some hypotheses for the following questions:

- What other animals do you think are part of this "food web"?
- How do you think this "food web" can influence what we eat at the surface? Think about fish moving up and down in the water column....

The animals/organisms we have discussed on this lesson are small and can differ from sea to sea. We still have a lot to learn about these organisms and how they behave. However, we know one thing for sure. The lives of these creatures are intrinsically connected to chemicals that smell really bad for us humans on the Earth's surface. Life from bad smells!