

2nd Grade Lesson Plan

Dice, Data, & Diversity in the Deep Sea

Created by Nadia Stoker

Edited by Trish Mace and Dr. Caitlin Plowman

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1. Title & Grade Level

Dice, Data, and Diversity in the Deep Sea (2nd Grade)

2. Lesson Summary

The deep sea is home to a wide diversity of marine animals that exhibit forms and behaviors that enable their survival in habitats very different from those on land or in shallow waters. Once thought of as a desolate, barren landscape with little life to study, we now know the deep sea has a high diversity of animals, as well as geochemical processes that allow it to be inhabited.

Students will learn about the diversity of life in the ocean by comparing animals they know to deep-sea animals. Students will work in small groups to gather data on diversity. Students will create and color their own dice featuring deep-sea animals, allowing them to “collect” and study these animals.

3. Objectives

- a. Reflect on prior knowledge of animals and their needs.
- b. Make observations and learn about marine animals that live in the deep sea.
- c. Compare and contrast “known” animals to these deep-sea animals.
- d. Use art and math to collect and understand data.
- e. Create a graphical representation of data as a class.

4. Estimated Time

60 minutes

5. NGSS Standards Addressed**2-LS4-1 Biological Evolution: Unity and Diversity**

Make observations of plants and animals to compare the diversity of life in different habitats.

Performance Expectation Grade: K-2, 2

K-ESS3-1 Earth and Human Activity

Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. Performance Expectation

Grade: K-2, K

6. Ocean Literacy Principles

OLP 5: The ocean supports a great diversity of life and ecosystems.

OLFC 5E: The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.

OLFC 5F: Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life.

OLFC 5G: There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps rely only on chemical energy and chemosynthetic organisms to support life.

7. Focus Question:

How do animals in the deep sea differ from animals you are familiar with?

8. MaterialsIncluded:

- a. Deep Sea Dice template
- b. Deep Sea Data Collection Sheet
- c. Background information on deep sea habitats and animals
- d. Resources for further exploration

Not Included:

- e. Safety scissors for each student
- f. Tape or glue sticks
- g. Coloring supplies
- h. Whiteboard, sticky notes or poster paper to record class thoughts

9. Preparation

- a. Print out deep sea dice templates (2 per student, one of each die)
- b. Gather supplies for dice assembly
- c. Read through background information and lesson steps

10. Lesson Steps

Step One: As a class, brainstorm and list needs that all animals have. Ask students to elaborate on known animals: how do these animals survive? What do they eat? Where do they sleep? How do they interact with other animals or their habitat? Share that there are animals that live as deep as the bottom of the ocean. They are harder to get to, which means they're harder to study, so we might not have heard as much about them.

Step Two: Ask students what they think or know about the deep sea and some of the challenges that animals living there might face.

Question 1: What makes the deep sea a challenging place to live?

Answer: Immense pressure, lack of sunlight, cold temperatures, and sparse, patchy food. These factors can make it hard to grow, find mates to reproduce, or see predators.

Question 2: Describe shared characteristics of deep-sea fish. How might each of these characteristics help a fish facing the challenges listed in question one?

Answer: Big eyes, large mouths with long and sharp teeth, bioluminescent features, use of lures, long skinny bodies or short spherical bodies.

- Big eyes: better adapted to see in low light
- Long teeth: success eating prey when able to find it
- Sharp teeth for capture, and large mouths for ambush attacks and engulfing entire prey
- Bioluminescence: confusing prey or attracting mates
- Use of lures: attracting/ambushing prey like an anglerfish
- Long skinny bodies: this body shape is suited for very slow swimming with periodic bursts of speed
- Short, spherical bodies: some fish, like anglerfish, have this body plan to withstand the immense water pressure in the deep ocean where they live.

10. Lesson Steps (continued)

Step Three: Use the provided background sheets (pages 5-6) to guide your students through the deep sea habitats they will explore today: hydrothermal vents and methane seeps.

Step Four: Provide coloring materials, scissors, and dice templates (pages 7-8). Each student should have two different dice. Give students the name of each animal and explain that they will learn more about them later. Coloring of the animals should take place first. Provide a demonstration of how to assemble the dice. Allow the class to construct their dice. Point out that the small tabs on each side of the squares on the dice template should not be cut off, as that is where glue will be applied. Allow time for glue to dry if necessary.

Step Five: Divide the class into small groups (2-5 students each). The more students per group, the faster the “collection” process will be. Explain to the class that they are marine biologists journeying to the bottom of the ocean, attempting to find as many animals as they can. All members of the group should roll their dice at the same time. In order to “collect” an animal, the same animal must be rolled on at least two dice during that roll. Student groups should keep a tally for each animal they collect on their data collection sheet (page 9). Instruct students to keep collecting by rolling their dice until they’ve collected a total of 10 animals as a group.

Step Six: Graph the results as a class by creating a bar graph. This can be done on a whiteboard with markers or using sticky notes. Share the provided passages (pages 10-12) about each animal, starting with the animal that was collected most to least. This should be an example for students that animals that are abundant are easier for scientists to learn about, while less common animals that are harder to find take more effort and time to study.

Step Seven: Remind students of the list of known animal needs from before the data collection activity. Ask students to share what they learned about deep-sea animals. Which behaviors or body parts are unique? How do animals in the deep-sea interact with their habitat and meet their survival needs? Create a list of class answers and compare it to the brainstorm list from step one.

11. Extension

- a. Visit this [Deep-sea Research Story Map](#) to learn more about the deep-sea animals you discovered as a class today and the research conducted by marine biologists in the deep sea.
- b. Watch the [Diving in Alvin video](#) on the [Born in the Abyss Film Website](#) to learn more about what it's like to visit the deep sea in a submersible.
- c. Watch the [Animal Encounters video](#) on the [Born in the Abyss Film Website](#) to hear stories of deep sea animals from scientists, engineers, and pilots.

12. References

[Next Generation Science Standards](#)

<https://www.nextgenscience.org/>

[Ocean Literacy Principles Handbook by NMEA/NOAA](#)

<https://www.marine-ed.org/ocean-literacy/overview#ocean-literacy-overview>

[Born in the Abyss Film Website](#)

<https://www.stephenlow.com/born-in-the-abyss/#larval-biology-basics>

[Deep-sea Research Story Map](#)

<https://storymaps.arcgis.com/stories/7aeb59bf68df4b8c94dff05c84aa1dd6>

[Yeti Crabs](#)

<https://oceanconservancy.org/blog/2020/12/18/curious-yeti-crab/>

[Grenadier](#)

<https://www.mbari.org/animal/rattail-fish/>

[Pompeii Worms](#)

<https://www.mbari.org/animal/pompeii-worm/>

[Scaly-foot Snails](#)

<https://www.marinebio.org/species/scaly-foot-snails/chrysomallon-squamiferum/>

[Deep-Sea Brittle Stars](#)

<https://www.shapeoflife.org/news/featured-creature/2023/03/27/deep-sea-brittle-star>

[Deep-Sea Brachyuran Crabs](#)

<https://oceanexplorer.noaa.gov/multimedia/oceanos-explorations-ex1903-dailyupdates-july1-media-crab/>

[Tube worms](#)

<https://www.boem.gov/newsroom/ocean-science-news/tube-worms>

[Bathimodiolus Mussels](#)

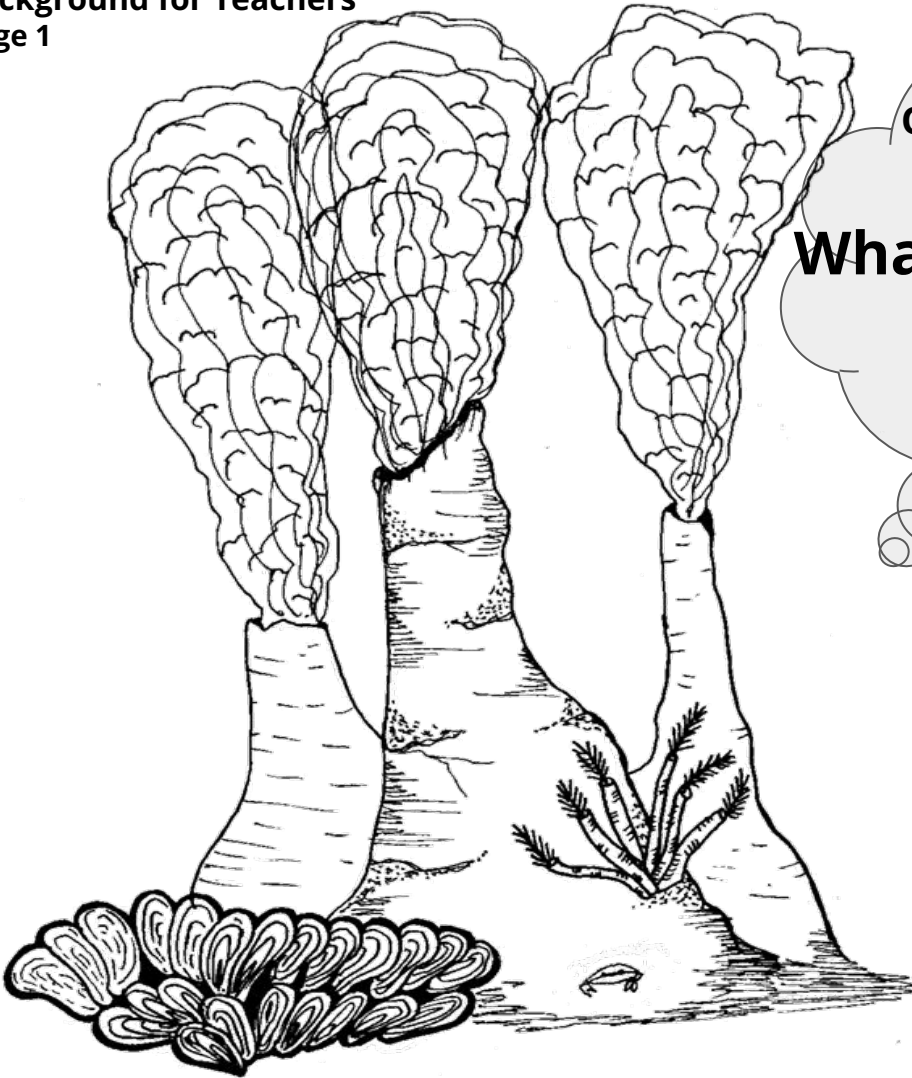
<https://kids.frontiersin.org/articles/10.3389/frym.2019.00076>

[Animal Encounters video](#)

<https://youtu.be/GitEvntQDZA>

[Diving in Alvin video](#)

<https://youtu.be/TMMF3Jc4GoM>



Question:

What is a hydrothermal vent?

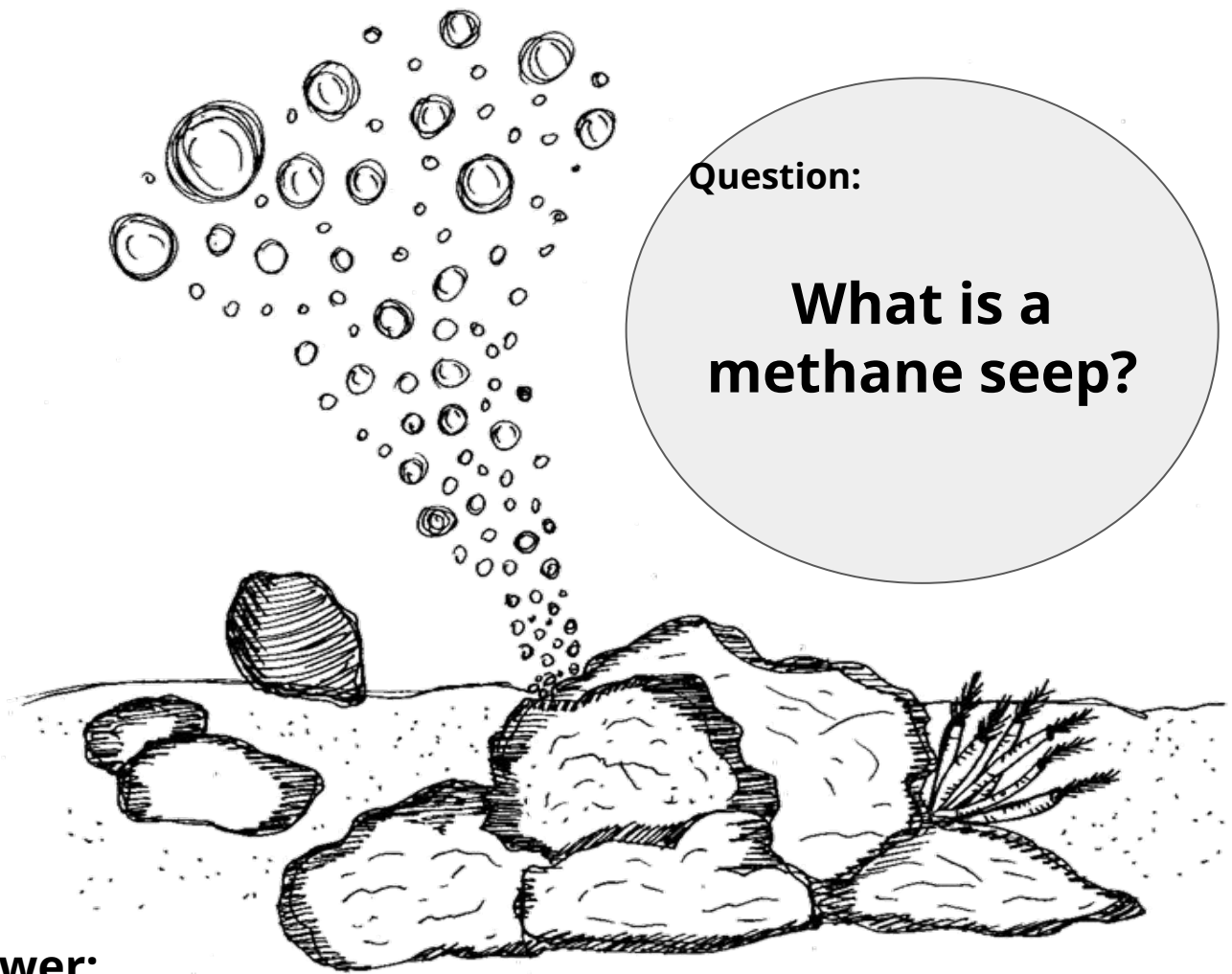
Answer:

Hydrothermal vents are like chimneys on the bottom of the ocean that are formed by volcanic activity and the movement of tectonic plates, resulting in vents that pump out fluids filled with minerals and chemicals.

A hydrothermal vent is formed when cold seawater sinks down through cracks in the ocean crust. These cracks are found near places with volcanic activity like spreading centers or subduction zones which are places on Earth where two tectonic plates move away or towards one another. In these areas, magma wells up to the surface or just below the seafloor. As ocean water moves down through cracks and porous rocks, the super-hot magma causes chemical reactions that remove oxygen, magnesium, sulfates, and other chemicals from the water. In the process, the fluids become hotter and more acidic, causing them to leach metals such as iron, zinc, copper, lead, and cobalt from the surrounding rocks. The heated fluids rise back to the surface through openings in the seafloor, known as hydrothermal vents. The fluid temperatures can reach 400°C (750°F) or more, but they do not boil under the extreme pressure of the deep ocean.

As they pour out of a vent, the fluids encounter cold, oxygenated seawater, causing temperatures to drop rapidly just inches away from the vent. This drop in temperature leads to a rapid series of chemical reactions. Sulfur and other solids precipitate—or come out of solution—to form metal-rich towers and deposits of minerals on the seafloor—some reaching over 30 feet tall! These minerals sometimes are visible in the gushing fluid, which is why some hydrothermal vents are called white or black “smokers.”

The hard structure of the vents and the chemicals in the vent fluid support a unique food web that survives without sunlight. In many hydrothermal vent communities, the ecosystem is based on bacteria that convert hydrogen sulfide and other chemicals in the vent fluids into sugar for energy. These “chemosynthetic” bacteria provide food for larger organisms such as tubeworms, shrimp, and mussels.



Answer:

A methane seep is an opening on the bottom of the ocean where methane gas escapes from below the Earth's crust into the surrounding ocean water. Seeps are caused when dead animals and plants deep within the Earth break down and dissolve into the dirt, which creates the methane gas. Methane seeps appear as columns of gas bubbles streaming upward out of the ocean floor.

In contrast to hydrothermal vents, methane seeps are known for the relatively low temperature of the fluids that ooze from the seabed which almost always match the temperature of the surrounding deep-sea water. These are called "cold seeps". They are termed "seeps" because the materials ooze slowly through cracks, rather than erupting quickly. Methane seeps also support unique communities of deep-sea animals, including mussels, clams, and tubeworms. These animals rely on chemosynthetic bacteria that can use methane from seeps to make food. In turn, these animals provide shelter for the bacteria.

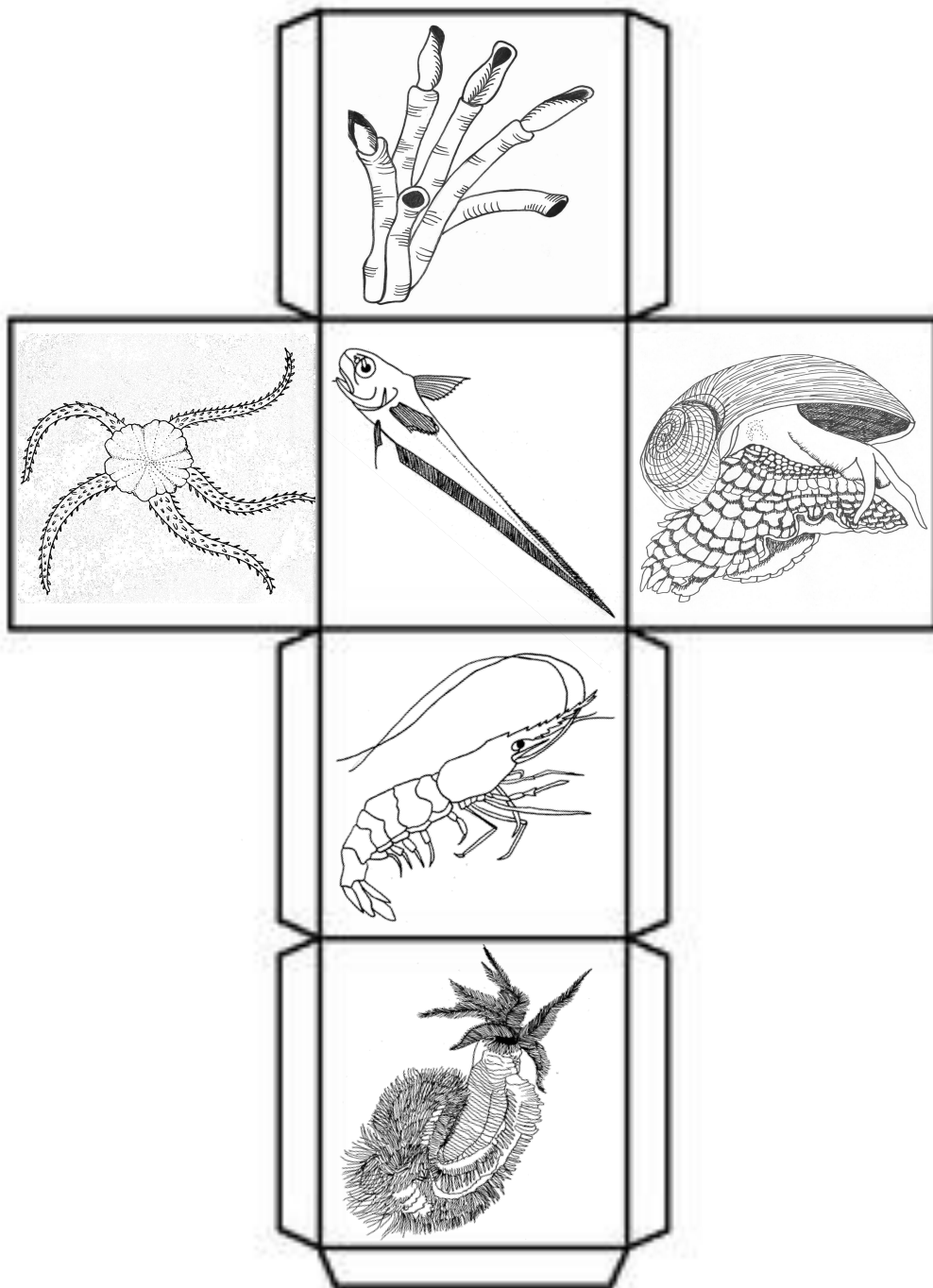
Deep-Sea Dice

Instructions:

Step 1: Using scissors, carefully cut around the outside of this template. Do not cut off the thin tabs on the sides of the squares.

Step 2: Once the entire shape is cut out, fold the thin tabs towards the blank side of the paper (away from drawings).

Step 3: Add a small amount of glue onto each tab and fold all squares toward the center, using the tabs with glue to secure the sides of the dice.



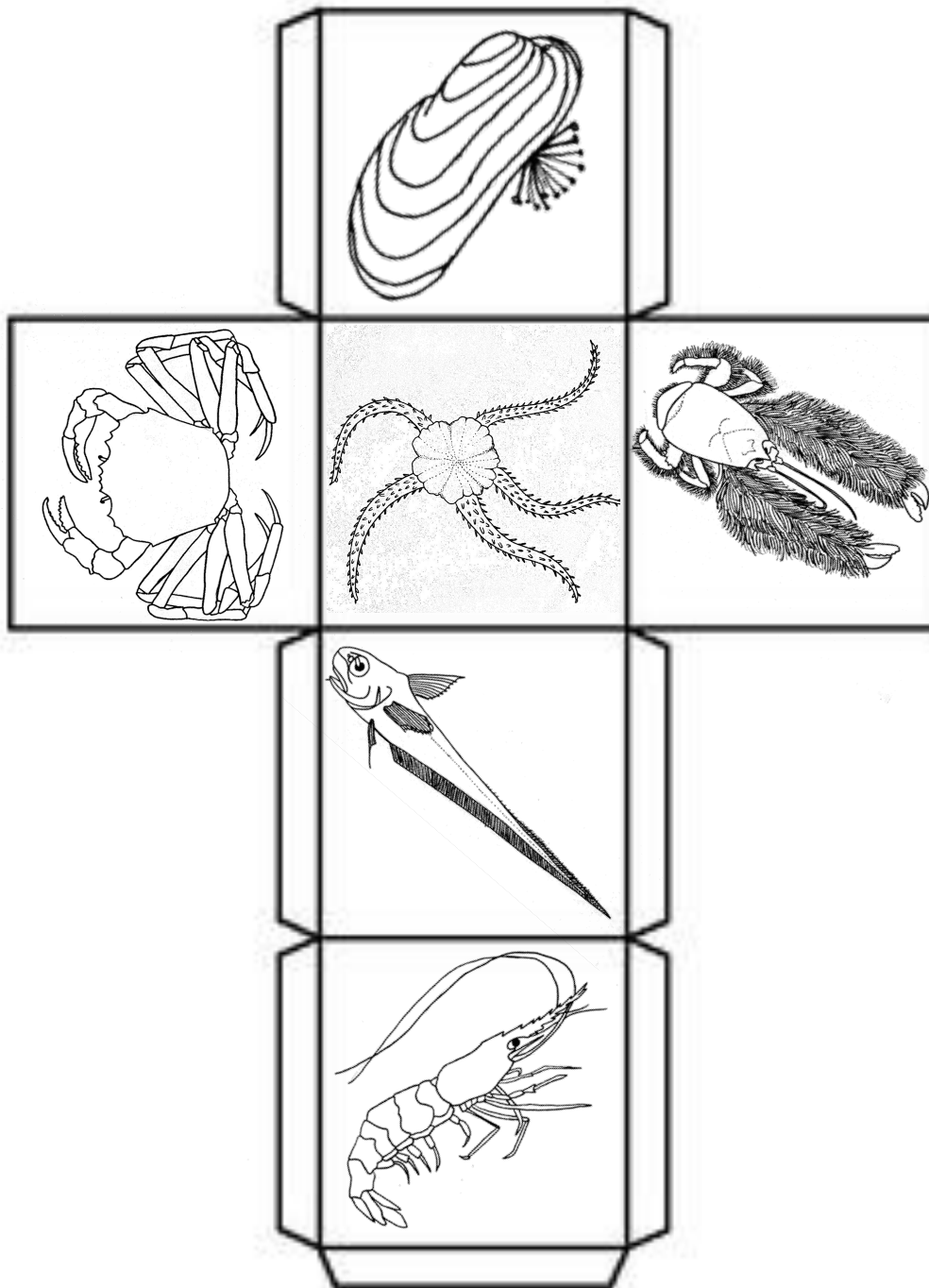
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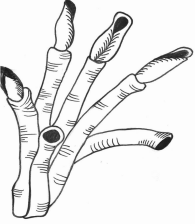
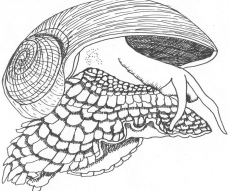
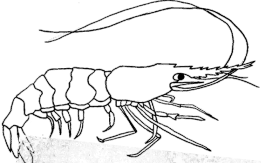
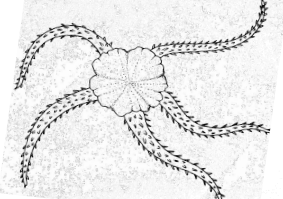
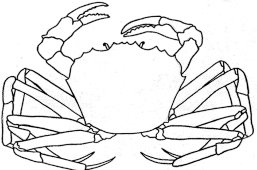
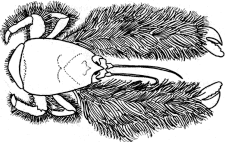
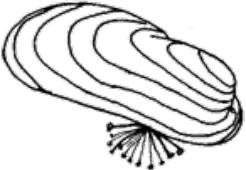
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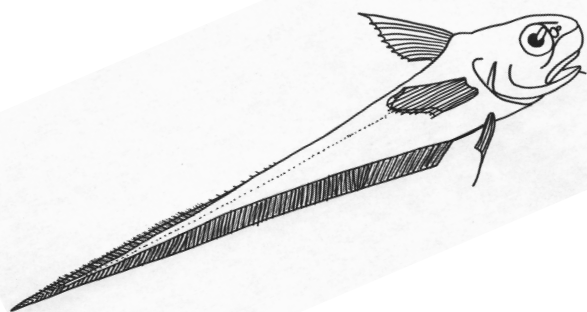


Data Collection Sheet

Animal	How many did you collect?
 Tube worms	
 Grenadier	
 Scaly-foot snail	
 Shrimp	
 Brittle star	
 Crab	
 Yeti crab	
 Mussel	
 Pompeii worm	

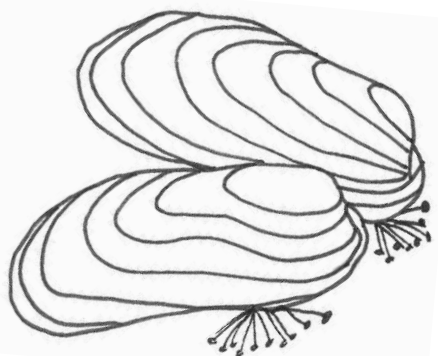
Common Deep-sea Animals

These animals are abundant in the deep sea. While they may resemble animals that are found in shallower water, they each have unique adaptations that allow them to survive in the deep sea where there is high pressure and no sunlight.



Grenadiers

These common deep-sea fish are dominant predators near hydrothermal vent and methane seep communities. They eat octopuses and other fish. Grenadiers travel between vent and seep sites and the surrounding deep ocean floor in search of prey. These slow-growing, long-lived fish live in darkness. They have large eyes to detect bioluminescent prey, sensitive barbels (whiskers) on their chins for tasting/feeling food on the bottom, and a lateral line system to feel vibrations in the water.



Bathymodiolus mussels

These deep-sea mussels are famous for their relationship with chemosynthetic bacteria that give them the energy and nutrition they need to survive. The bacteria live in the gills of the mussels and turn chemicals from vents and seeps into the energy that keeps the mussels alive. This symbiosis is a very important adaptation in the dark, deep sea where food can be hard to find. Mussels are important because they provide hard surfaces for other animals to live on.

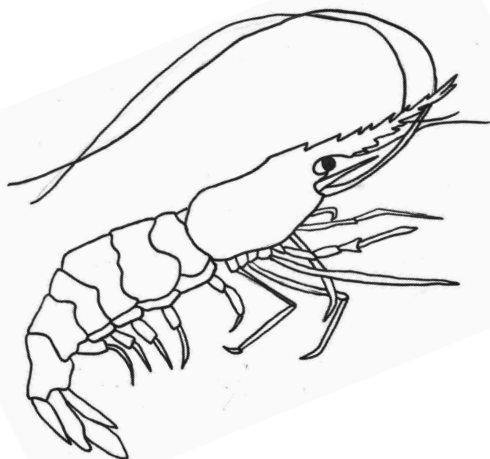


Tube worms

Tube worms are commonly found living in clusters near hydrothermal vents and methane seeps. These animals host symbiotic, chemosynthetic bacteria that live inside the worms. Lacking a mouth and a gut, these worms rely on the bacteria for all of their food. In turn, the worms provide protection for the bacteria. The bacteria turn the chemicals into nutrients, allowing some tubeworms to grow up to six feet tall or live up to 1,000 years.

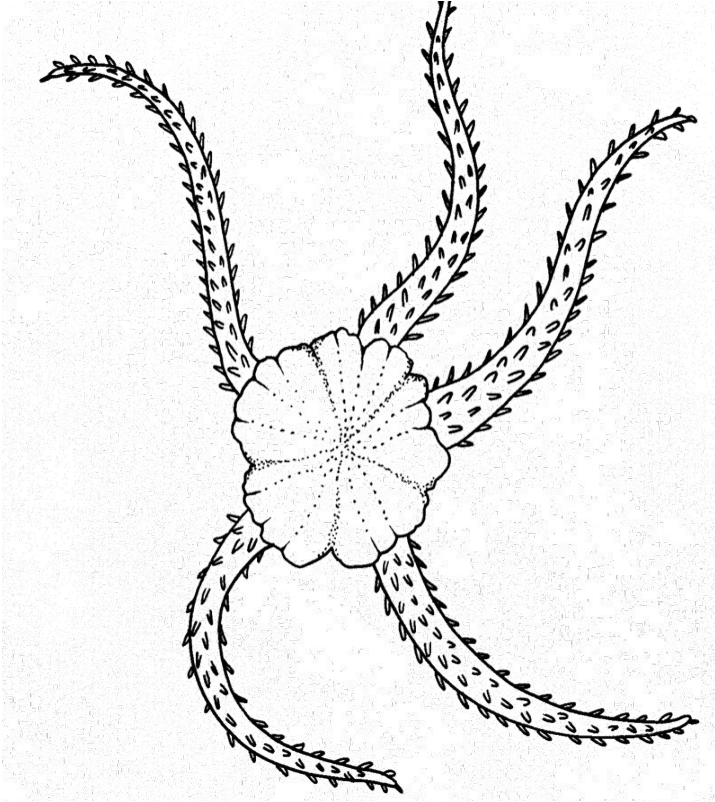
Shrimp

Deep-sea shrimp are abundant at hydrothermal vent ecosystems in the Atlantic and Indian Oceans. In some places, there are over 300 shrimp per square foot. These shrimp host chemosynthetic bacteria in their mouths and gill covers. The shrimp give the bacteria a home while the bacteria provide the nutrients the shrimp need. Many vent shrimp are blind but have a light-sensitive area on the top of their heads that detects the faint glow from hydrothermal vents, which helps them move through the darkness without entering dangerously hot water.



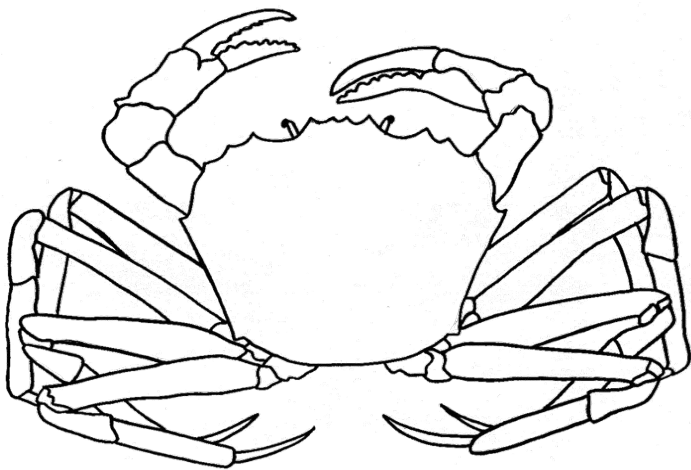
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Deep-sea brittle star

Relatives of sea stars, brittle stars live in all parts of the ocean, including the ocean's deep. Their Latin name is ophiuroid, meaning serpent tail, as they have snake-like arms radiating from their bodies. There are approximately 2,000 species of brittle stars. They can be very small (less than an inch across) or reach up to 4 feet across. Brittle stars appear to “walk” with their arms. Any arm can lead the way. This means it’s easy to go in reverse—another arm just takes the lead. More than half of known brittle star species live in the deep sea, as deep as 11,000 feet.

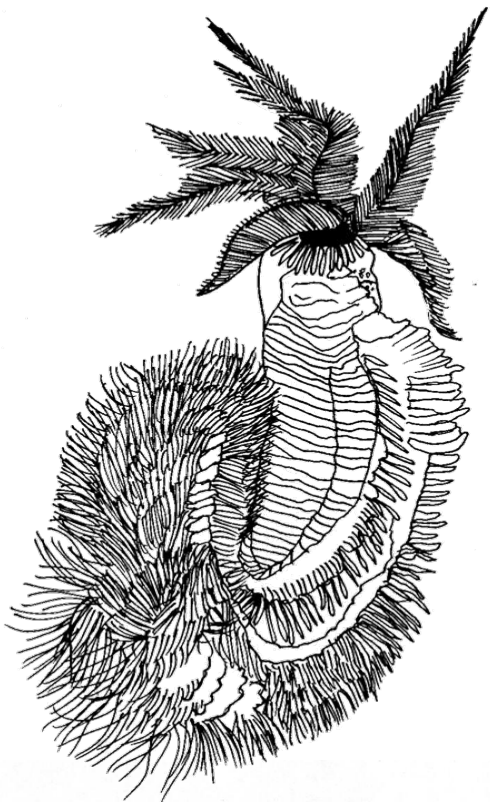


Deep-sea brachyuran crabs

Deep-sea crabs resemble the crabs you know or may have eaten. They can live in a variety of habitats throughout the deep sea but are mostly found on muddy or rocky bottoms. Some brachyuran crabs have been found deeper than 9,000 feet below the surface. Brachyuran crabs are very good at scavenging, as food can be difficult to find on the bottom of the ocean. They have special structures on their legs that allow them to sense small animals hiding in the mud or sand. Some species of deep-sea crabs carry sponges or other animals on their bodies as defense or camouflage. These crabs also grow very slowly compared to shallow-water crabs.

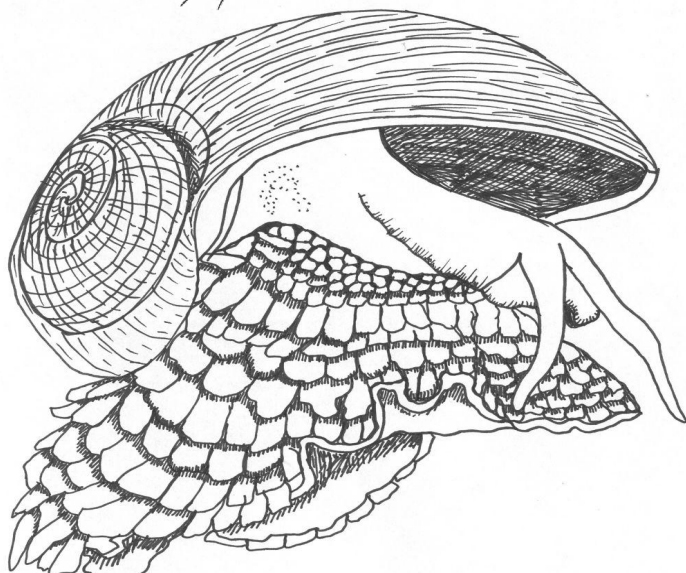
Less Common Deep-sea Animals

While found in the deep sea, these animals are limited to a few locations. They each exhibit unique adaptations that allow them to survive in the deep sea where there is high pressure and no sunlight.



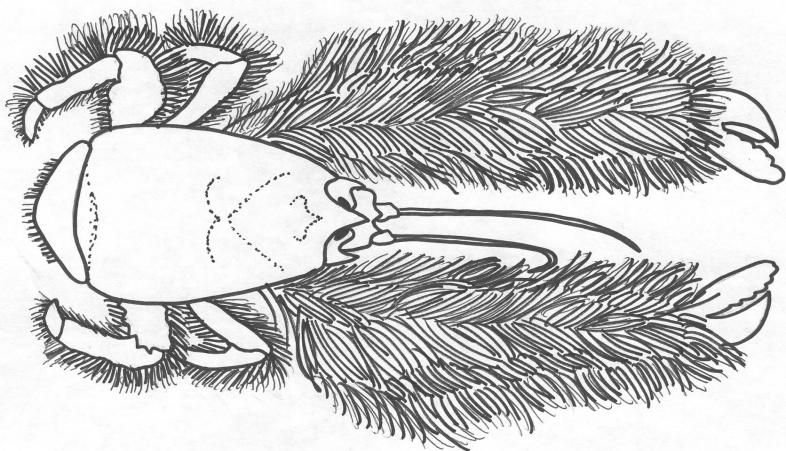
Pompeii worm (*Alvinella pompejana*)

The pompeii worm is one of the most heat-tolerant animals on the planet. These worms live in tubes on hydrothermal vent chimneys in the Pacific ocean, surviving temperatures up to 176°F (80°C). They position their tails in this hot water while their heads stay in cooler water (71°F or 21°C), inches away. They are protected by a layer of bacteria that can be up to 1/2 inch (1cm) thick. The bacteria feed on the mucus secreted by the worm and act as an insulation layer that protects the worm's head from extreme heat. These worms also survive by eating the bacteria that grow on their bodies. These animals were named after the ancient Roman city of Pompeii that was buried in ash from a large volcanic eruption.



Scaly-foot snail (*Chrysomallon squamiferum*)

The scaly-foot snail is the only known animal to incorporate iron sulfide into hard parts of its body including its shell. It also uses iron sulfide to create a metallic armor of overlapping scales on its foot. These snails do not eat but rely on symbiotic, chemosynthetic bacteria in their esophagus. The snails provide protection and the bacteria provide nutrients for the snails. The snails have one of the largest hearts compared to their body size in the animal kingdom (4% of their body mass) to provide oxygen to their bacteria.



Yeti crab (*Kiwa tyleri*)

Yeti crabs were first discovered in 2005 near hydrothermal vents in the Pacific. These crustaceans are roughly 6 inches long and are known for their "furry" claws that are covered in bacteria-trapping bristles called setae. These setae allow the yeti crabs to "farm" the bacteria, cultivating colonies of bacteria on their own arms to eat later. They have even been noticed by scientists to "dance"—wave their arms to stimulate bacterial growth. These crabs are blind and white. Their white, hairy look gives them their yeti name.