An educational resource about dark environments.

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Cassandra Snodgrass' daddy.

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Purpose of this book

This book concentrates on five aspects of the dark: the world at night; cave environments; underground environments; the deep sea; and how humans relate to darkness.

The purpose of this activity book is to provide teachers with information and activities that will enable students to:

- learn about the unique creatures that dwell in darkness and how they relate to the environments they inhabit as well as to each other.

- understand the importance of dark environments as part of the global structure of biodiversity.

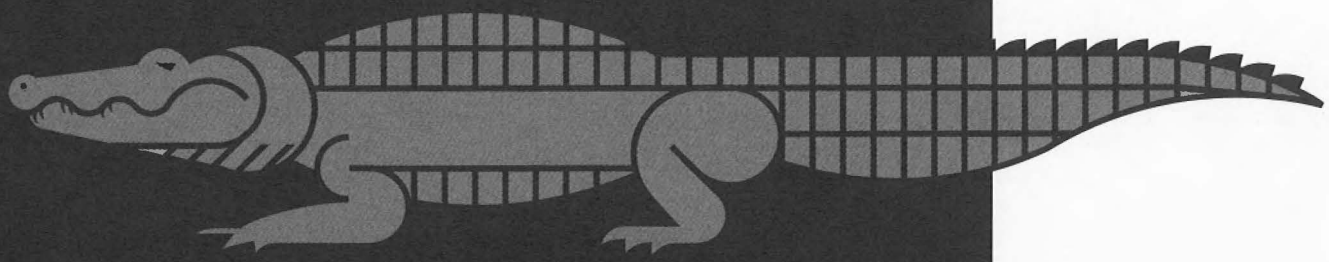
- become aware of how humans have creatively responded to darkness.

The dark has always been a place of mystery and apprehension for humans. From early human myths about controllers of darkness devouring makers of light to modern legends of things that go bump in the night, our fascination with the unknown or unseen continues. Perhaps we respond to a primal fear ingrained in our species from a distant time when fierce nighttime predators stalked human prey in the dark . . .

Perhaps it is just these feelings that have spurred a desire to understand the unknown and unseen. Perhaps we need to explore hidden environments below the Earth's surface like caverns, or the deepest depths of the oceans, or the dark forest, or even the soil beneath our own backyards. Perhaps we need to do this because understanding dispels fear.

To us, darkness can be mysterious. Light is synonymous with life, since the primary source of the energy of living systems is the sun. But to many species, the darkness is their home. Their lives go on at night, in caves, within the soil, and beneath the surface of the ocean. Selection has led them along the paths to darkness so that they can escape the brutal heat of day, or become better predators or – to flip that around - become better protected from predators. For whatever reason, selective pressures have fashioned a host of animals superbly adapted to inhabit worlds without light.

In keeping with current trends in national science education reforms, the activities in this booklet are designed to address learning outcomes put forth by the *Project 2061: Benchmarks for Science Literacy*. Although we understand that each state and each district will interpret the benchmarks in a manner appropriate to their region, these activities will provide educators with resources to enhance the process of learning science. The activities in each section are designed to provide multiple experiences that build on each other and incorporate hands-on and inquiry-based methods of learning. Also in the spirit of Project 2061, the interdisciplinary nature of science has been incorporated into the text.



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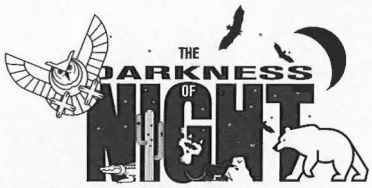
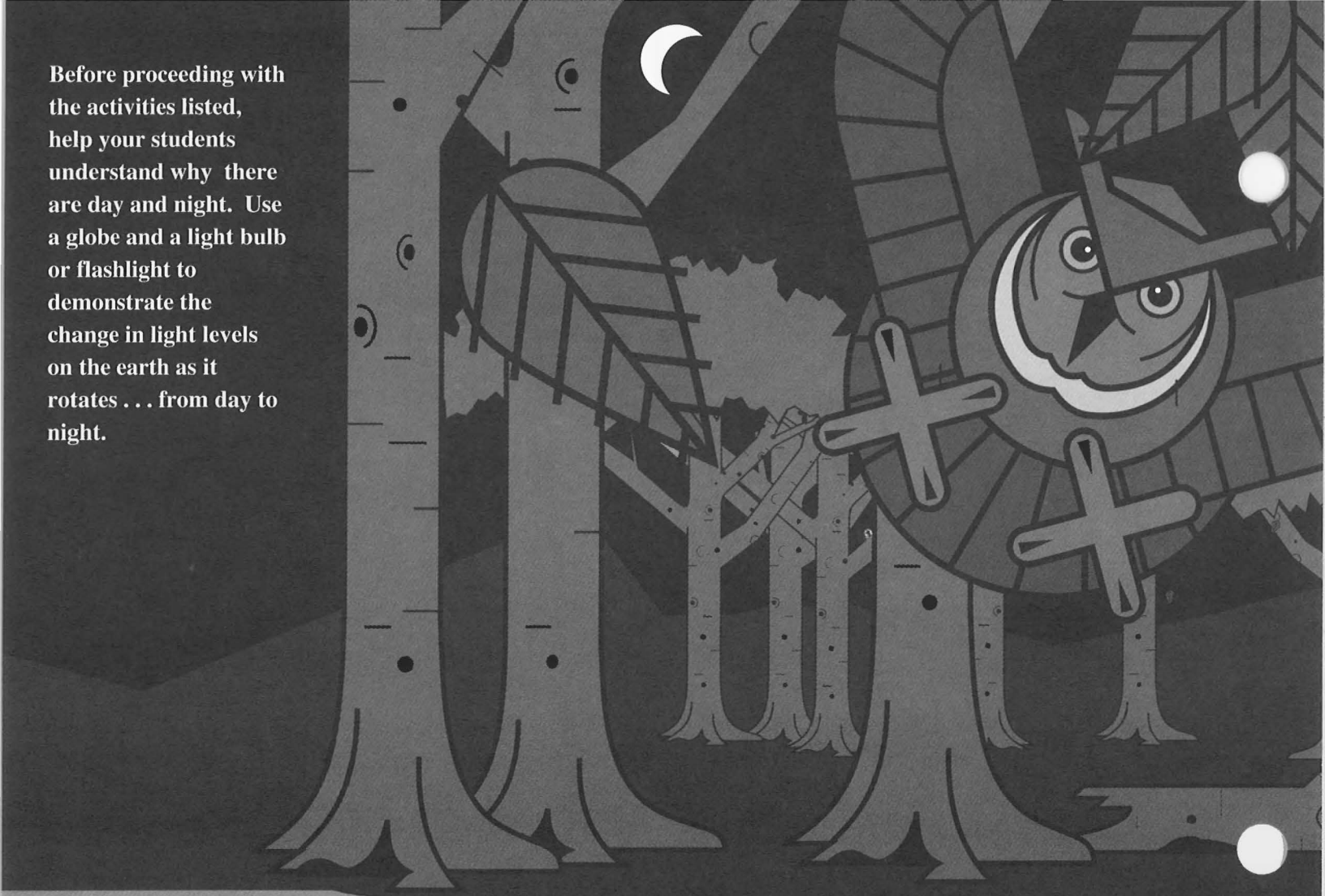
This book is divided into five sections, each with three activities.

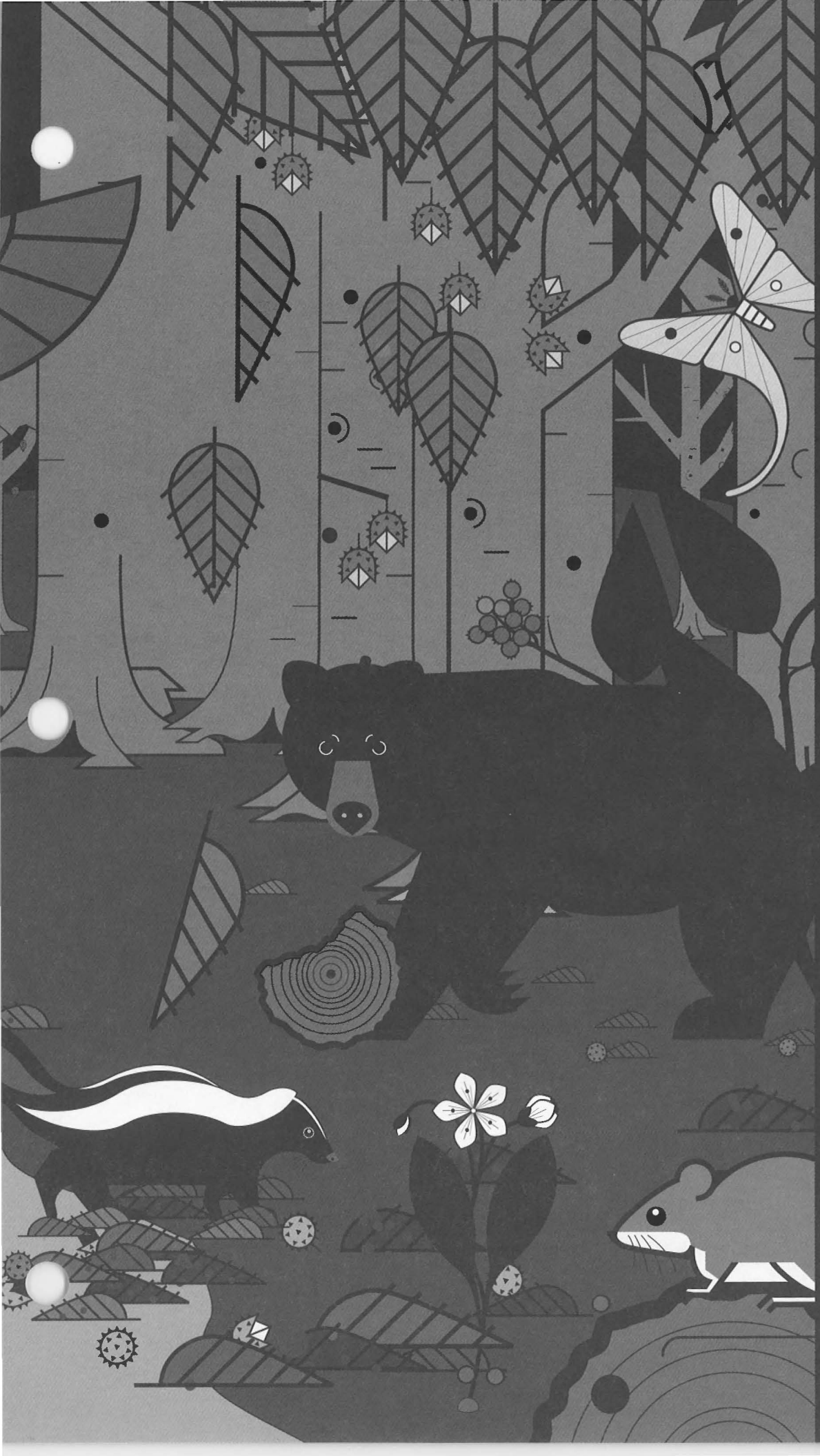


Before proceeding with the activities listed, help your students understand why there are day and night. Use a globe and a light bulb or flashlight to demonstrate the change in light levels on the earth as it rotates . . . from day to night.



When the sun goes down and life slows down for daytime creatures, another whole world comes to life. What goes on outside while most people sleep? There are many plants and animals that are active during the night. How do they function in the dark?

Nocturnal environments differ from the constant darkness of caves and the ocean depths because they are dark for only part of each day. Animals that live there can be active during the day, the night or both. Also, the night environment is not totally dark. It has degrees of darkness depending on moonlight, artificial light, cloud cover, etc.



THE DARKNESS OF NIGHT

ACTIVITY 1

This activity demonstrates heightening of the senses of hearing and vision. This leads to a discussion of the features common to noctural animals.

ACTIVITY 2

A few animals have evolved the ability to make their own light. Students will play a code game to demonstrate how fireflies communicate in the dark.

ACTIVITY 3

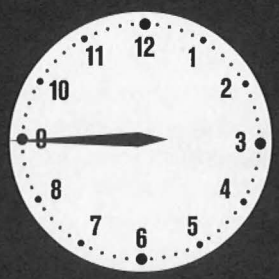
By counting the number of chirps a cricket makes, you can determine the temperature. This will demonstrate that environmental factors can influence animal behavior.

ACTIVITY 1

In Brief

Access to a dark room is required for this activity – if this is not possible, use blindfolds. Students will be asked to observe how many paper plates they can see initially in a dark space, and then how many they can see after their eyes have gotten accustomed to the dark. They also will be asked to listen to the sounds they hear in the dark.

A DARK ROOM



45 minutes

How do our senses adjust to the dark?

Objective

To make students aware of how their senses of sight and hearing are more acute in an environment where there is reduced light.

Materials

- blindfolds, if dark room is unavailable
- 10-12 white paper plates
- string
- tape
- paper
- pencil

Vocabulary

nocturnal \näk-'tərn-ᵊl\ – occurring at night.

pupil \'pyu-pel\ – the dark circle in the center of the colored part of the eye that permits the entry of light.

tapetum lucidum \tə-'pet-əm lü-'sid-um\ – a reflective structure in the eye that improves night vision by reflecting light back to the retina.

Background

People as well as other animals have senses that can adjust to darkness. The following activity demonstrates to students that their bodies can make changes to better function in darkness.

Directions

To effectively carry out this activity, you will need to darken your classroom completely.

1. Ask your students to wait quietly in a lighted hall.
2. Hang several paper plates from the ceiling at 3-foot intervals along one end of the room.
3. Turn off the lights.
4. Students enter and sit at one end of the room facing the paper plates.
As soon as they are seated, ask how many paper plates they can see.
Have them sit in the dark for 5-10 minutes, noticing every sound they hear.
At the end of the time span, have them look at the paper plates again.
How many can they see now?
5. Before turning on the lights, have the students pair up and observe the pupils of each other's eyes when you turn on the lights.
6. When the students return to their desks, they should record all the sounds they heard while they were sitting in the dark.

Questions

1. Could you see more or fewer paper plates after being in the dark for a period of time? What happened to cause this? *Students should be able to see more paper plates as the pupils of their eyes enlarge to allow them to see better in the dark.*

2. When the lights are turned on, what happened to the pupils of your eyes? Why? *When going from a dark to a lighted room, the pupils of the eyes constrict so that less light enters the eyes.*

3. What must the pupils of the eyes do to adapt to the dark? What do they look like in the dark? *The pupils enlarge in the dark in order to allow what little light there is to enter.*

4. List all the sounds you can remember hearing. Do you hear all these things when you are in a lighted room? Would you have heard more sounds or fewer sounds in the dark room? Why? *Let students enumerate the sounds they have heard. They should hear more when they are in the dark, since the sense of hearing becomes more important than the sense of sight.*

5. What often happens to a blind person's senses of touch, hearing and smell? *When a person has lost the sense of sight, he/she has to rely on his/her remaining senses to relay information about his/her surroundings. These senses generally become sharper.*

6. Elicit comments on what adaptions nocturnal animals might have to survive in the dark. *Comments may include larger ears in order to hear better, larger eyes that can gather more light, a better sense of smell.*

ACTIVITY 1

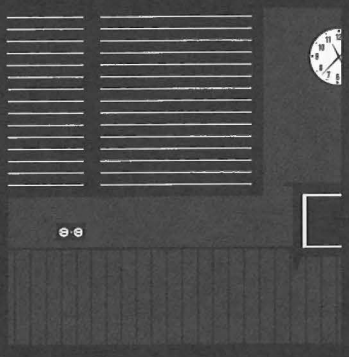
This activity can be altered by blindfolding the students if you do not have access to a dark room. Then omit the paper plate activity, but do the others.

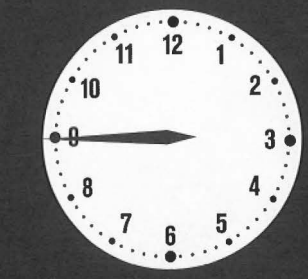
ACTIVITY 2

In Brief

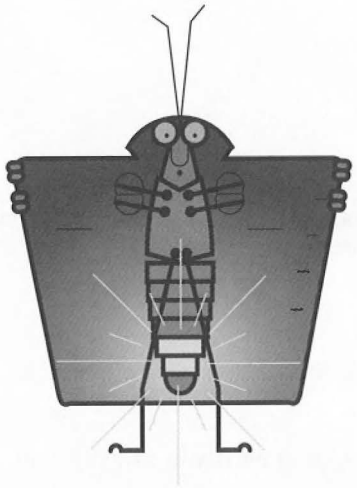
Using flashlights, students will send out codes that other students must identify.

A DARK ROOM





45 minutes



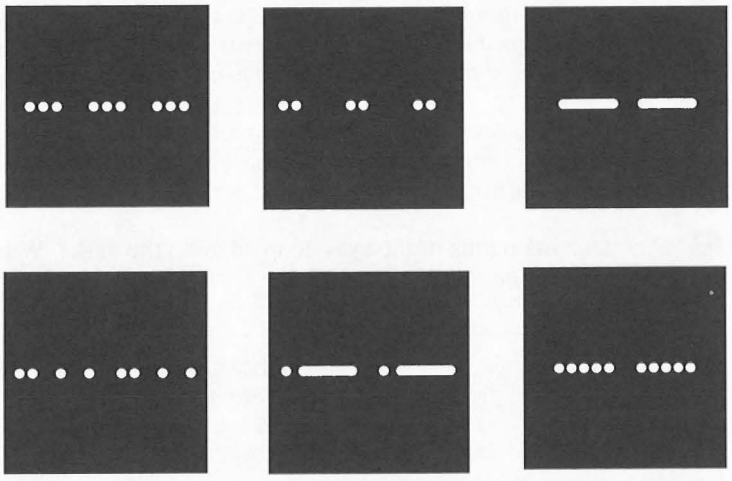
How do fireflies communicate?

Objective

To teach students how animals, especially fireflies, send out light patterns that allow them to find each other for food or mating purposes.

Materials

- flashlight for each student
- pattern cards



Vocabulary

braille \'brā(ə)l\ – a system of writing and printing for the blind in which varied arrangements of raised dots representing letters and numerals can be identified by touch.

Morse code \'mȯrs-'kȯd\ – a system of communication in which letters of the alphabet and numbers are represented by short and long patterns that may be conveyed as sounds, flashes of light, written dots and dashes, or wigwags of a flag.

synchrony \'siŋ-krə-nē\ – several occurrences that happen at the same time.

Background

Animals that are nocturnal or live in constant darkness must evolve effective ways to communicate in the dark. Many animals communicate with sound. However, fireflies use light to flash species-specific patterns that attract mates. Male fireflies fly in the air. Each species produces a distinct flashing signal. Unmated females on vegetation respond to males of their own species by issuing return flashes. The male then flies down to the female. However, there is one species of firefly in which the mated female responds to the flashes of males that are not of her species. Her intentions are not to mate with these males, but to eat them. The following activity deals only with females that respond to males of their own species.

Directions

1. Make four copies of each card.
2. Give each student a flashlight (bring from home).
3. Before handing out the cards, the teacher should hold up each pattern card and have the students practice flashing the pattern that appears on it.
4. Shuffle the cards, and hand one to each student.
5. Darken the room.
6. On a designated command, have the students start flashing their patterns. The object is to match up with the other three students who have the same pattern.

Questions

1. Was it easy or difficult to find your match?
2. What skills did you need to accomplish this task?
3. Why do fireflies flash certain patterns in the darkness?
Fireflies flash either to find a mate, or in the case of one species, to find prey.

Taking it Further

1. Some fireflies flash in synchrony, that is, they all flash at once. Have one group of students flash their pattern together. Then have other students join in as they understand the pattern. (NOTE: In Singapore, in Southeast Asia, entire trees light up as the fireflies in them flash in synchrony!)

2. Give out the cards again, but this time give each student a pattern of hand claps. Have students find their matches by listening to the clapping patterns. What animals make noises in the night and why? *Frogs, crickets and katydids make noises to attract mates or to communicate with each other.*

3. Using the braille alphabet, have students construct simple sentences by punching holes into paper with sharp pencils. Have students trade their papers with another student, and see if the student can decipher what is written on the paper they touch.

4. Using the Morse code alphabet, have students write simple sentences in the code, and see if a partner can decipher the code when it is tapped out on the desk.

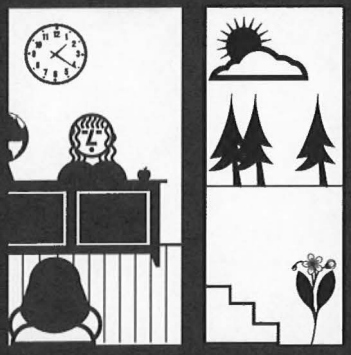
ACTIVITY 2

ACTIVITY 3

In Brief

Crickets use sound to communicate in the dark. Since crickets are cold-blooded animals, they cannot regulate the temperature of their bodies. The temperature of the air around them determines the number of chirps male crickets can make each minute.

INSIDE OR OUT

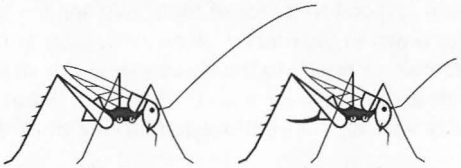


30 minutes

Can crickets tell the temperature?

Objective

To demonstrate how temperature can affect an animal's activity level.



Male Female

Materials

- male cricket (see diagram to distinguish male from female cricket)
- one opaque jar or clear jar covered with a box or dark cloth (crickets generally only chirp in the dark)
- nylon stocking or cheesecloth
- rubber band
- thermometer
- stopwatch or watch with a second hand

Vocabulary

cold-blooded\'kol(d)-'blәd-әd\ – having a body temperature that fluctuates with the external environment.

Background

Many animals that live in the dark communicate using sound because they cannot see each other. The purpose of those sounds is to attract mates, or to establish territories.

Temperature can have an effect on the sounds animals make, especially in cold-blooded animals, such as crickets. In general the higher the temperature, the higher the level of activity. Crickets make sounds by rubbing their wings together. Air temperature in degrees Fahrenheit can be determined by counting the number of chirps a male cricket makes (female crickets do not chirp) in 14 seconds and adding 40 to that number.

Directions

1. Use the diagram to determine whether you have a male cricket.
2. Place the cricket in a jar.
3. Cover the top of the jar with a nylon stocking or cheesecloth held in place with a rubberband. Drape a dark cloth over the jar or put a box over it to shut out the light. When the cricket starts chirping, count the number of chirps in a 14-second interval. Add 40 to this number. The total is the temperature in degrees Fahrenheit of the air around the cricket.
4. Hold a light bulb over the jar for a few minutes, then count the number of chirps again. Repeat several times for accuracy. Don't let light into the jar, or the cricket will not chirp.

Questions

1. What was the temperature for your first calculation? What was the temperature for you second calculation?

2. What does this tell us about the activity of some animals in warmer temperatures? *The activity of some animals is generally higher at warmer tempertures. This is especially true of cold-blooded animals such as insects, reptiles and fish.*

3. How could you check to determine the accuracy of the chirp method of temperature calculation? *You could put a thermometer in the jar.*

4. If you were a cricket, in what environments would it be advantageous to be active at night? *In very warm environments such as deserts, it is better to be active at night rather than in the day to prevent overheating and dehydration.*

For this activity you will need to collect a cricket. During the spring, summer and early fall, crickets may be found beneath rocks or boards lying on the ground. Or they may be caught in a pit trap consisting of a bottle or can buried with its rim flush with the ground surface and baited with a little molasses. Crickets also are available at many bait shops and some pet stores.

ACTIVITY 3

Taking it Further

1 Fill a 2-cup measure with white sand. Pour the sand onto a paper plate. Repeat this procedure to get two plates of sand. Hang a light bulb over one plate of sand for several hours. Have students feel the two samples. Which plate of sand is cooler and why? What does this have to do with nocturnal animals in a desert? The plate of sand without the light should be cooler. Many desert animals are active at night in order to avoid heat and the accompanying risks of dehydration and overheating.

2 Have students take night walks with their parents. They may take flashlights, which should be used only in case of emergencies. Have them record everything they see, feel, hear, etc. You can record the results of those walks in the classroom. Generate a list of all the animals encountered. Compare characteristics of those animals.

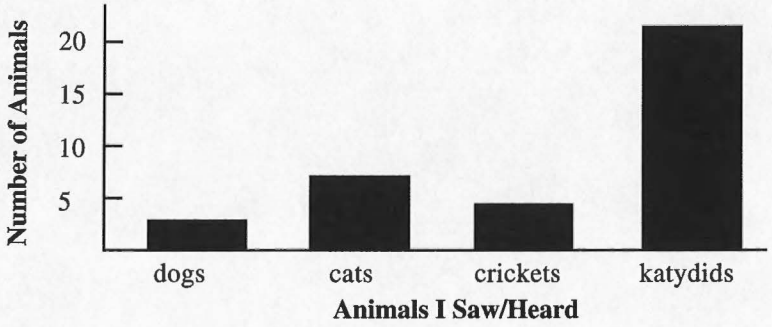
3 Suggest the students turn on porch lights at home and observe what animals are attracted to the light.

Across the Curriculum

Math

Scientists take temperature measurements with thermometers marked in the Celsius (centigrade) scale. To arrive at the air temperature in degrees Celsius, determine the number of cricket chirps in 14 seconds, add 8, multiply the sum by 5, and divide that product by 9. The formula for this calculation is $T = 5 \div 9 (n+8)$ where T is the air temperature and n is the number of chirps in 14 seconds.

Construct a bar graph of the numbers of animals encountered on the night walk.



Language Arts

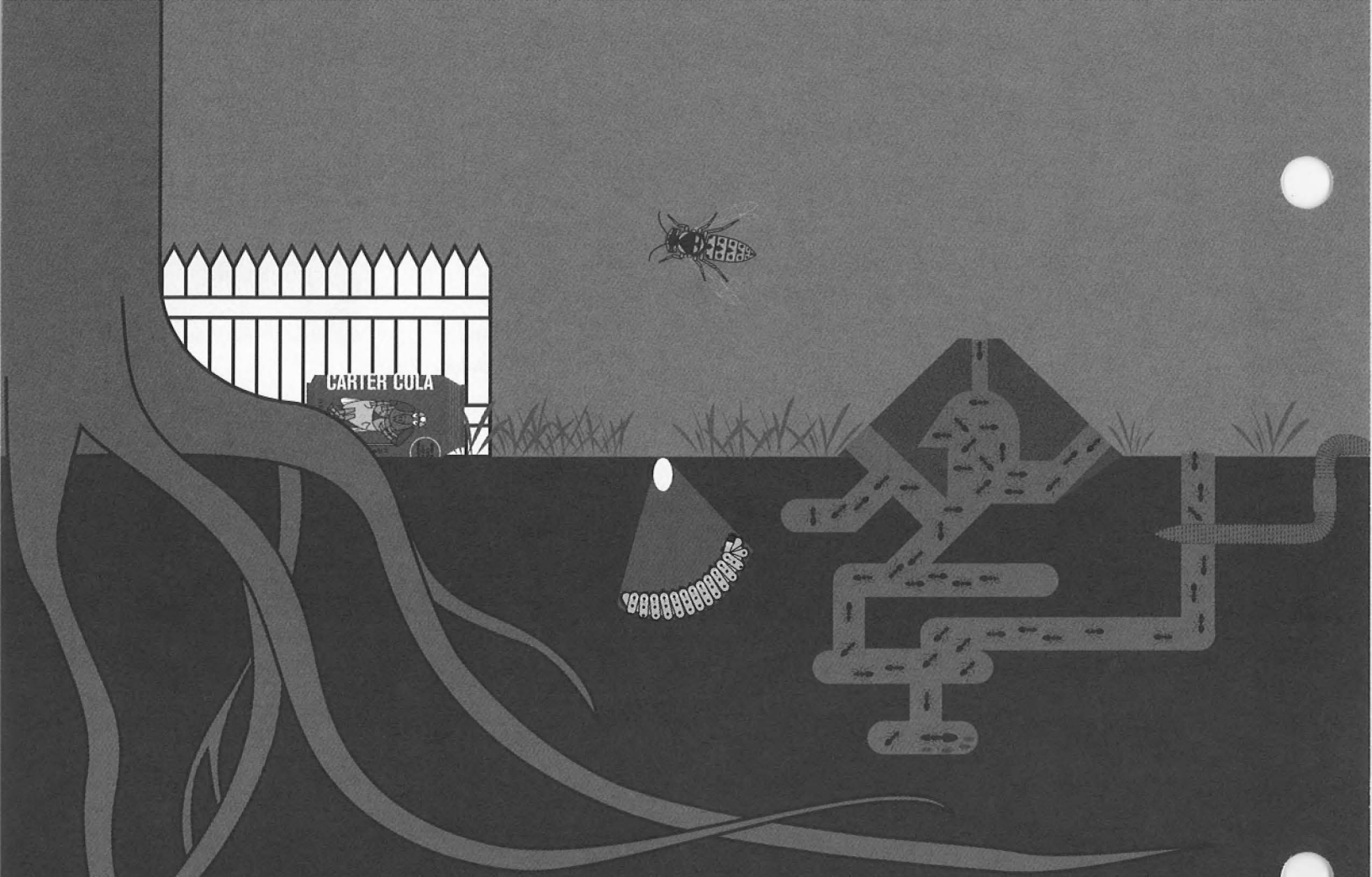
Read ghost stories. Create ghost stories to tell around a campfire. You can create such an environment in the classroom by darkening the room and creating a campfire (non-burning, of course!) from sticks. Students can color pieces of paper (or use colored tissue paper) to make "flames" for the fire.

Social Studies

Have students research and discuss the importance of Morse code. Why was it significant for the armed forces? Do the same for braille. Write out messages in Morse code and braille.

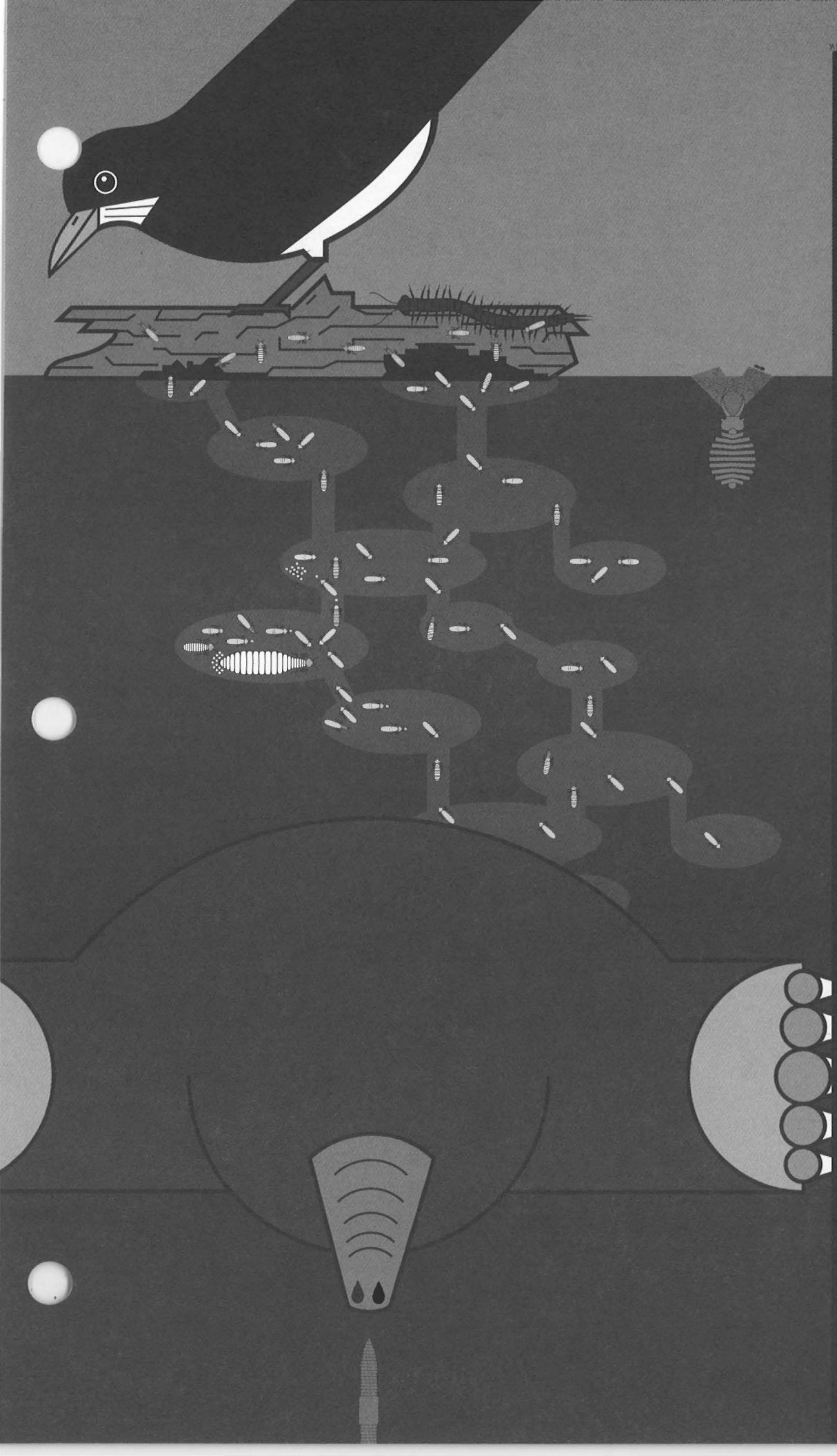
Science

Diagram the human eye and its parts. Discuss how vision works in the human eye. Compare the human eye to an insect's eye.



Under your feet, on the other side of the basement wall, or beneath your own backyard, a world hidden from sunlight bustles with activity. Even though we cannot see it, the soil is teeming with life. Earthworms, moles, chipmunks storing food, maybe even harvest mice, cicadas, shrews and insect larvae are all there. If soil did not have its dwellers of the dark, it would be packed down tight. It would be hard and dense – like concrete. But all the organisms that live there keep the soil broken up as they tunnel and burrow through it. This makes it lighter and fills it with air holes – like a sponge cake. This aeration makes it possible for trees and other plants to grow more efficiently. So soil-dwelling organisms that never see the sun at all are very important to the sun-loving green plants that live on the surface.

An entire world dwells underground – out of our sight, yet so close. Careful inspection will reveal a food web amongst these creatures that live in this dark world.



DARKNESS WITHIN THE SOIL

ACTIVITY 1

Explore the world of earthworms. By observing their actions, students will better understand how much these worms contribute to enriching our planet.

ACTIVITY 2

Explore the world of ants. Through this activity students will study how ant pheromones work, how they modify ant behavior, and how they instruct the ants to do the jobs necessary for the survival of the colony.

ACTIVITY 3

What animals live in the soil? Using a Berlese Funnel (named after the person who first used this device), the students will be able to examine carefully some animals that live underground.

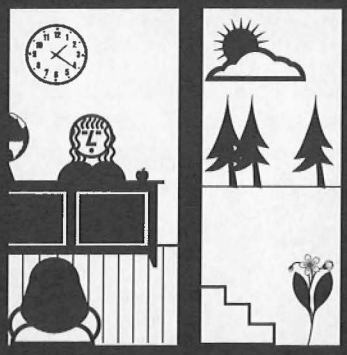
ACTIVITY

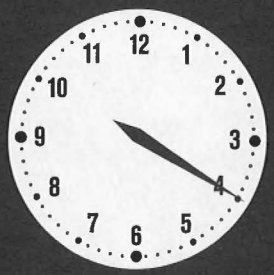
1

In Brief

Animals use a variety of senses to assist their survival in dark places. Smell is one of the senses used by earthworms to protect them from harm.

INSIDE OR OUT





20 minutes

The world of earthworms.

Objective

Students will test the reaction of earthworms to different chemicals to demonstrate the importance of "smell" or chemoreception to these animals.

Materials

- paper towel
- earthworms
- nail polish remover (acetone)

Vocabulary

aerate \'a(-ə)r-ˌāt\ – to expose to the circulation of air.

nervous system \'nər-vəs 'sis-təm\ – a coordinating mechanism present in all multicellular animals, except sponges, that regulates internal body functions and responds to external stimuli by rapidly sending messages along nerve cells.

organic debris \or-'gan-ik də-'brē\ – the decomposed remains of plants and animals.

ACTIVITY 1

Background

Earthworms are important creatures in soil. Their activities aerate soil, mix it, and provide organic debris to fertilize plants. In this activity we will see that earthworms can react to potentially harmful chemicals in their environment. Please remind your students that earthworms are living animals with nervous systems. The senses and the nervous system enable animals to respond to harmful things in their environment. In humans, the nose is a structure with a moist environment to trap the chemicals that we perceive as odors. Nerves then transmit information about these chemicals to the brain. In earthworms, the whole outer surface of the skin is moist and functions in much the same way as does our nose.

A chemical such as acetone will "burn" a worm's skin, so students must take great care not to put a cotton ball containing this material too close to the worm's skin. Also, worms must be kept moist or they will die. Worms should be returned to a moist place when students are finished with the experiments.

Directions

1. Place earthworms in the center of a damp paper towel.
2. Place a drop or two of acetone (nail polish remover) on a cotton ball.
3. Place the ball near the earthworm, but be careful it doesn't touch the earthworm. Observe the earthworm's reaction.
4. Place a dry cotton ball near the earthworm. Observe the worm again.

Questions

1. How did the earthworm react to the acetone? *The earthworm will move away from it.*

2. What does this tell you about earthworms? *They have a sense of smell that helps protect them from harm.*

3. Why was it necessary to use a dry cotton ball in this test? *This is called a "control." It is used to test whether or not the worm is reacting to the acetone or to the cotton ball.*

Further Activities

1. Repeat, using different chemicals like vinegar and alcohol.
What do the earthworms do and why? *They move away from the chemicals which are harmful.*

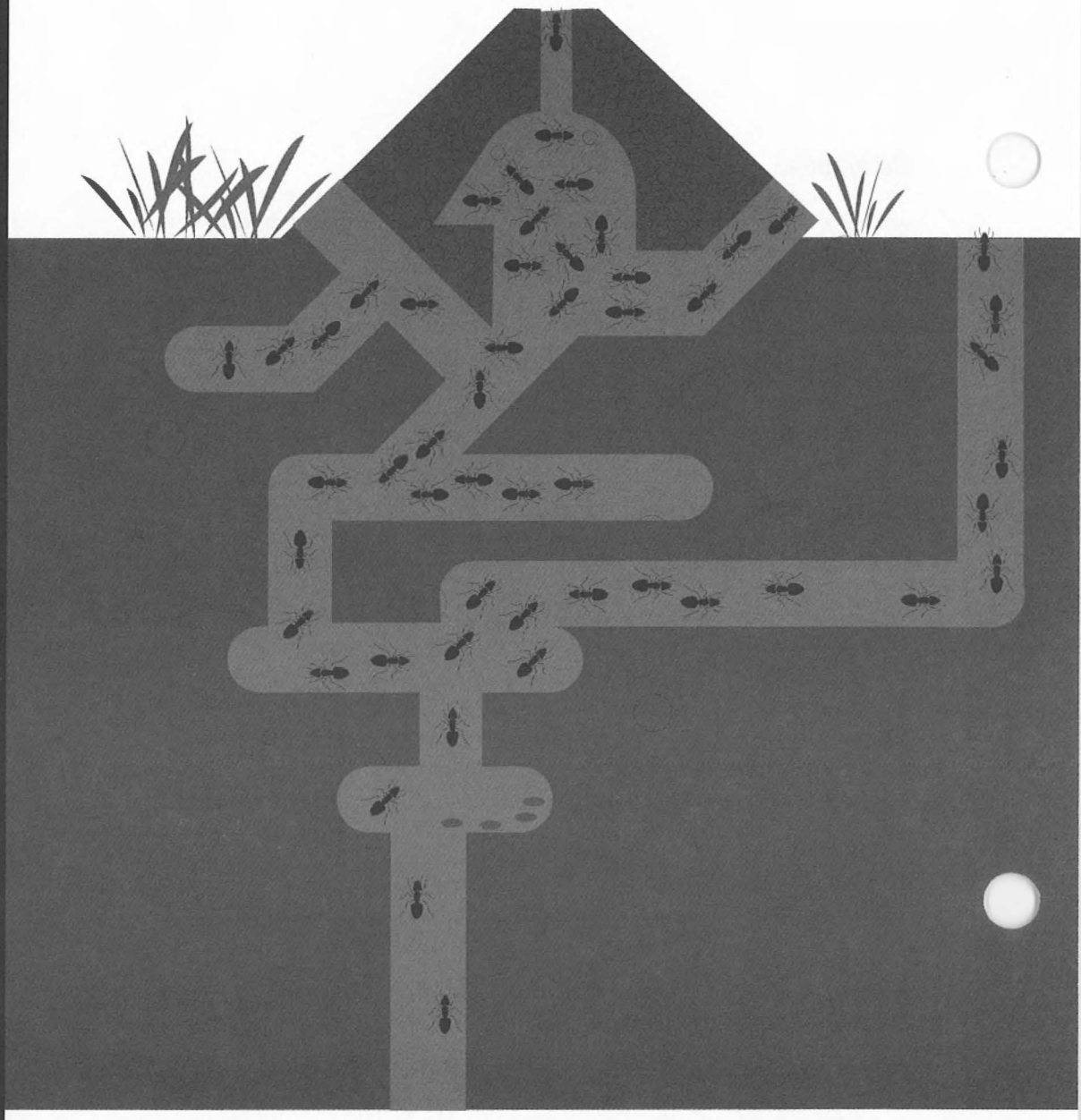
2. Repeat, using mashed fruits and vegetables instead of simple chemicals.
What do the earthworms do now and why? *They move toward the fruit and vegetables, which represent food.*

3. Construct a maze out of pieces of cardboard. Place on a moist towel. Help direct the worm's path through the maze by placing acetone soaked cotton balls in the areas that you do not want the earthworms to enter. Is this exercise successful?

ACTIVITY 2

In Brief

Students act out various roles in order to learn how special chemicals called pheromones assist in ant communication.



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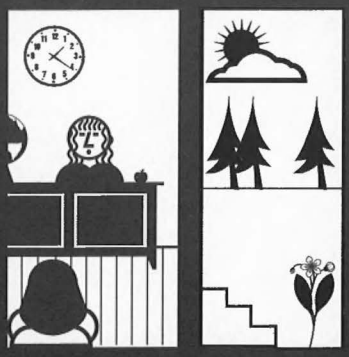
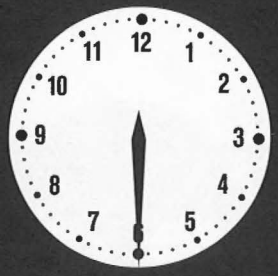




30 minutes

Explore the world of ants!

Objective

This activity demonstrates how odors direct the activity of some animals that live in the dark.

Materials

- plastic film canisters or other small containers
- cotton balls
- cinnamon extract
- nail polish remover (acetone)
- perfume
- vanilla
- job signs (Appendix A)
- pheromone cards (Appendix A)

Vocabulary

pheromone \'fer-ə-ˌmon\ – a chemical substance released by some animals, such as ants and moths, to influence the behavior or development of other individuals of the same species.

species \'spē-(ˌ)shēz\ – plants, animals or other organisms that can interbreed with each other to produce offspring that can also interbreed successfully.

Background

Many kinds of animals live in the soil. Many of them are arthropods, such as insects, pill bugs and millipedes. They, too, react to stimuli other than light. Many of them give off scents that are designed to communicate with other animals of the same species. Those scents are called pheromones. They're messages. This activity demonstrates how pheromones tell ants how to behave.

Directions

1. Tape job signs (Appendix A) in different places around the classroom.
2. Place cotton balls in plastic film canisters. Put a drop of liquid with a strong odor like cinnamon, nail polish remover, perfume, vanilla, etc., on each cotton ball. Close the canisters.
3. Explain to the students that they are ants, and their jobs are directed by their senses of smell. Each smell (see pheromone cards in Appendix A) signifies a different thing to an ant.
4. Associate each smell with a specific job. For example, cinnamon represents a nurse who takes care of larvae. Each child is then given one canister to sniff.
5. Using smell as a guide, students should stand next to the appropriate sign for their job.

Questions

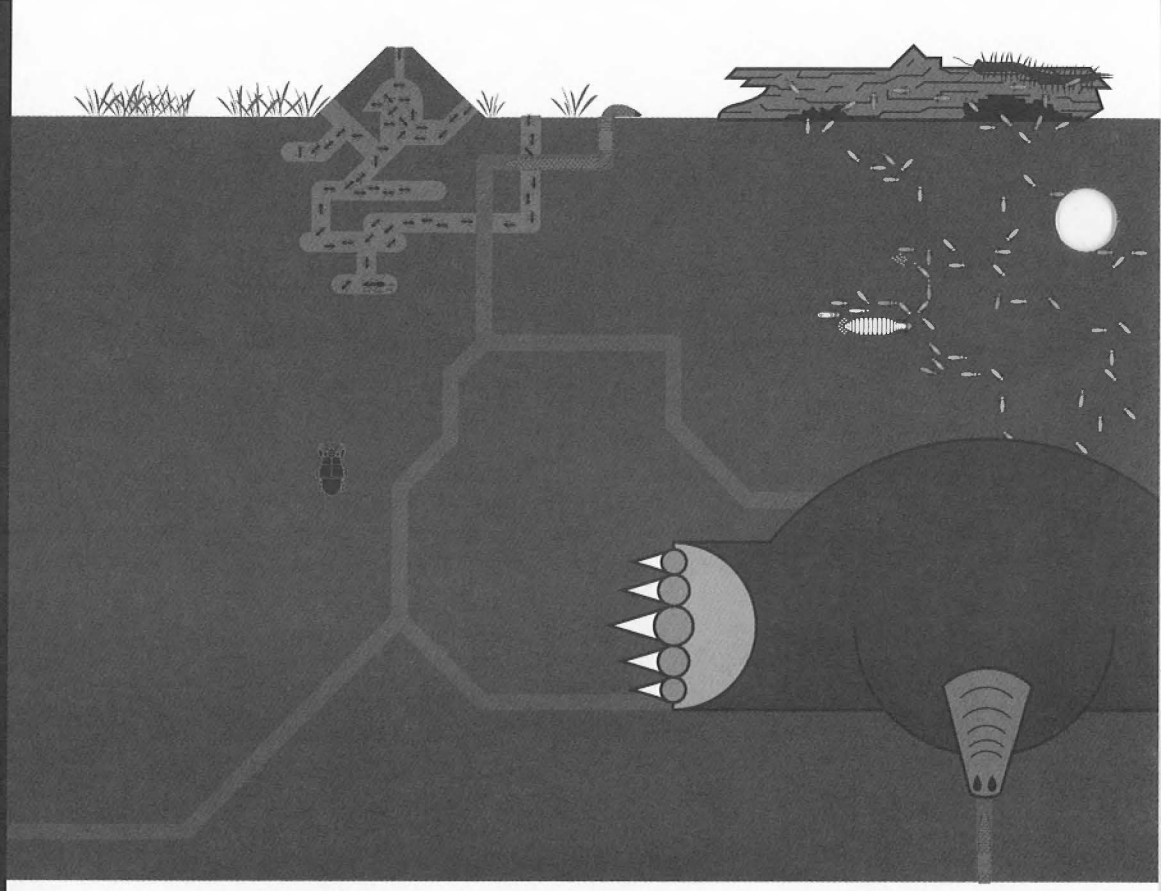
1. Was it hard to identify what the smell was? Why? (Was the smell too strong, too weak, or not recognized?)
2. Do you think you will remember the smell later? Why?
3. How do you think ants can remember the odors that tell them what to do?
4. What smells in your life influence your actions?
5. List all the words you can to describe smells.

ACTIVITY 2

ACTIVITY 3

In Brief

The purpose of this experiment is to illustrate what animals live in the soil. Using a Berlese funnel, students will collect and preserve soil dwelling animals.



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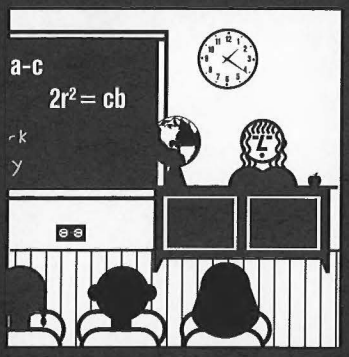
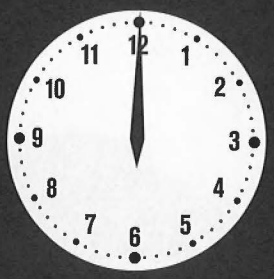




60 minutes

What animals live in the soil?

Objective

By examining some of the animals that live in soil and their characteristics, students can better understand how these animals survive in a dark environment.

Materials

- a clean empty one or two liter soda bottle
- cheesecloth from a fabric or grocery store or a strainer that will fit easily into the diameter of the soda bottle and a rubberband to secure it.
- rubbing alcohol
- a goose-neck lamp or clamp-on lamp
- a small dish to hold specimens preserved in alcohol
- a sample of soil or leaf litter from a forest floor
- microscope or magnifying glass
- forceps or tweezers

Vocabulary

aeration \'a(-ə)r-'a-shən\ – the act of supplying oxygen.

Class \'klas\ – the unit of taxonomic classification just below phylum, e.g. Phylum Chordata, Class Primates (class to which humans belong).

classification \ˌklas-(ə-)fe-'kā-shən\ – the grouping of organisms into categories based on shared characteristics.

invertebrate \(')in-'vərt-ə-brət\ – an animal lacking a backbone, e.g. insects, snails, corals, etc.

Phylum \'fi-ləm\ – the unit of classification just below kingdom, e.g. Phylum Mollusca (snails and clams), Phylum Porifera (sponges), Phylum Chordata (fish, frogs, humans).

Background

Many animals that live underground are small and easy to overlook. One way to collect them is to use a Berlese funnel. This device will flush the animals from the dirt and catch them in alcohol so they can be preserved for identification. Students will use a key to classify the animals they find. They should also keep journals of all their findings to record the environment from which the soil was taken and answer the questions below.

Directions

1 **A.** Cut the top off the soda bottle. (see diagram). **B.** Invert it into the bottom part of the bottle, leaving the bottle cap securely fastened. **C.** Fill the inverted top with 1/4 cup of alcohol. **D.** Drape cheesecloth or put a strainer into the mouth of the funnel, being careful to keep it from touching the alcohol. Secure it with a rubberband.

2 Select a measured sample of earth or leaf litter (1/2 to 1 cup), and place it in the cheesecloth or strainer. Examine the sample for large animals such as earthworms or sow bugs. Students will record in their journals the number and kind of organisms they find and place these animals in a moist, damp place.

3 Place a 40-watt light bulb about 6 inches above the funnel. Leave the light on for at least 24 hours. As the light heats and dries the soil, the animals will move down the funnel, fall into and be preserved by the alcohol.

4 After about 24 hours students should pour the alcohol into a dish and with a microscope examine whatever has been preserved in the alcohol. Caution them to look closely, as some of the organisms will be very tiny.

5 Place the animals in groups that share similar characteristics. They should list the characteristics they used to group the animals. Use a scientific key to identify and list the animals collected.

Please note that this activity involves preserving invertebrate animals in alcohol. Although the deliberate killing of animals should be avoided, students need to understand that scientists must sometimes use these methods to study and understand the world around us.

ACTIVITY 3

Questions

1 What kinds of animals did you find in the soil? *Mostly small invertebrates.*

2 How large are most of these animals? *They are smaller than the size of the mesh in the strainer or cheesecloth.*

3 How many groups did you find when you classified the animals **before** using the scientific key? **After** using the key?

4 Were the characteristics you used similar to those used in the scientific key? *The characteristics used by the students will probably vary widely and be more general in nature than those found in the scientific key. Scientists looking at a very broad spectrum of animals are constantly changing keys as they learn more about animals through detailed study.*

5 According to the scientific key, to which phylum or class do most of the animals belong?

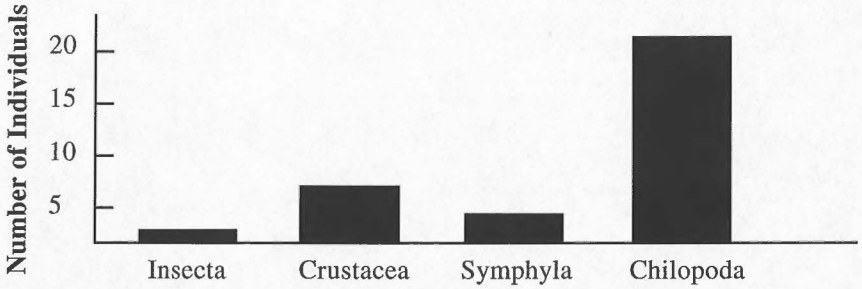
6 Using reference books, find out what each of these animals eats.

The most obvious and easily recognized organism you may encounter will be an earthworm. Earthworms belong to the Phylum Annelida, which also includes leeches. Most of the animals you find belong to the Phylum Arthropoda (invertebrates with jointed legs).

Taking it Further

1 Repeat the Berlese funnel activity using soil and leaf litter from different areas.

2 Construct a bar graph representing the number of individuals of each group that you found in each sample.



Soil from Sally's Garden

3 Do you observe any differences among the samples?

4 Put each group of animals into separately labeled baby food jar with alcohol. Use these to set up a small display. Look up and discuss what each species eats.

5 Create a food web by connecting the baby food jars with strings.

Across the Curriculum

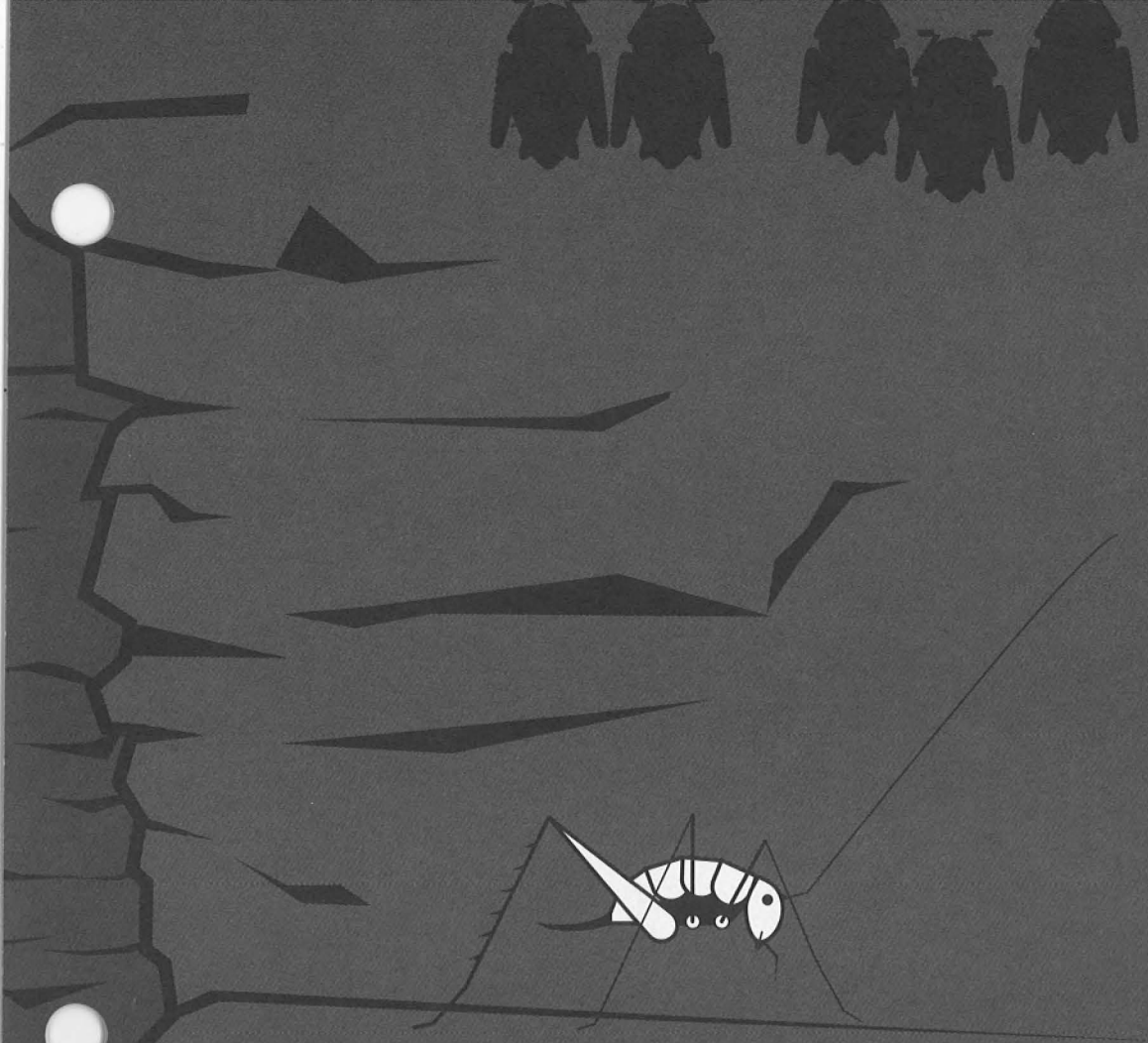
Math
Lift up a large rock, brick or piece of wood outside to expose all the living creatures underneath. Use a shovel to collect them in a box, and group the animals together – pill bugs, earthworms, etc. Count how many of each type are found, and graph the results.

Language
Imagine that there is a need for you and your family to live underground. Draw an architectural floor plan of your "Underground City." Write a story about what it is like to live in your underground environment. Discuss how you would play sports and go grocery shopping. What is your school like? Where do your parents work? How do you get water?

Suggested Reading: *Mrs. Frisby and the Rats of NIMH* by Robert O'Brian.

Social Studies
Research how people escaped from many prison camps during World War II by digging tunnels underground. What did they do with the dirt they removed? How big were the tunnels they built? How were the tunnels supported? How did the prisoners keep them hidden and how many people used them to escape? Point of interest: There was a famous underground tunnel dug under the Berlin Wall which helped people escape from East Berlin into West Berlin. Find out more information about this tunnel.

Science
Start your class's own ant farm. First, have the students draw what they think the ants' underground home will look like. Remind them of the ants' different chambers and needs. Then, after the ants have established their own habitat, compare the student's drawings to the actual home. Discuss how they are similar or different.



DARKNESS CAVES
DEEP WITHIN

Deep inside caves, many species live their whole lives in total darkness. Other creatures, such as bats, use caves for shelter, but emerge into the twilight and hunt in the darkness of night. Despite this affinity to the dark, all cave dwellers depend ultimately on the sun for their food.

Animals that live in darkness have adapted to this environment in specific ways. Bats, although they have good eyesight, cannot see clearly in the dark. So instead of using their eyes, they use their ears "to see." They do this by making sounds that bounce back after hitting a solid object, such as a wall, a tree or insects on which to feed. Returning sounds are called echoes. Echoes help a bat to make a picture in its brain of its surroundings. This use of sound is called echolocation. It works like the radar used in aircraft.

ACTIVITY 1

Using ripples in water as a visual analogy, students will investigate how sound waves travel and are reflected by objects as echoes.

ACTIVITY 2

Students will use their own sense of hearing to simulate how bats use echolocation to locate or avoid objects.

ACTIVITY 3

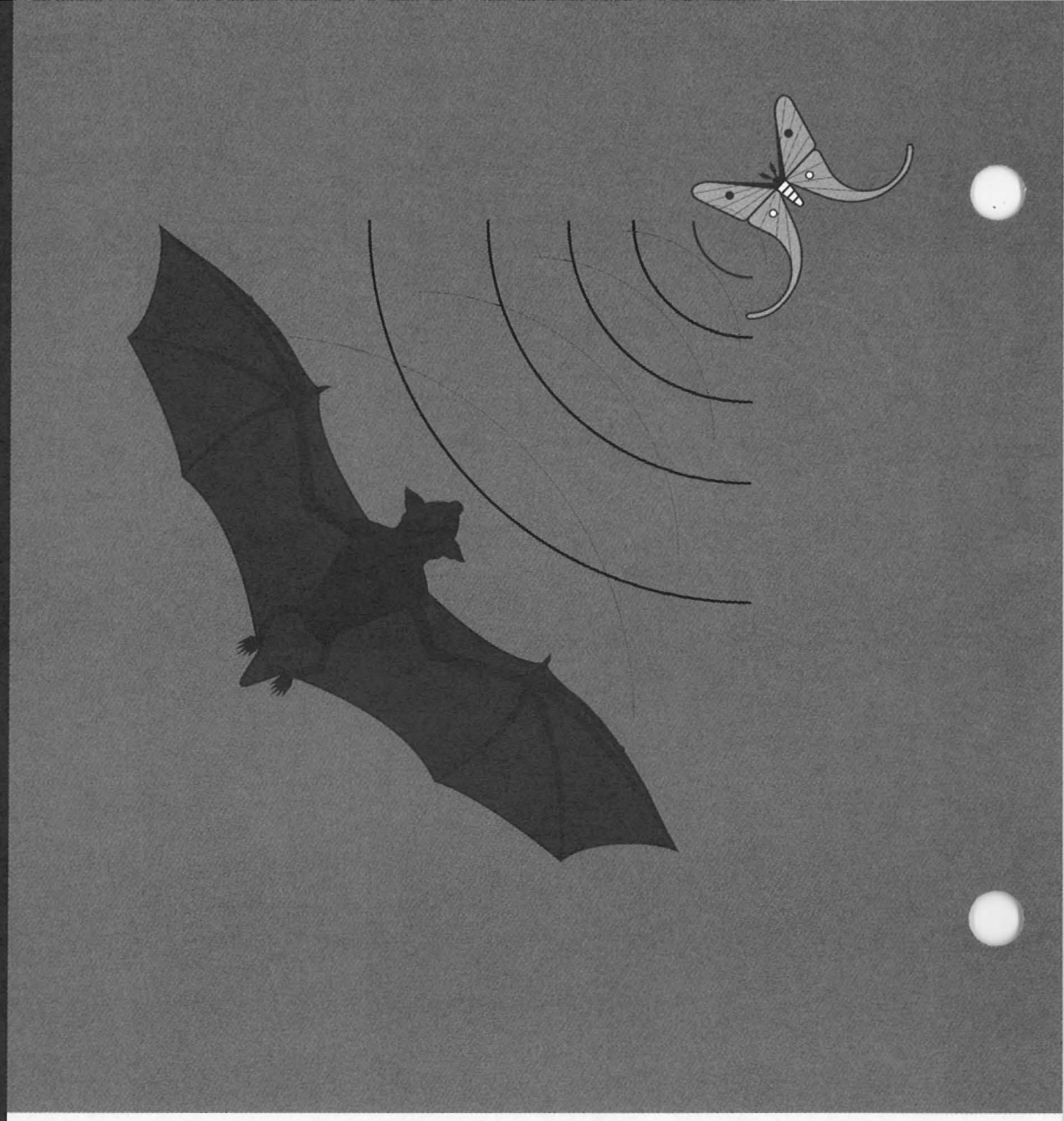
Students will experiment with different objects to understand how those objects reflect sound differently.

ACTIVITY

1

In Brief

Since sound waves are invisible, students will use waves in water to understand their nature.



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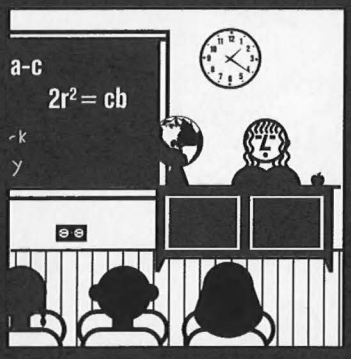


25 minutes

What makes echoes?

Objective

Water waves are used as an analogy to understand how sound waves travel and produce echoes.

Materials

For each child:

- 20-in. length of aluminum foil
- water
- stick of modeling clay
- a lamp

Vocabulary

echo \'ek-(,)ō\ – reflected sound produced when sound waves intercept any object in their path.

echolocation \ˌek-ō-lō-'ka-shən\ – process for locating objects by means of sound waves (echoes) that are reflected back to an emitter (such as a bat, dolphin or submarine) from the objects in question.

ACTIVITY 1

Background

Sound travels in waves. When these waves encounter an object, they bounce back toward their origin. In this activity, students use water waves as an analogy to sound waves to visually demonstrate how echoes are produced.

Directions

1. Use the sheet of foil to make a tray. Fold the edges of the foil up and over twice to make the sides of the tray.

2. Use the modeling clay to make a wall with flat sides about 5 inches long. Place the wall in the tray about 4 inches in from one edge.

3. Place the tray on a flat surface with a light shining onto it from the far end. Make sure the light source is near the surface of the water, but higher than the wall. Fill the tray with water to a depth of about 2 inches.

4. With one fingertip, touch the surface of the water at the near end of the tray. Then lift your finger, and watch the ripples flow away in all directions and then return.

Questions

1. Why did touching the water's surface produce ripples? *Let the students discuss this question to see if they can arrive at an answer just from simple observation alone. The following has occurred: Energy from the movement of the finger is transferred to the water producing ripples that move out in all directions from the source.*

2. What happens to the ripples when they hit the wall? *They are reflected from the wall, in much the same way that sound echoes would be produced when sound strikes an object.*

3. What happens to the ripples when they go past the wall? *They are reflected from the wall of the tray.*

4. Are the waves reflected from the clay wall stronger or weaker than the waves reflected from the back wall of the tray? *They are stronger.* Why? *Because they were made from a closer object.*

5. Which set of waves returns first? *The waves reflected by the wall return first because it is closer.*

6. Sound in air is similar to waves in water. How is an echo like the returning wave you observed? *An echo represents sound waves reflected off an object.*

7. Bats produce sounds and listen for returning echoes. How can this help them inside a dark cave? *A bat can "see" how far objects are by the time it takes for the echo to return to its ears.*

ACTIVITY 2

In Brief

Students use their sense of hearing to locate some objects and avoid others.

LARGE OPEN SPACE

45 minutes

How do bats depend on echolocation for survival?

Objective

To help students become more aware of their sense of hearing and how they can use it to locate objects.

Materials

• a blindfold

Vocabulary

dominant \'däm(-ə)-nənt\ – exercising the most control or influence.

navigate \'nav-ə-ˌgāt\ – to follow a determined course on, across or through something.

prey \'prā\ – any creature hunted or caught for food.

ultrasonic \ˌəl-trə-'sän-ik\ – referring to frequencies of sound above the range of human hearing (above approximately 20,000 cycles per second).

Background

Bats use echolocation to navigate dark places safely and to locate and capture prey such as moths. They emit ultrasonic sounds and listen for those sounds to bounce off objects as echoes. Echoes help bats locate and avoid obstacles. This process is called echolocation.

Directions

1 Ask students to decide which of the bat's senses seems to be the most dominant. Bats generally have large ears indicating that hearing is a very important sense.

2 Seat students in a large circle. These students represent obstructions such as buildings or trees.

3 Have one student act as a bat. Have five or six others representing flying insects such as beetles, moths or mosquitoes go to the center of the circle.

4 Blindfold the bat.

5 The bat will call out in a loud voice, "Bat." When he/she does this, students facing the bat will respond by saying the name of the obstruction or insect they represent.

The object of the game is for the bat to tag the flying insects and avoid the obstructions. When a flying insect is tagged, he/she becomes an obstruction in the circle.

The game is over when all the flying insects have been tagged.

Questions

1 Do flying insects or obstacles really make sounds? *Insects in flight make sounds. This exercise just demonstrates how bats use echolocation.*

2 In the game, what had to happen before a flying insect or obstacle could make a sound? *The bat had to make a sound first.*

3 In a cave, how can a bat use sounds to find walls? *Refer to the action of the waves in Activity 1.*

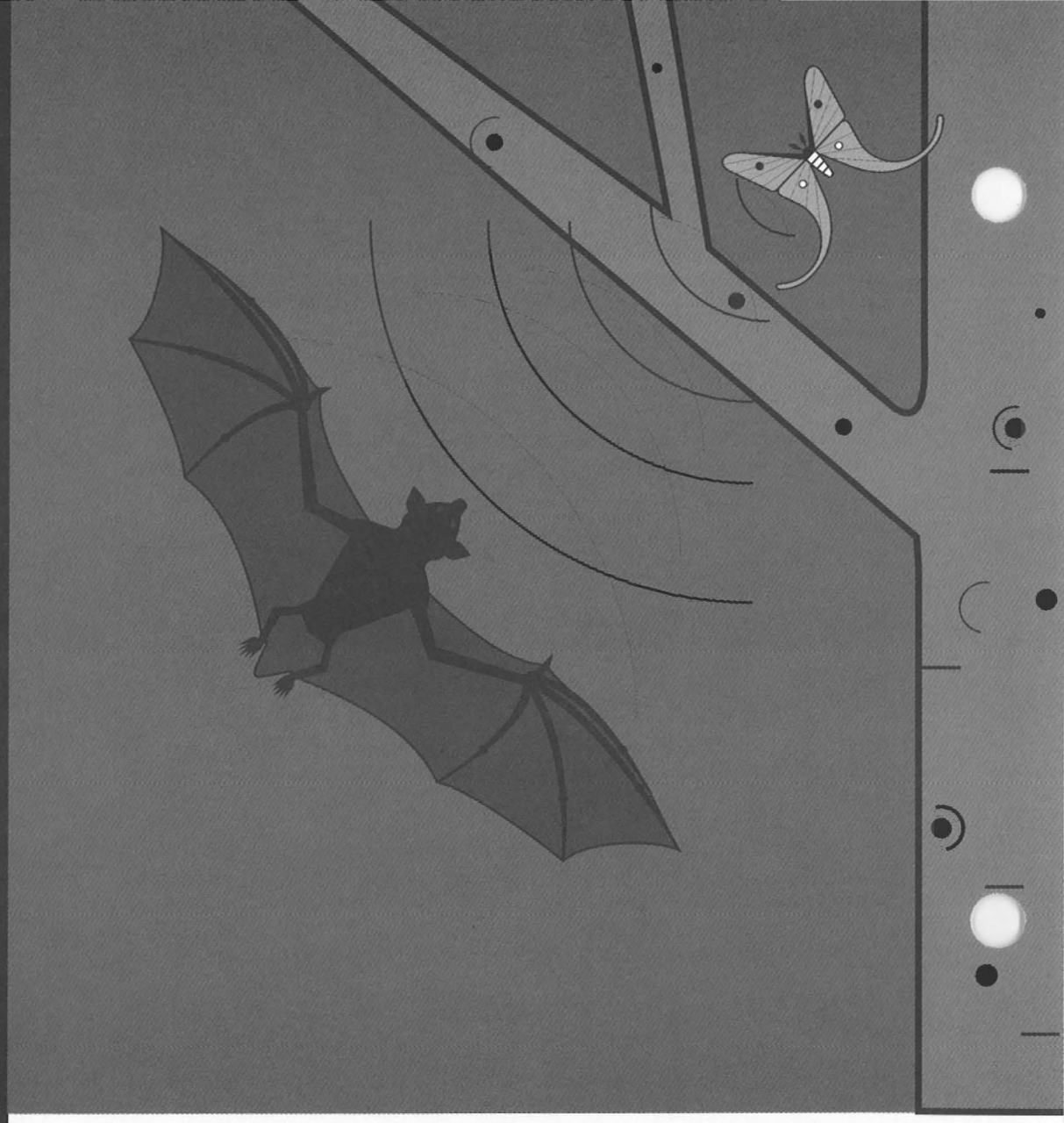
4 Why do you think bats make their sounds in short bursts with periods of silence in between? *This allows time for the bat to hear the echo it receives back so that it can locate obstacles or prey.*

ACTIVITY 2

ACTIVITY 3

In Brief

This activity demonstrates how objects made from different materials make a different sound when struck by a coin.



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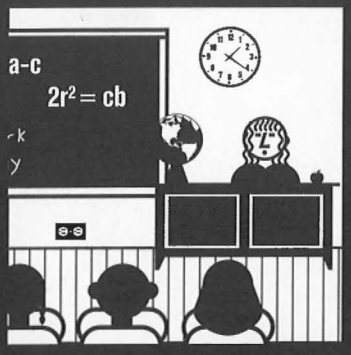


30 minutes

How do bats use echolocation to differentiate objects?

Objective

By understanding how they can distinguish the characteristics of an object using sound, students will learn how bats use echolocation to differentiate between objects such as potential prey and inanimate objects.

Materials

Select samples from the following list. Include as many as you wish:

- glass
- pottery
- metal
- fabric
- thick towel
- liquid
- plastic
- paper
- rubber bands
- 10 pennies

Background

Bats flying in the dark need to assess the nature of objects in their surroundings. This activity demonstrates that objects made from different materials return the bat's echolocation signals in different ways. An object absorbs and reflects sound waves depending on its surface structure. Also, if an object, or parts of an object (an insect's wings, for example), is moving, the sound waves that return to the bat are altered in very specific ways. The bat's brain can compare differences in the sounds that it produces and the echoes it receives to determine location, size, shape, degree of softness and movement of most objects in its path.

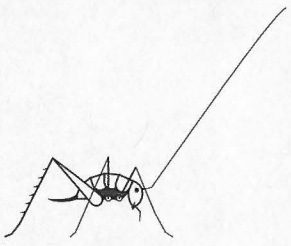
Directions

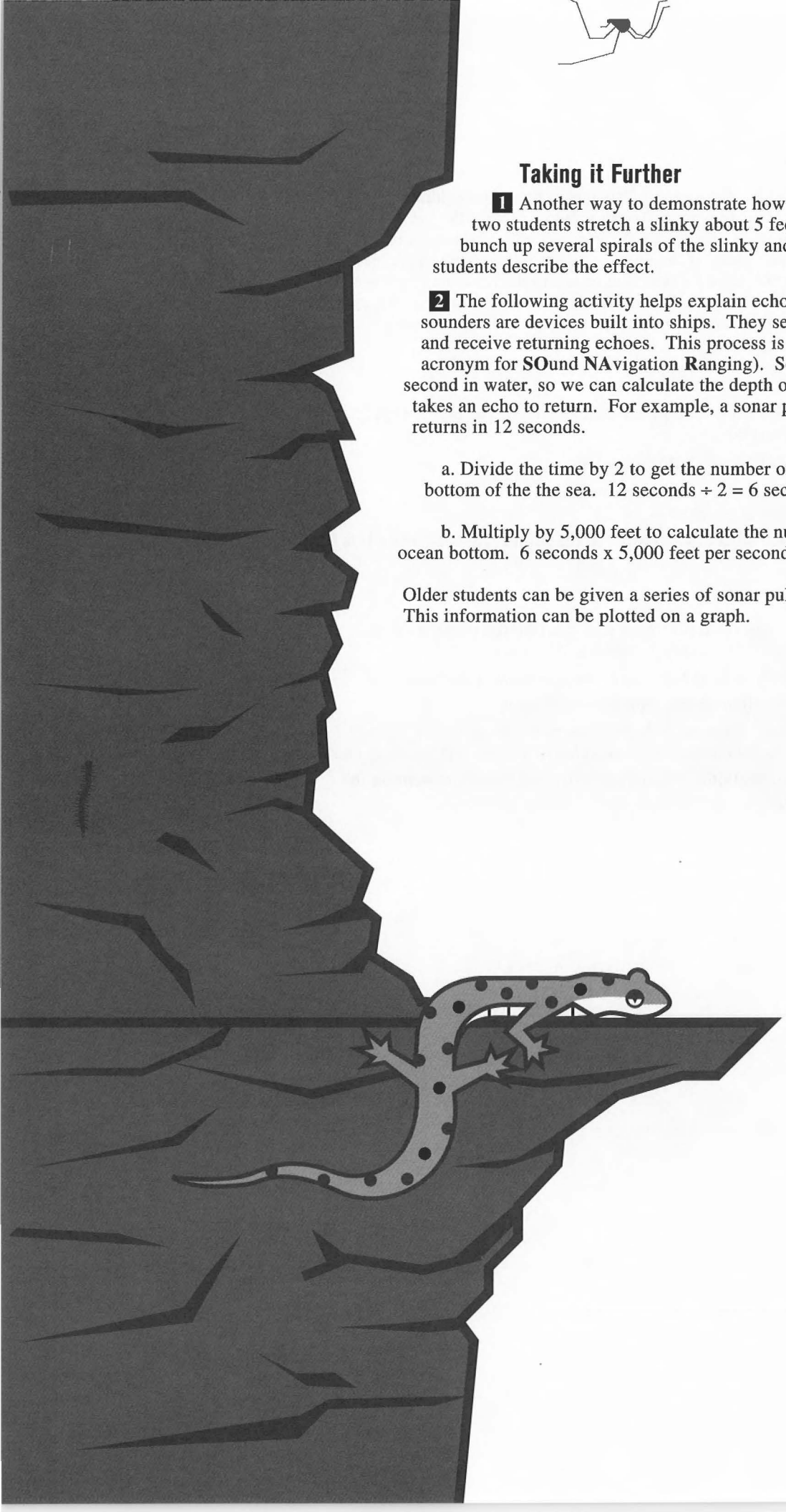
1. Place a thick towel on a desk. On it arrange the items listed on the previous page, leaving about one foot between items.
2. Blindfold a student. This student will represent a bat.
3. Bring him/her near the desk.
4. Give the student a coin to toss at the objects.
5. The student should name each object by listening to the sound produced when it is hit by a coin.

Questions

1. How did you decide which object you hit? Can you describe the sound a metal, plastic or glass object made when hit by a coin? *Answers may vary.*
2. How do you think bats identify objects? Explain. *Answers may vary.*
3. In your own words, describe echolocation. *Answers may vary.*
4. How do bats use echolocation? *Bats use echolocation to locate obstacles in their path, to locate prey and to determine the nature of objects (Is it hard, soft, moving, etc?).*
5. What other animals use echolocation? *Whales and porpoises use echolocation in order to know their surroundings.*

ACTIVITY 3





Taking it Further

1 Another way to demonstrate how sound waves work is to have two students stretch a slinky about 5 feet apart. Have one student bunch up several spirals of the slinky and then release them. Have the students describe the effect.

2 The following activity helps explain echo sounding to students. Echo sounders are devices built into ships. They send sound waves into the water and receive returning echoes. This process is called sonar (sonar is an acronym for **SO**und **NA**vigation **R**anging). Sound travels 5,000 feet per second in water, so we can calculate the depth of the ocean from the time it takes an echo to return. For example, a sonar pulse is emitted and its echo returns in 12 seconds.

a. Divide the time by 2 to get the number of seconds it takes to go to the bottom of the the sea. 12 seconds ÷ 2 = 6 seconds

b. Multiply by 5,000 feet to calculate the number of feet it traveled to the ocean bottom. 6 seconds x 5,000 feet per second = 30,000 feet

Older students can be given a series of sonar pulse times to calculate depths. This information can be plotted on a graph.

Across the Curriculum

Language Arts
Read *Dracula* by Bram Stoker. Compare Count Dracula to a real bat. Research the origin of the vampire legend. Generate a list of words to describe a bat in positive terms. Use words from this list to write a poem or paragraph.

Math
Solve these problems:
If a bat can catch 27 insects each waking hour, and bats are awake and hunt 16 hours a day, how many insects do they eat per day? Per week?
Insects eaten per day: 16 x 27 = 432 insects
Insects eaten per week: 16 x 27 x 7 = 3,024 insects

If 100 insects weigh 1 gram, how much does a bat eat per day by weight? What weight in insects does a bat eat every week?
Weight of insects eaten by a bat per day: 432÷100 = 4.32 grams
Weight of insects eaten by a bat per week: 3,024÷100 = 30.24 grams

Science
Use the correct scientific research format to describe the procedure you would use to determine the percent of your body weight you eat in food each day. To do this: State the question to be answered, the method used to answer it, the number of times the procedure is repeated, results and a discussion of those results.

Why would it be difficult for a blind person to use echolocation to navigate in a typical human environment? *Because it is too noisy.* In what places might echolocation be useful to a person?

Look up sonar and radar (**RA**dio **D**etecting **A**nd **R**anging) and discuss the relationships between these two and echolocation.

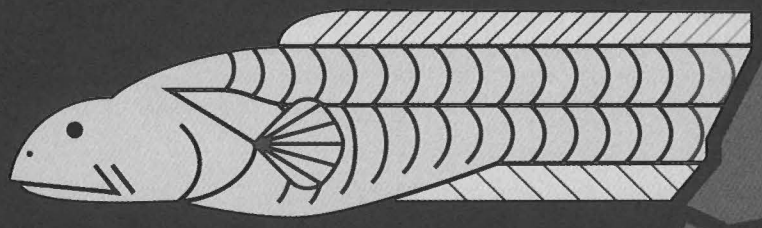
Get four cardboard boxes (cigar or shoe boxes will work), two smaller boxes that fit inside two of the first four boxes, four marbles, and a sheet of poster board cut to fit diagonally and vertically across the two larger boxes. Place the poster board strips in the two larger boxes and the small boxes inside the two remaining boxes. Place one marble in each of the boxes. Make sure the lids will shut, and tape them closed. Label the boxes 1-4. Ask students to rotate the boxes back and forth and determine from the sound heard from the marble the shape of the open space inside each box. The sound of the rolling marble sends a mental picture into the mind that defines the structure of the inside of the box.

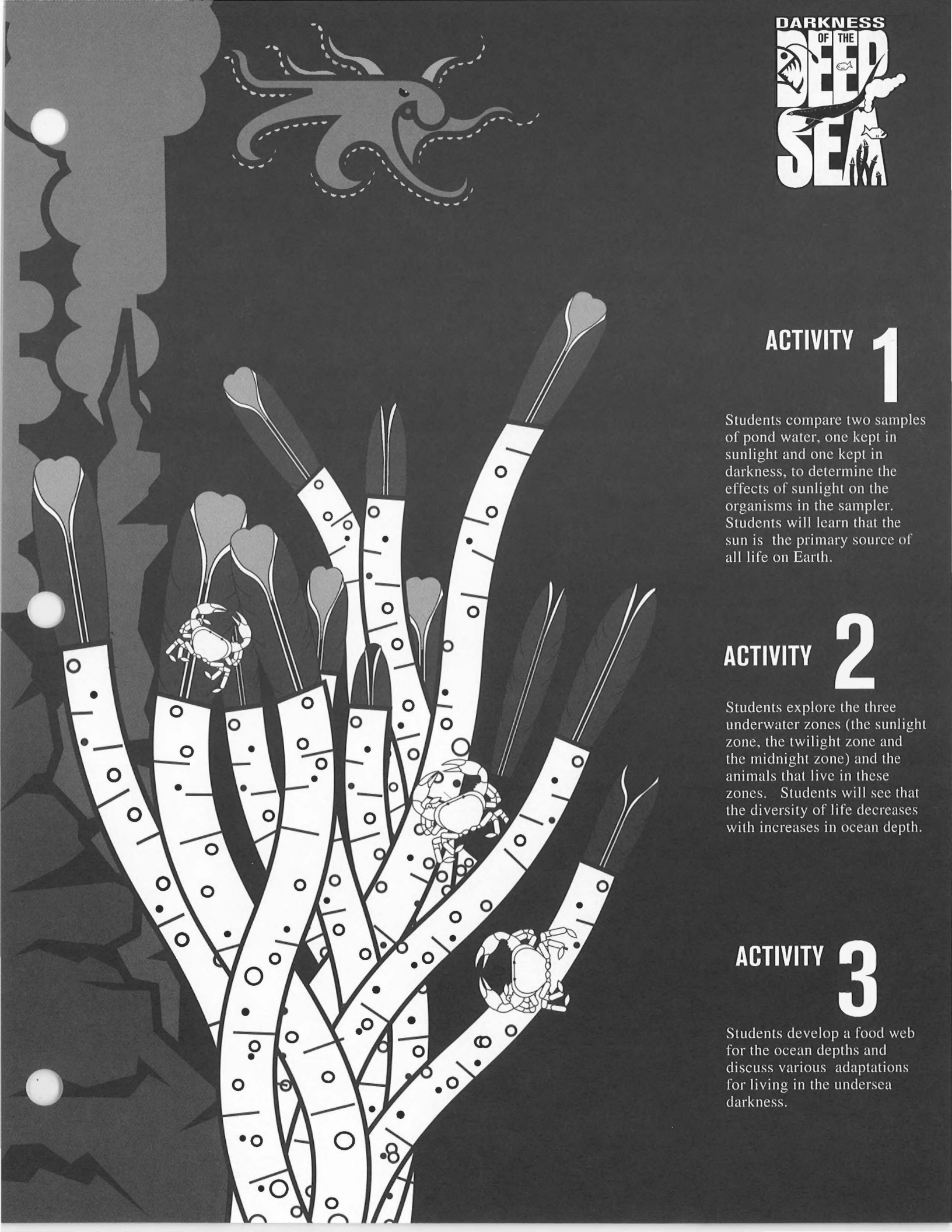
Social Studies
On a world map, indicate ranges of different bat species.

Art
Make bat ears of various sizes that can be worn. Have students decide which ones work the best and why.

Deep beneath Earth's oceans lies a world of inky darkness. Although the top, sunlit layers of the ocean are rich in plant and animal life, another world exists in the dark realm below the farthest reach of the sun's rays. Here, strange and fascinating creatures go about the business of survival.

The ocean is not as uniform as it looks. In clear waters, light penetrates only to a depth of about 600 feet. This top layer of the sea is rich with plant, and therefore, animal life. Most of the ocean life with which we are familiar is found in this topmost layer. However, as one goes deeper into the ocean, it becomes darker and colder, and the water pressure increases dramatically. More than 80 percent of the ocean exists in this dark state. The organisms that live in this cold, dark environment have special adaptations that enable them to survive. Also, the food web in the ocean depths is only indirectly based on plants (in other words, energy gained from photosynthesis). Organisms are either predators or scavengers, or live on the constant rain of organic debris from the sunlit layers. In rare instances, along the rift zones in the ocean floor hot vents provide a unique ecosystem based not on photosynthesis, but on the energy gained from the chemosynthesis of sulfur.





ACTIVITY 1

Students compare two samples of pond water, one kept in sunlight and one kept in darkness, to determine the effects of sunlight on the organisms in the sampler. Students will learn that the sun is the primary source of all life on Earth.

ACTIVITY 2

Students explore the three underwater zones (the sunlight zone, the twilight zone and the midnight zone) and the animals that live in these zones. Students will see that the diversity of life decreases with increases in ocean depth.

ACTIVITY 3

Students develop a food web for the ocean depths and discuss various adaptations for living in the undersea darkness.

ACTIVITY 1

In Brief

Students will compare samples of pond water, one placed in sunlight and the other in darkness.

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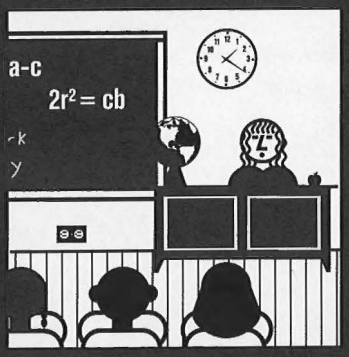
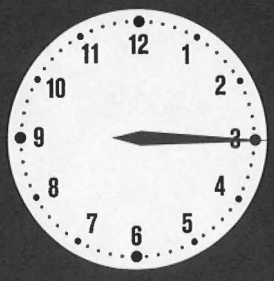




15 minutes set up
2 weeks observation

Can sunlight penetrate water and make plants grow?

Objective

Students will see that without sunlight, the diversity of living things decreases dramatically. They will understand the importance of photosynthesis.

Materials

- a small fish net
- 2 clear quart-size glass containers
- pond water
- a dissecting microscope or magnifying glass

Vocabulary

algae (plural for alga) \'al-gə\ – primitive plants, often aquatic plants, that lack roots, stems and leaves.

photosynthesis \ˌfōt-ō-'sin(t)-thə-səs\ – the ability of green plants to convert water and carbon dioxide to carbohydrates with the release of oxygen.

ACTIVITY 1

Background

Sunlight can penetrate water. Where it does, plants ranging from tiny microscopic algae to large seaweeds will grow in abundance. The ability of chlorophyll-containing green plants to convert carbon dioxide and water to carbohydrates is essential to life on Earth. In this experiment, students will compare two pond water samples (one of them kept in sunlight, the other in darkness) to see the effect of sunlight on the growth of plants in water.

Directions

Students should keep a journal of daily observations.

1 Using pond water, fill the two glass containers (without lids). Place one in an area that receives strong light and the other in a place that receives no light. Each container may be covered with a black cloth or black plastic bag).

2 Observe the growth of algae in both samples over a period of two weeks. Compare the differences.

3 Have students scoop up some of the algae that grows in the jars and examine it under a microscope.

Questions

1 What do you observe happening in each of the samples? *The jar left in the light should have significantly more growth than the one in the dark.*

2 What is living in the pond water samples? *With the naked eye, students should be able to see green algae and tiny organisms swimming in the water of the sample kept in the light. If the classroom has a microscope, even more organisms can be viewed.*

3 How does sunlight affect the pond water's living organisms? *Sunlight promotes photosynthesis by the green algae. Small animals feed on the algae, and other animals feed on the algae eaters.*

4 How does the lack of sunlight affect the pond water's living organisms? *Without algae, the basis of the food chain is missing so the sample kept for a long time in the dark should have few, if any, organisms living in it.*

5 What is the sunlight contributing to the growth of the algae? *Algae are simple plants that undergo the process of photosynthesis, which converts the energy of the sun to sugars and starches. This is the basic process upon which all life on Earth depends. Without sunlight algae would die.*

6 How do animals that live in water beyond the reach of sunlight survive? *They either depend on the rain of organic matter from areas in which light penetrates or feed on other animals that do.*

ACTIVITY 2

In Brief

The students will create a mural illustrating the undersea zones and the food web that exists among the plants and animals that live in each zone.

Explore the underwater zones and the animals that inhabit them.

Primary-age students will play a game that will expose them to the undersea zones in which some organisms live. Intermediate students will research the zones in which animals live.

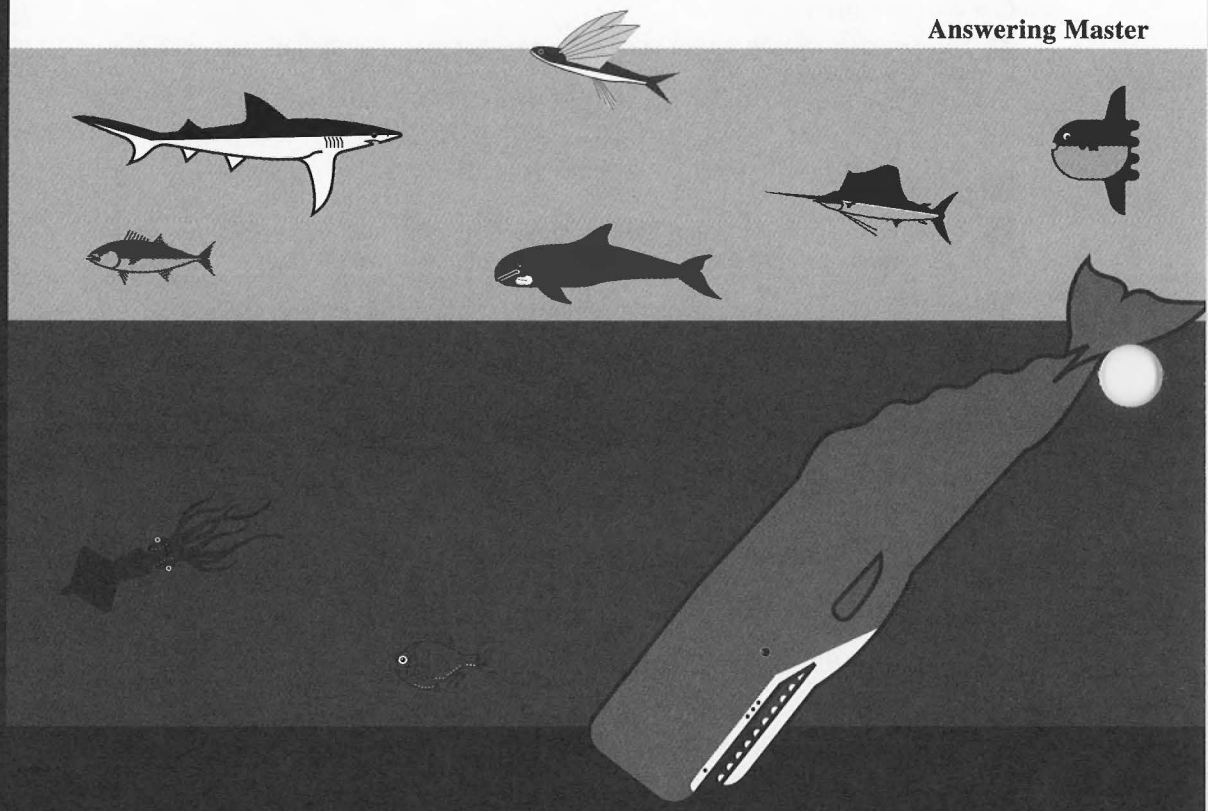
Objective

Students will become better acquainted with the three undersea zones and the animals that inhabit them.

Materials

- animal and zone label cards (Appendix B)
- resource books (use your nearest library or computer resources)

Answering Master



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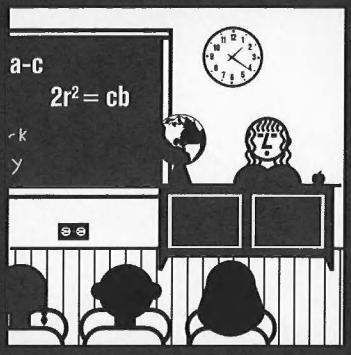


30 minutes beginners -library research for intermediate

Background

The ocean's **sunlight zone** is highly productive, and most of the ocean's species live there. This zone extends roughly 450 feet below the water's surface.

The **twilight zone** extends from the lower boundary of the sunlight zone to a depth of about 3,000 feet. The only light seen in this zone is a blue light that barely forms silhouettes. Plants cannot grow in this zone. Consequently, food in the form of vegetation is scarce, and the animals tend to be smaller and less abundant. Some animals swim up into the sunlight zone each night to feed; others prey on the animals found in the twilight zone. Animals also rely on animal and plant remains that drift down from the upper zone.

The **midnight zone** stretches from about 3000 feet to the bottom of the ocean floor. It occupies about 3/4 of the ocean – or approximately 250 million cubic miles of water. Water pressure may exceed two tons per square inch (as compared to 15 pounds per square inch at the surface), and the temperature is near freezing. It is completely dark day in and day out all year round. Scientists estimate that only 1percent of all the ocean species live in this zone. The animals that survive at this depth are small and have low metabolic rates. This means that their digestive rates, heart rates and other body functions are much slower than those of animals living in shallower regions of the ocean. Because of this, these animals tend to grow slowly and live a long time. The food they eat comes from the remains of the ocean's sunlit areas and the bacteria-rich ooze on the ocean's floor.

Directions

For Primary Students: "Find My Zone" game:

1. Make copies of the fish and labels in Appendix B. Laminate them if possible.
2. Have students sit on the floor in circles composed of 8-10 students.
3. Pass the cards out to the students, with the pictures of the animals facing up.
4. Place the three zone labels in the middle of the circle facing the students.
5. Ask one student to start the game. Each student should read the name of his/her animal and the "Where Do I Live?" information on the back. They should ask the other students if they know what zone that animal lives in.
6. Place the animal under the appropriate zone when the right answer is given.
7. Ask another student to do the same until everyone has had a turn.
8. Use the "Answering Master" (located to the left) to check the students awareness.

For Intermediate Students:

1. Copy the picture/name side of each animals' card in the "Find My Zone" game.
2. Make a label for each of the three zones.
3. Divide students into groups of two.
4. Give each group a picture/name, and ask them to use the resources available to them to find the answers to these four questions:
    1. How would you describe what the animal looks like?
    2. About how big does it grow?
    3. Where does it live in the ocean – near the surface, on the bottom, or in mid-water?
    4. What does it eat, and how does it get its food?
5. Ask the students to share what they have learned about their animals and place the pictures of the animals under the appropriate zone labels.
6. Using the answer guide, see if the students have placed the animals in the correct places.

ACTIVITY 2

ACTIVITY 3

In Brief

The students will create a mural illustrating the undersea zones and the food web that exists among the plants and animals that live in each zone.

What is the food web for the ocean depths?

Objective

This activity demonstrates the three undersea zones, their relative sizes, and the animals that occupy the zones. It also illustrates the food web found in the ocean as well as the importance of bioluminescence.

Materials

- wall space about 8 feet high and 3 feet wide
- green construction paper 4 inches by 3 feet
- blue construction paper 14 inches by 3 feet
- black construction paper 6.5 feet by 3 feet
- glow-in-the-dark paint (available at craft stores)
- animal and zone game cards (Appendix B)

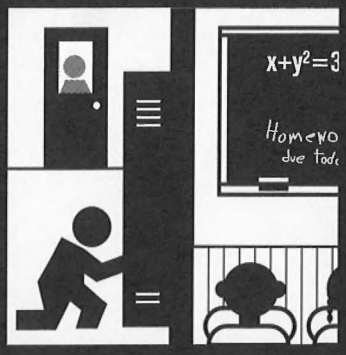
Vocabulary

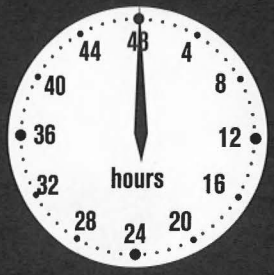
bioluminescence (ˌbī-o-ˌlü-mə-'nes-ᵊn(t)s) – the emission of visible light by living organisms such as fireflies, various fish, fungi and bacteria.

phytoplankton (ˌfit-ō-plaŋ(k)-tən) – microscopic plants that drift or float with the water's currents.

zooplankton ('zō-ə-'plaŋ(k)-tən) – microscopic animals that drift or float with the water's currents.

HALLWAY OR CLASSROOM





2 days

Background

Like animals that live on the land, most animals that live in the ocean depend on plants for food. The most important marine plants are phytoplankton. Millions of these tiny, mostly one-celled plants drift near the ocean's surface. Tiny animals called zooplankton eat the phytoplankton, as do clams, corals and small fish. Corals, jellyfish and some kinds of fish and whales feed on zooplankton as well. Many of the larger fish eat the animals that feed on the plankton. The best way to explain the relationship between these animals and plants is to construct a food web. For example, a food web can show that even a top predator, such as the killer whale, depends on phytoplankton even though it does not feed directly on it.

Many animals in the twilight and midnight zones use bioluminescence to attract mates or prey. Bioluminescence is a chemical reaction that produces a cold light.

The purpose of this activity is to demonstrate the relative sizes of the undersea zones and to show possible food webs that connect these zones together.

Directions

1 At the top of an 8-ft. wall mount a strip of green construction paper 4 inches high and at least 3 feet wide. This represents the sunlight zone.

2 Below the green strip, mount a strip of blue paper 14 inches high and the same width. This represents the twilight zone.

3 The remainder of the wall, all the way to the floor, should be covered with black paper to represent the midnight zone. It should measure 6 feet 6 inches or so. If your wall is higher than 8 feet, make the black layer 7 feet long.

4 Use the drawings from the animal and zone label cards (Appendix B), have the students duplicate the animals and place them in their correct zones. Be sure to let the students use glow-in-the-dark paint on the gray markings of the animal cards to represent bioluminescence.

5 When the animals are mounted on the wall, use the information on the back of the animal and zone cards and create a food web by linking plants and animals together with string and straight pins according to how they feed.

Questions

1 What is the basis for the food web in the sunlight zone? *Phytoplankton form the basis of the food web.*

2 What provides the food for the animals in the twilight and midnight zones? *Animals living in these zones generally feed on the dead plants and animals that fall from above. Others may use bioluminescence to attract other animals to prey on.*

3 What would happen if one of the game cards was removed? *An important link in the food web would be missing, and that could affect the animals that depend on it for food.*

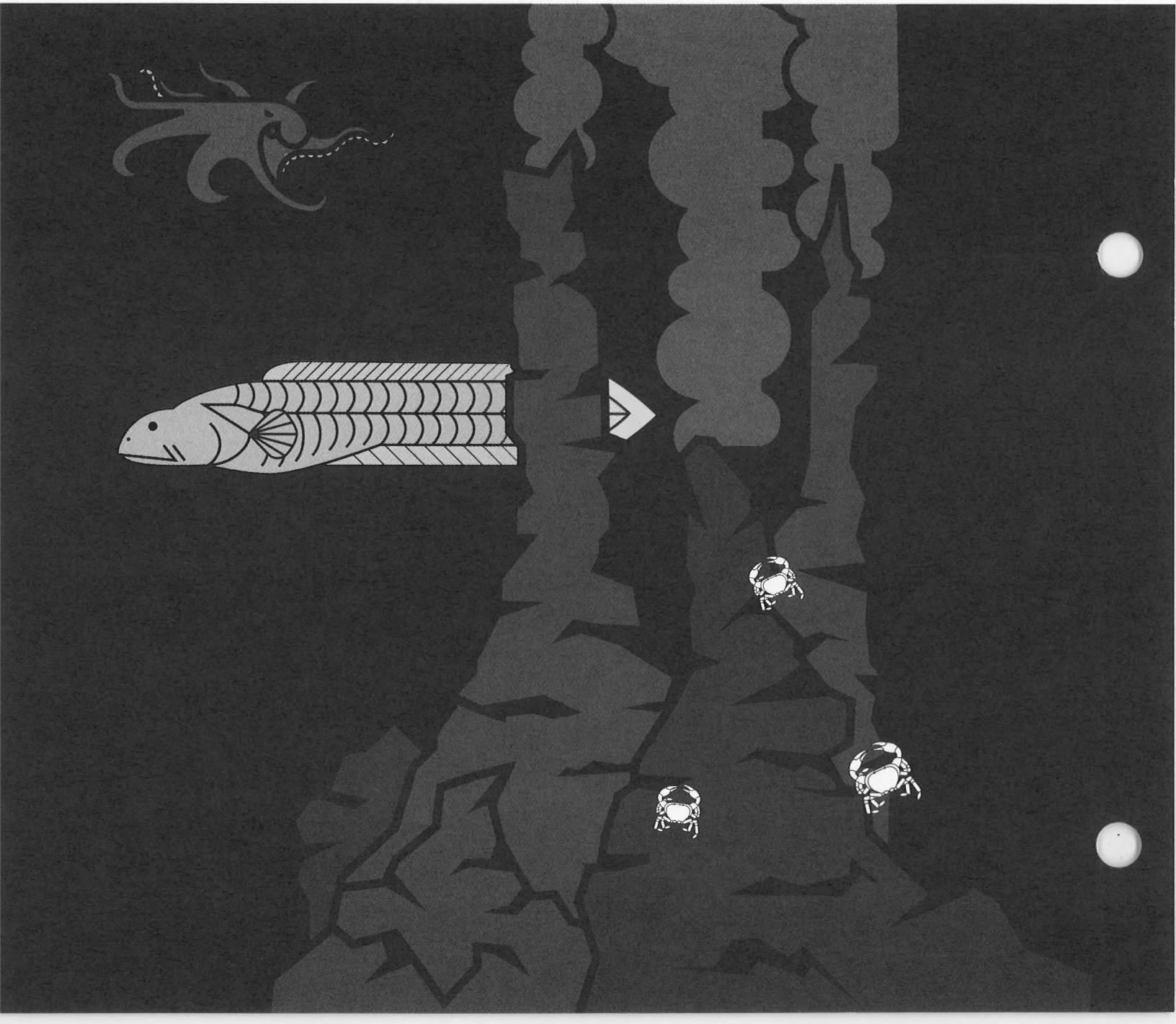
4 Why do some animals in the midnight zone have bioluminescent structures? *Animals use bioluminescence to attract prey or others of their own species for mates.*

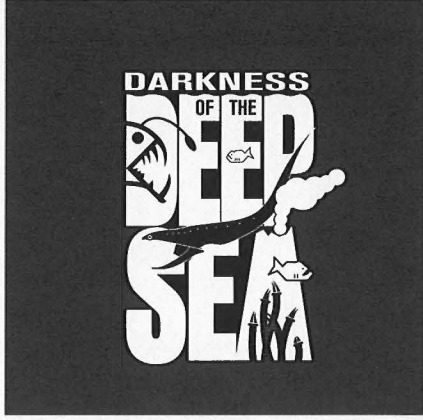
5 Explain how a large animal such as the killer whale depends on the phytoplankton in the sunlight zone for its food. *Even though the whales do not feed directly on phytoplankton, they feed on seals and sea lions that, in turn, feed on fish that, in turn, feed on phytoplankton.*

Taking it Further

The previous exercise shows the relative scale of the oceans' zones, but does not allow for demonstrating relative sizes of the animals involved. Using the information from the animal and zone cards (Appendix B), measure and mark off the sizes of the animals on adding machine tape or string. The students send the tapes or strings into the appropriate zones so they can see the differences in animal sizes. The strips can be displayed along the hallway or hung from a tall ceiling, such as in the gym. Alternatively, chalk drawings can be made on a sidewalk or blacktop area to represent the zones and sizes of the animals in each one.

Look at the pictures, and decide which ones look like predators because they have big mouths, long teeth, etc.). Discuss how these predators still depend on plants for their food.





Across the Curriculum

Language Arts
Give each child an animal card. Have each child list as many words as possible to describe the animal. This activity can be expanded into thesaurus/dictionary work. Students can use their words to write poems about the animals. These poems can vary from simple, single-word-per-line poems to complete sentences. This can lead into discussion of adjectives.

Read *The Kraken Wakes* by John Wyndham or *The Kraken* by Jack Prelutsky. Have students draw their ideas of a "Kraken" based on their knowledge of sea creatures and the clues given in the poem. They can also write a paragraph describing their drawings.

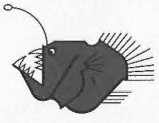
Read *20,000 Leagues Under the Sea* by Jules Verne. Compare Jules Verne's concept of the ocean depths to what we know today.

Math
Use the information on animal sizes to develop a unit on measurement. For older students, have them use the adding and subtracting of fractions in comparing sizes of the animals.

History
Look up and describe some of Leonardo Da Vinci's inventions for exploring the sea.

Science
Arrange the animals in the game cards into groups: arthropods, bony fish, cartilaginous fish, jellyfish, corals, worms, etc.

Look up the function of the lateral line in fish.



How do humans cope with and react to the dark? Human activity in the dark has changed over the years as technological advances have enabled us to conquer the difficulties encountered in the dark. Infrared light detectors, artificial light, radar, sonar, etc. now give us access to dark environments.

However, years and years ago people functioned in the dark without technology. Because the dark was mysterious and frightening to them, they used their imaginations to populate it with fantastic creatures. This section explores our creative responses to the dark.

DARKNESS AND HUMANS

ACTIVITY 1

Students will connect the dots of constellations to create their own pictures. Students will read myths and create their own myths. By doing this activity, they will become aware that humans, before the advent of audiovisual technology, used their imaginations to explain their world as well as for entertainment.

ACTIVITY 2

Students will project star patterns on the ceiling and read myths. They will realize that patterns can be seen all around us, including in the stars. They also will learn that patterns can be interpreted differently by different people.

ACTIVITY 3

Using their imaginations, students will create creatures to inhabit one of the dark environments they have studied.

ACTIVITY 1

In Brief

Using patterns of dots, students will create their own constellations and then create myths based on their constellations.

How to design a constellation.

Objective

The human imagination can observe a seemingly random pattern of dots and organize those dots into recognizable patterns. Those patterns can form the basis of a myth. By creating their own myths, students will better understand how people developed mythology in the past.

Materials

- *In a Dark, Dark Room* by Alvin Schwartz
- dot patterns (Appendix C)
- constellation pictures (Appendix C)

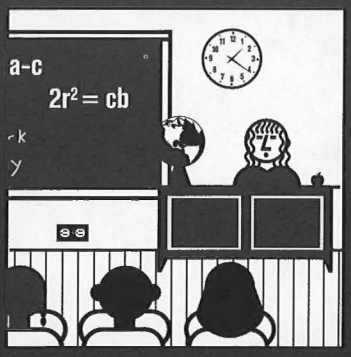
Vocabulary

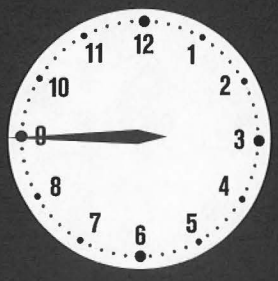
constellation \ˌkän(t)-stə-'lā-shən\ – any star group considered to resemble and named after a mythological character, inanimate object or animal.

legend \'lej-ənd\ – an unverified popular story handed down from earlier times.

myth \'mith\ – a traditional story originating in preliterate society dealing with supernatural beings, ancestors or heroes that serves as a model in a primitive view of the world: "Myths bring the unknown into relation with the known." (Cecil M. Bowra)

CLASSROOM





45 minutes

ACTIVITY 1

Background

Every culture has its own ideas about the world around it. Those ideas are reflected in the legacy left by that group of people. For example, Greeks, Romans and Native Americans are among the many peoples who left behind a wealth of wonderful stories in the form of myths. Today we use science to understand the world around us. In the past, mythology was used by ancient civilizations to explain the world around them. This mythology was based on observation and used the richest resource we have – the human imagination.

Directions

1. Set the scene by darkening the room and reading *In a Dark, Dark Room* by Alvin Schwartz. Lead students into a discussion of why humans fear the dark. Elicit some ideas of fun things to do in the dark. See if they can suggest activities that people might have done before the advent of electricity.
2. Give each child a dot pattern from Appendix C.
3. Students should connect the dots to create pictures. Tell them that the dots are stars in the sky and that people thousands of years ago looked at the same patterns and created pictures.
4. Show them the pictures of the constellations from Appendix C. Compare their pictures to the originals.
5. Read the myths that match the constellations. Explain that myths are made-up stories to explain phenomena in nature.
6. Have each child write a myth or a legend about his/her picture.

Questions

1. Do your pictures resemble the original constellation pictures?

2. Why or why not? *Don't assume that the students' pictures should resemble the original constellation pictures. The whole point is that people, using their imaginations, see different patterns.*

3. How is this activity like telling stories around a campfire?

ACTIVITY 2

In Brief

Students will project their own constellations on the ceiling or wall.

Project a constellation.

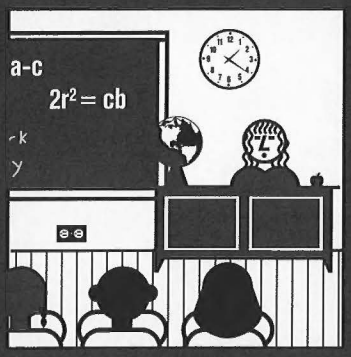
Objective

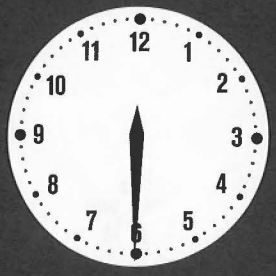
Students will realize that the same pattern can lead to a variety of interpretations.

Materials

- clean soup can or dixie cup
- nail
- hammer
- flashlight
- darkened room

CLASSROOM





30 minutes

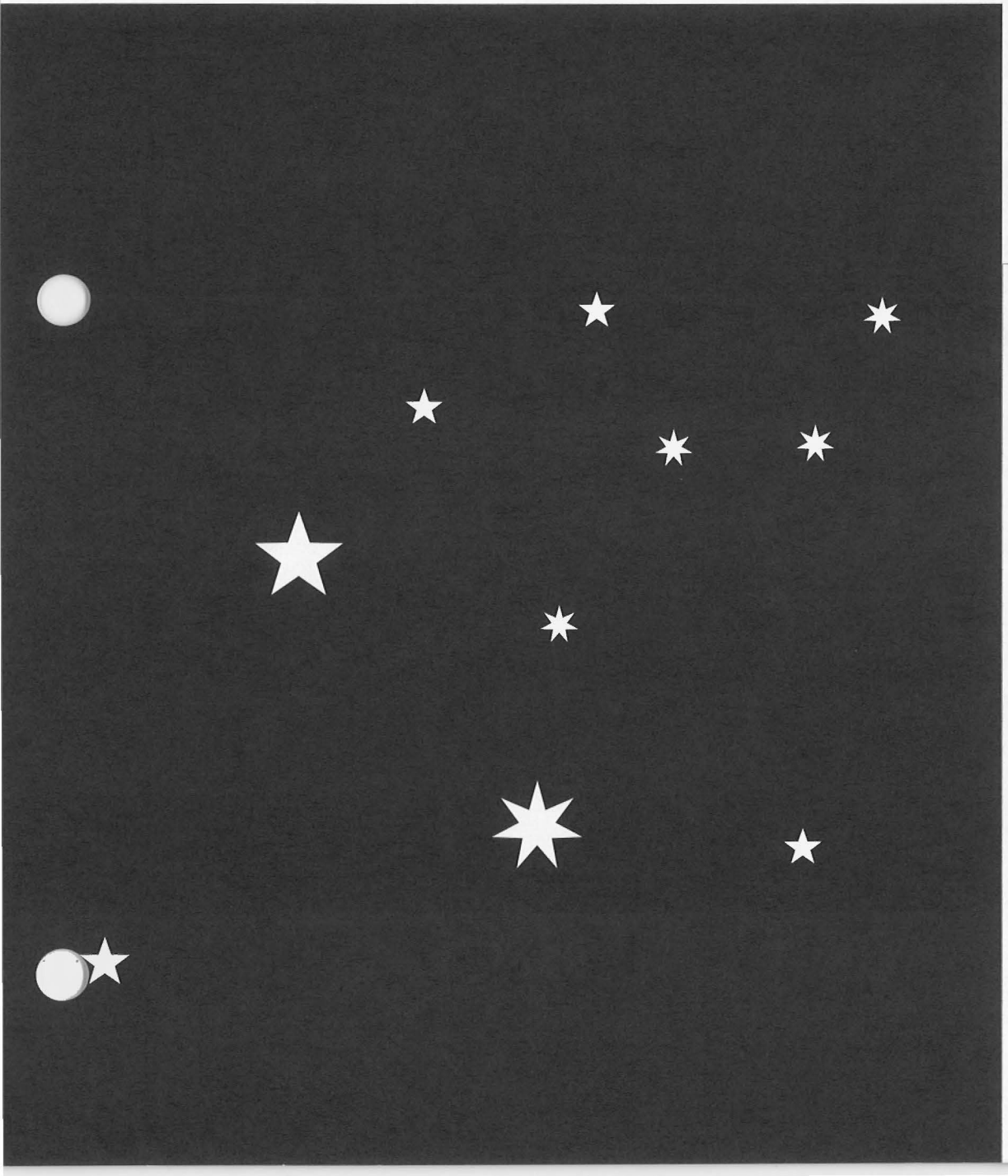
Directions

1 Have each child punch holes in the bottom of a soup can or dixie cup to duplicate the star pattern of his/her constellation.

2 Darken the room, insert a lighted flashlight into the can, and project star patterns on the ceiling or wall.

3 Have each child show his/her picture, and read his/her legend about the constellation.

Note to the teacher: Have other students interpret the constellation.



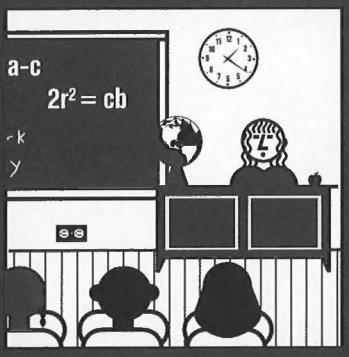
ACTIVITY 2

ACTIVITY 3

In Brief

Students will design creatures adapted to one or more of the environments studied.

CLASSROOM



varies

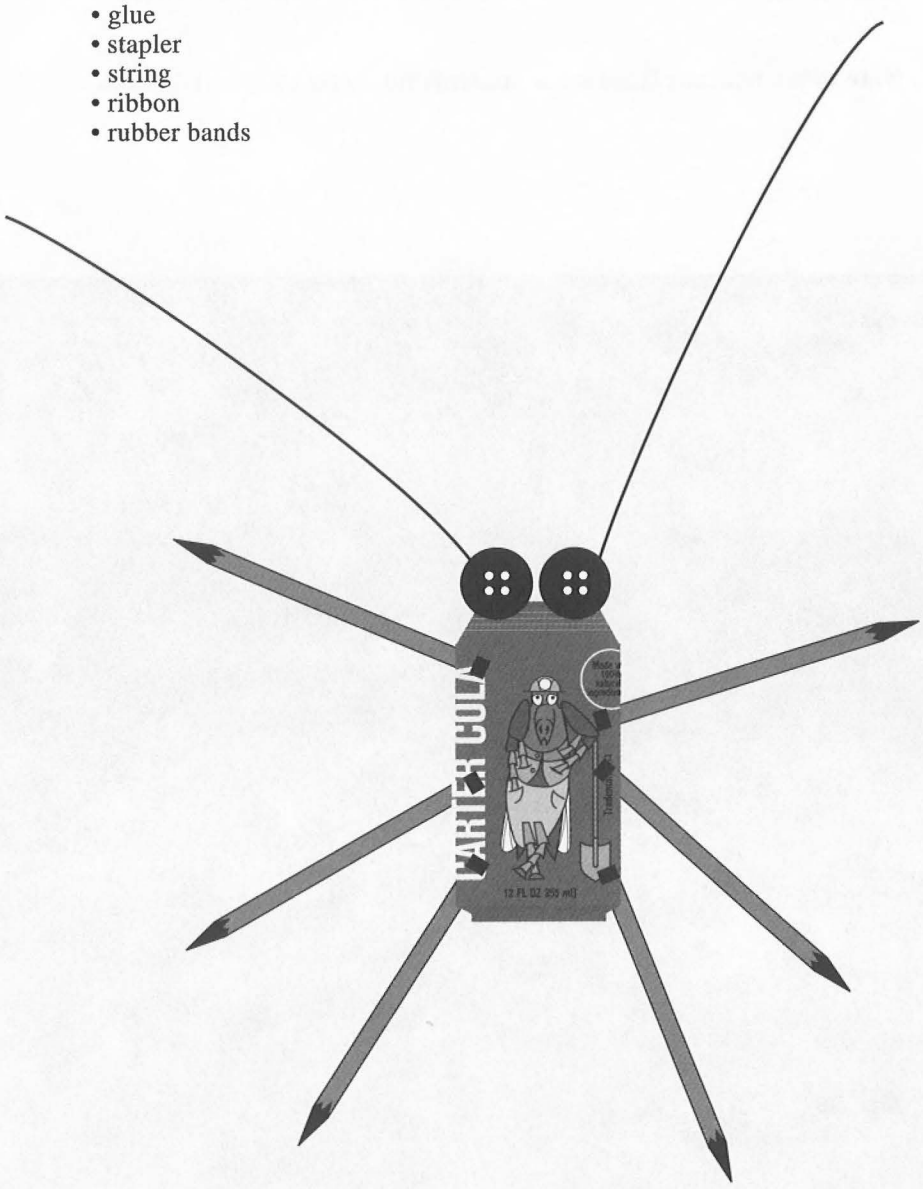
Creating a creature of the dark.

Objective

This activity is an assessment tool for the teacher to test the knowledge and concepts learned in this unit about dark places.

Materials

- found materials, clean recyclable trash
- glue
- stapler
- string
- ribbon
- rubber bands



Directions

Using any found materials or clean recyclable trash, have students design creatures that could live in any one of the dark environments that we have studied. They must be sure to include specific adaptations to that particular environment.

Questions

1. How is your creature adapted to its environment?

2. What changes must evolve in human beings in order for us to become adapted to that environment?

3. Without any change of form, how can humans make use of technology to cope with each dark environment? *Sonar, radar, seeing-eye dogs, infra red vision equipment, night vision glasses and lights are all used in coping with the dark. Also keep in mind SCUBA (self-contained underwater breathing apparatus), submarines, ROVER (an unmanned vehicle used to explore the deep sea,) cave exploration equipment and tunneling equipment are also used to explore the dark.*

4. Draw a human tourist for one of the environments. Be sure to include the equipment he/she must pack in order to visit successfully.

Taking it Further

1. Have students create a model of a scary monster in great detail and tell where it lives. Then decide if this monster could actually survive in that environment.

2. Have the class sit in a circle, as if around a campfire. Then have them create a scary story. Each student should take a turn to complete it. *In a Dark, Dark Room* is a good example for them to duplicate for their first attempt.

Across the Curiculum

Language Arts
Have the students write scary stories or ghost stories and publish them. Have the class make a big book out of a class-created story about the dark.

Listen to *Nightmares* and *The Headless Horseman*: P*oems to Trouble Your Sleep* by Jack Prelutsky. Have students read scary stories themselves. Discuss how often these stories are set in darkness. Discuss the monsters in the poetry, and decide which environment each monster might live in best.

Social Studies
Discuss some of the ancient theories on the structure of the solar system and the universe.

Science
Study astronomy and the locations of the constellations. Find out why the constellations cross the sky and appear at different times of the year.

Math
Light travels at a speed of 300,000 kilometers (km) per second. The moon is 382,240 km from Earth, and the sun is 150 million km from Earth. Have students calculate the length of time it takes for light to travel from the moon and from the sun to Earth.
382,240÷300,000 = 1.27 seconds for the light to travel from the moon to Earth. 150,000,000÷300,000 = 500 seconds÷60 (seconds in a minute) = 8.33 minutes for the light to travel from the sun to Earth.

Nonfiction

Barkan, Joanne. 1991. *Creatures That Glow.* Doubleday. NY.

Baskin, Esther. 1962. *Creatures of Darkness.* Little, Brown. NY.

Behnke, Frances L. 1977. *A Natural History of Termites.* Scribner. NY.

Bronin, Andres. 1972. *Cave: What Lives There.* McCann & Geoghegan. NY.

Chinery, Michael. 1992. *Desert Animals.* Random House. NY.

Coldrey, Jennifer. 1986. *Discovering Worms.* Bookwright Press. NY.

Darling, Lois. 1972. *Worms.* Morrow, NY.

Feldman, Eve. 1992. *Animals Don't Wear Pajamas.* H. Holt. NY.

Gallant, Roy A. 1991. *The Constellations, How They Came to Be.* Four Winds Press, NY.

Gans, Roma. 1976. *Caves.* Crowell. NY.

Garden, Nancy. 1973. *Werewolves.* Lippincott. Philadelphia, PA.

George, Jean Craighe. 1967. *The Moon of the Owls.* Crowell. NY.

Gibbons, Gail. 1993. *Caves and Caverns.* Harcourt. San Diego.

Gowell, Elizabeth. 1993. *Sea Jellies: Rainbows in the Sea.* F. Watts. NY.

Greenaway, Frank. 1991. *Amazing Bats.* Knopf. NY.

Hamilton, Edith. 1942. *Mythology.* Little, Brown. Boston.

Hess, Lilo. 1969. *The Misunderstood Skunk.* Scribner. NY.

Hinkley, James W. 1979. *The Book of Vampires.* F. Watts. NY.

Kramer, Stephen P. 1995. *Caves.* Carolrhoda Books. Minneapolis, MN.

Lauber, Patricia. 1990. *Seeing Earth From Space.* Orchard Books. NY.

Lauber, Patricia. 1994. *Earthworms: Underground Farmers.* Henry Holt, NY.

Lavine, Sigmund. 1969. *Wonders of the Bat World.* Dodd, Mead. NY.

Laycock, George. 1976. *Caves.* Four Winds Press. NY.

McDonald, Mary Ann. 1993. *Flying Squirrels.* Child's Word. Mankato, MN.

Oughton, Jerrie. 1992. *How the Stars Fell into the Sky*: a Najavo legend. Houghton Mifflin Co. Boston, MA.

Preston-Mafham, Ken. 1990. *Discovering Centipedes and Millipedes.* Bookwright Press. NY.

Rinard, Judith E. 1977. *Creatures of the Night.* National Geographic Society. Washington, D.C.

Royston, Angela. 1992. *Nighttime Animals.* Aladdin. NY.

Rue, Leonard Lee. 1983. *Meet the Opossum.* Dodd, Mead. NY.

Schultz, Ron. 1993. *Looking Inside Caves and Caverns.* J. Muir Publications. Santa Fe, NM.

Stafford, Patricia. 1992. *Dreaming and Dreams.* Atheneum. NY.

Sterling, Dorothy. 1956. *The Story of Caves.* Doubleday. Garden City, NY.

Taylor, Harriet Peck. 1993. *Coyote Places the Stars.* Bradbury Press. NY.

Yajima, Minoru. 1986. *Firefly.* Raintree Publishers. Milwaukee, WI.

Zim, Herbert. 1977. *Owls.* Morrow, NY.

READING LIST

Fiction

Bauer, Marion Dane. 1987. *Touch the Moon.* Clarion Books. NY.

Cooper, Susan. 1973. *The Dark is Rising.* Atheneum. NY.

Ewart, Claire. 1992. *One Cold Night.* G.P. Putnam Sons. NY.

Field, Eugene. 1985. *Wynken, Blinken and Nod.* Scholastic. Richmond Hill, ONT.

Garden, Nancy. 1984. *Prisoner of Vampires.* Farrar Straus Giroux. NY.

Katchen, Carole. 1989. *Your Friend, Annie.* Scholastic, NY.

Mayle, Peter. 1986. *Sweet Dreams and Monsters.* Harmony Books. NY.

O'Brian, Robert C. 1971. *Mrs. Frisby and the Rats of NIMH.* Atheneum. NY.

Prelutsky, Jack. 1976. *Nightmares and the Headless Horseman: Poems to Trouble Your Sleep.* Greenwillow Books. NY.

Schwartz, Alvin. 1984. *In a Dark, Dark Room and Other Scary Stories.* Harper & Row. NY.

Seymour, Miranda. 1986. *The Vampire of Verdonia.* Deutsch. London, England.

Smucker, Anna Egan. 1994. *Outside the Window.* Knopf. NY.

Steiner, Barbara A. 1990. *Ghost Cave.* Harcourt Brace Jovanovich. San Diego.

Stoker, Bram (Leonard Wolf, ed). 1993. *The Essential Dracula.* Plume. NY.

Stolz, Mary. 1987. *Scarecrows and Their Children.* Harper & Row. NY.

Verne, Jules. 1954 reprint. *20,000 Leagues Under the Sea.* Rand McNally. NY.

Wright, Betty Ren. 1987. *A Ghost in the Window.* Holiday House. NY.

Wyndham, John. 1983. *The Kracken Wakes.* Chiver Press. Bath, England.

DARKNESS WITHIN THE SOIL

FROM ACTIVITY 2

JOB SIGNS

WORKER

SOLDIER

QUEEN

PHEROMONE CARDS

ATTACK

CARE FOR QUEEN

FIND FOOD

LAY EGGS

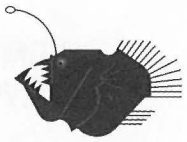
BUILD COLONY

DEFEND

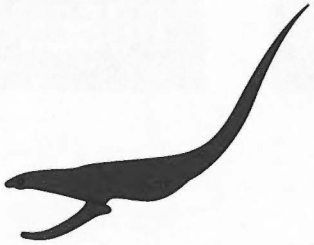
FEED YOUNG

APPENDIX A

DEEP SEA ZONE CARDS

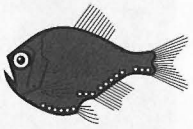


Angler Fish
lives in the deep, deep sea.
(midnight zone)

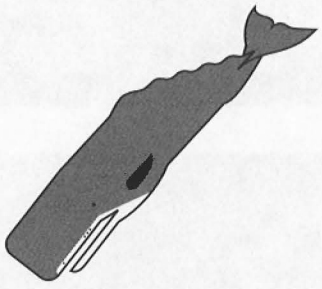


Gulper Eel
lives in the deep, deep sea.
(midnight zone)

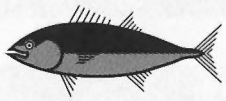
Squid
lives in the deep, sea.
(twilight zone)



Lanternfish
lives in the deep sea.
(midnight zone)



Sperm Whale
lives in the sea, the deep sea, and the deep, deep sea.
(all 3 zone)

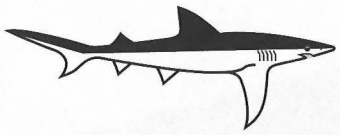


Tuna
lives in the sea.
(daylight zone)

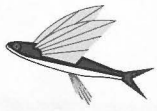
DARKNESS OF THE DEEP SEA

FROM ACTIVITY 2&3

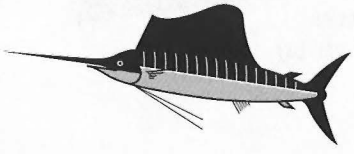
APPENDIX B



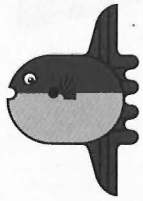
Blue Shark
lives in the sea.
(daylight zone)



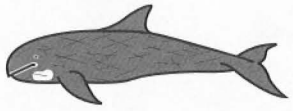
Flying Fish
lives in the sea.
(daylight zone)



Swordfish
lives in the sea.
(daylight zone)

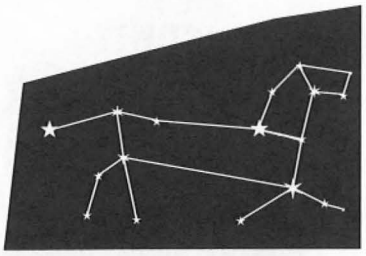


Sunfish
lives in the sea.
(daylight zone)

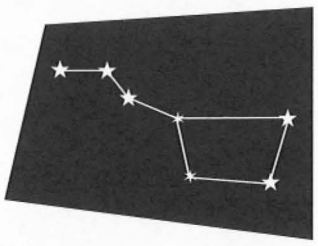


Risso's Dolphin
lives in the sea.
(daylight zone)

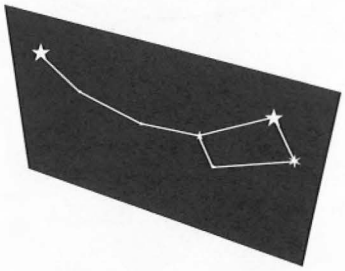
CONSTELLATIONS



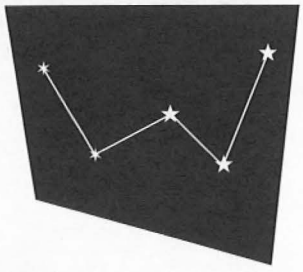
The Lion (Leo)
(Lee-o)



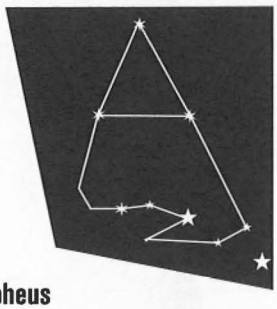
The Big Dipper



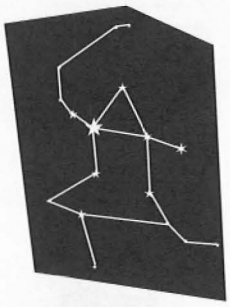
The Little Dipper



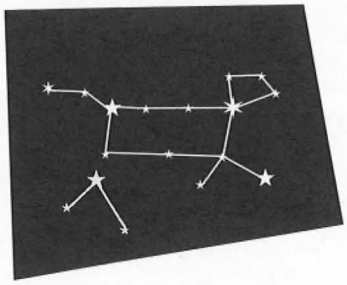
Cassiopeia
(Cassey-o-pee-a)



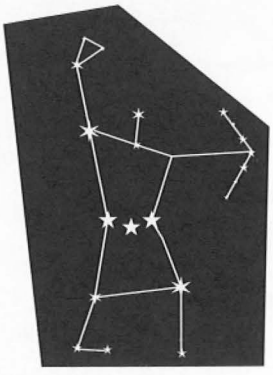
Cepheus
(See-fee-us)



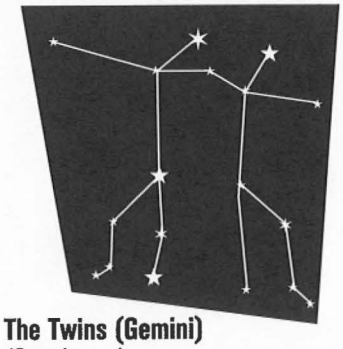
Perseus
(Per-see-us)



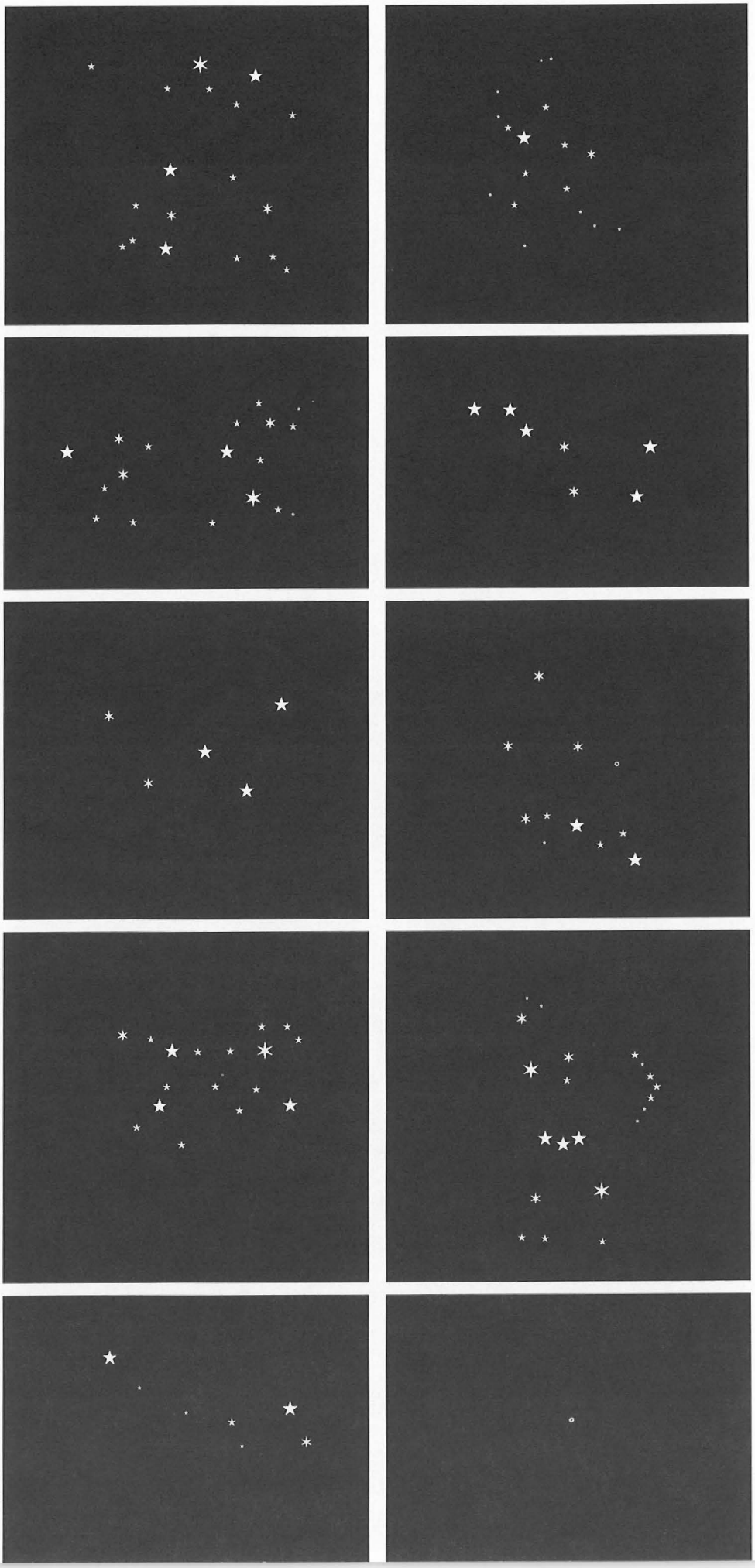
The Big Dog (Canis Major)
(Cane-us May-jor)



Orion
(O-rye-on)



The Twins (Gemini)
(Gem-in-eye)



APPENDIX C

CINCINNATI MUSEUM CENTER