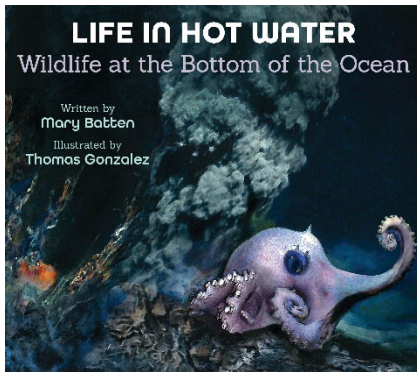


  
PEACHTREE  
**TEACHER'S GUIDE**

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## Life in Hot Water: Wildlife at the Bottom of the Ocean

Written by Mary Batten | Illustrated by Thomas Gonzalez

HC: 978-1-68263-152-2

Ages 6–9

### ABOUT THE BOOK

The most extreme environments on the planet lie more than a mile (1609 meters) below the ocean's surface. Here hot springs called hydrothermal vents gush water hot enough to melt lead. This is a world where liquid Earth and solid Earth interact, where volcanoes erupt daily, spewing plumes of superhot fluids above the seafloor. It is a world of darkness where the sun never shines. You might think nothing could possibly live in such conditions, but an amazing ecosystem of mussels, shrimp, fish, tube worms, octopuses, snails, and other animals thrives here. Discovering it is one of the greatest adventures in science.

### THEMES

Ecosystems | Food chains |  
Survival adaptations | Life in extreme  
environments | Deepsea animals | Ocean  
science | Underwater exploration technology  
| Underwater volcanoes | Geology

### SKILLS

Reading comprehension | Main ideas |  
Vocabulary development | Writing | Critical  
thinking | Science literacy | Problem solving  
using math computations

### BEFORE YOU READ

- Show students the book's front and back covers and ask what they are seeing. Where do they think the book takes place? How do they think we know what is at the bottom of the ocean?
- Discuss the students' ideas and establish that the book is nonfiction. Discuss the difference between fiction and nonfiction.
- Show students a map or globe displaying the ocean floor with mid-ocean ridges clearly labeled. Explain that the mid-ocean ridge is the longest mountain range on Earth. Portions of the ridge occur in each ocean. Both Woods Hole Oceanographic Institution (WHOI.edu) and National Oceanographic and Atmospheric Administration (NOAA.gov) have excellent visuals, including videos of hydrothermal vents. Hydrothermal vents occur along the mid-ocean range.

<b>CURRICULUM CONNECTIONS</b>
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**LANGUAGE ARTS**

- Ask students who made this book. Some students will name the author and illustrator from the cover. Discuss what each does. This will elicit a discussion of writing and art.
- Open the book and bring students' attention to the publisher, editor, and design credits. Ask students what they think these professionals do in the production of a book. Establish that it takes a team to produce a book from an author's manuscript. Later you can use this concept in a writing activity.
- Discuss what the book is about. What ideas from the book support the main idea?
- What discovery about hydrothermal vent ecology caused textbooks to be rewritten? Discuss the discovery of chemosynthesis—the vent food chain based on chemicals from the interior of the Earth rather than on energy from the sun.

**VOCABULARY**

chemosynthesis	the process that bacteria at hydrothermal vents use to convert toxic chemicals from Earth's interior into food for themselves and vent creatures
photosynthesis	the process that green plants and some other organisms use to turn water and carbon dioxide into food (sugar) using light energy from the sun
extremophile	an organism that can tolerate extreme environmental conditions
geologist	a scientist who studies rocks to learn what Earth is made of and how it evolved
HOV	human-operated underwater vehicle
hydrothermal	of or related to hot water
invertebrate	an animal without a backbone

microbes	bacteria and other microscopic organisms
ROV	remote-operated underwater vehicle
symbiosis	the living together of two or more different species of organisms
tectonic plate	a gigantic moving slab of Earth's solid outer layer
volcanic action	the expulsion of molten lava, gases, and rocks from within the Earth through cracks or vents in Earth's crust

**WRITING**

- Ask students to choose a detail from the book that they find particularly interesting and write a paragraph (or a report) about it. Their paragraph/report should use facts from the book and at least one source outside the book. Assign students to do research by using their school library and/or the internet.
- Divide the class into several groups, each of which will function as a team to write and produce a "book" based on ideas from *Life in Hot Water*. Among themselves, students can divide their group into writer, editor, illustrator, and book designer.

## SCIENCE – BIOLOGY

- Ask students what the book teaches about the adaptations animals have evolved for surviving in the hot vent environment.
- Discuss food chains. Ask students what the base of the vent food chain is. How does chemosynthesis differ from photosynthesis? Have them draw a vent food chain using facts from the book.

## SCIENCE – GEOLOGY

- Review the structure of Earth: crust, mantle, outer core, inner core. Explain that the Earth is dynamic. Movement is taking place continuously in all of its layers. The continents are moving, too. The idea that continents were in motion was revolutionary when German meteorologist Alfred Wegener first proposed it in 1912. He called his theory continental drift. He proposed that Earth had once been one supercontinent that had broken up into the separate continents we see on today's globe. Today geologists know that the continents indeed have moved over great expanses of geologic time. Wegener's theory, which some geologists of his time dismissed as a fairy tale, has been proven and expanded in the process called plate tectonics. The main mechanism that causes oceans to widen and continents to move is volcanoes. Volcanoes occur continuously along the mid-ocean ridge. Explain how volcanoes occur along the edges of tectonic plates. (A good image of plates is <https://image3.slideserve.com/5857847/mosaic-of-earth-s-plates-1.jpg>.) Scientists who study these Earth processes are called geologists. Scientists who study the oceans are called oceanographers.
- Until 1977, no human being had seen a hydrothermal vent. Vehicles called submersibles that could take scientists thousands of feet below the ocean's surface made exploration possible. Use visuals of the *Alvin* from Woods Hole Oceanographic Institution (WHOI.edu).

## ART

- Ask students to draw a picture of the vent animal that they found the most fascinating, unusual, or just interesting.

## MATH

- Explain water pressure. At any depth in the ocean, the weight of the water above pushes against any object below. The deeper the dive, the greater the pressure. Help students make a graph showing pressure at different depths.

- Pressure is measured in atmospheres. One atmosphere equals about 14.6 pounds (6.62 kilograms) per square inch. At sea level, air presses down on our bodies with the force of one atmosphere. We don't feel it because the fluids in our bodies are pushing outward with the same force. But pressure increases 1 atmosphere for every 10 meters (32.8 feet) of depth. When you dive below the surface of the sea, you feel an increase in pressure on your eardrums.
- Ask students to figure out: How many atmospheres are acting against divers at 30 meters (about 100 feet); at 75 meters (about 250 feet)? What is the pressure against an underwater submersible such as the *Alvin* at 2,000 meters (1.24 miles)?
- In order to descend to the depth of hydrothermal vents, scientists and explorers must use specially designed equipment like remote-operated vehicles (ROVs) and human-operated vehicles (HOVs) like the *Alvin* that are built to operate under extreme ocean pressures. How extreme? An ROV diving to a depth of 2,000 meters experiences over 1,270 kg (2,800 lb) of force exerted on each square inch of its surface!

## HANDS-ON ACTIVITY

Materials needed:

- 1 2-liter (67.6 fluid oz) plastic bottle, such as a soda bottle
  - electrical or duct tape
  - nail for making holes in bottle
  - plastic pan with sides.

Directions:

Punch 3 approximately equidistant holes in a vertical row on one side of bottle. Make sure that the nail makes clean holes in the bottle.

Cover holes with a strip of tape.

Fill bottle with water.

(Before you conduct this experiment in class, be sure to do it at home yourself.)

- Discuss with students what they expect to happen when the tape is removed. Set bottle in the pan and remove tape. Water will spurt out of the holes. Water will spurt out in the shortest stream at the top hole, which has the lowest pressure, and in the longest stream at the bottom hole, which has the highest pressure. Did any students predict this result? Discuss why water from the bottom of the bottle is spurting out in the longest stream.

Have students measure how far the water squirts from each of the holes. Then help them make a graph showing the relationship between the water pressure at each hole depth and the distance of each stream of water.

## AFTER READING THE BOOK - CLASS DISCUSSION QUESTIONS

- What is a hydrothermal vent?
- How do scientists discover hydrothermal vents?
- How do scientists find new vents?
- What are some of the animals that live in vent environments?
- What are the extreme conditions in hydrothermal vents?
- How do these animals tolerate such extreme conditions?
- How do vent animals eat?
- What is the base of the vent food chain?
- Why did the discovery of the vent food chain cause textbooks to be rewritten?
- How do vent chimneys form?
- What are some of the chemicals and metals flushed up by the vents?
- Do you think mining companies will eventually try to extract some of these metals? Why? (This is an open-ended question that has no correct answer. Use it to engage students' critical thinking.)
- Why have some vent animals, such as blind shrimp and pale octopuses, lost the use of some sensory organs?
- What is a tectonic plate?
- How do tectonic plates re-shape Earth?
- What were the first forms of life on Earth?
- Writing a nonfiction book takes research. During her research, author Mary Batten contacted many scientists who study hydrothermal vents. One of them, Dr. Jeffrey Hawkes of Uppsala University, Sweden, said, "Vents are like the recycling centers of the sea . . . They take the waste products of marine life and convert them into small molecules that provide food for small bacteria that live in the vents. These bacteria then form the start of a new food web, and so life continues." What do you think Dr. Hawkes means?
- Did reading this book give you ideas for writing your own nonfiction book one day? What would you write about?
- What are some things you learned from this book that you didn't know before?
- Another scientist whom the author contacted, Dr. Janet Voight of the Field Museum in Chicago, Illinois, said: "There's so much about the deep sea that we haven't even begun to explore. It's all discovery, and that makes it exciting." What do you think she means?

## ABOUT THE AUTHOR

Mary Batten, an award-winning writer for television, film, and publishing. She was nominated for an Emmy for her work on the Children's Television Workshop's science series *3-2-1 Contact* and has written more than fifty nature documentaries for television, including the syndicated series *Wild, Wild World of Animals*. She lives in Virginia.

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## ABOUT THE ILLUSTRATOR

Thomas Gonzalez was born in Havana, Cuba, and moved to the United States as a child. An artist and painter, he directed campaigns for clients such as Coca-Cola, Delta Airlines, NASCAR, the NFL, and McDonald's, in addition to illustrating children's books. He lives in Georgia.

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Peachtree Educator's Guide Prepared by Mary Batten

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