

Freshwater Mussel
Activity Book and
Learning Resource

North Carolina
Freshwater Mussel
Conservation Partnership



Freshwater Mussels

Activity Book & Learning Resource

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North Carolina State University

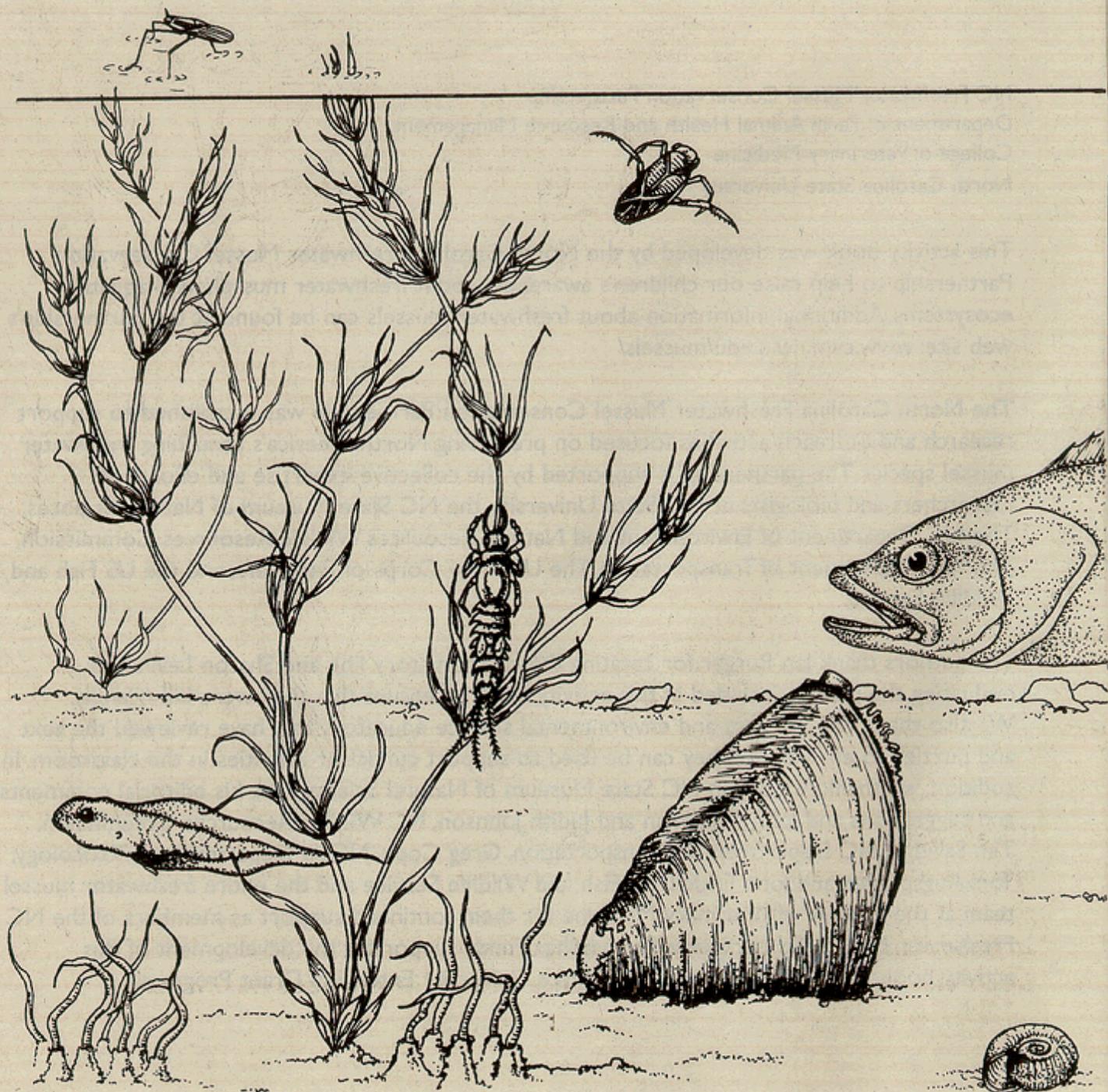
This activity book was developed by the North Carolina Freshwater Mussel Conservation Partnership to help raise our children's awareness about freshwater mussels, and aquatic ecosystems. Additional information about freshwater mussels can be found at the partnership's web site: www.cvm.ncsu.edu/mussels/

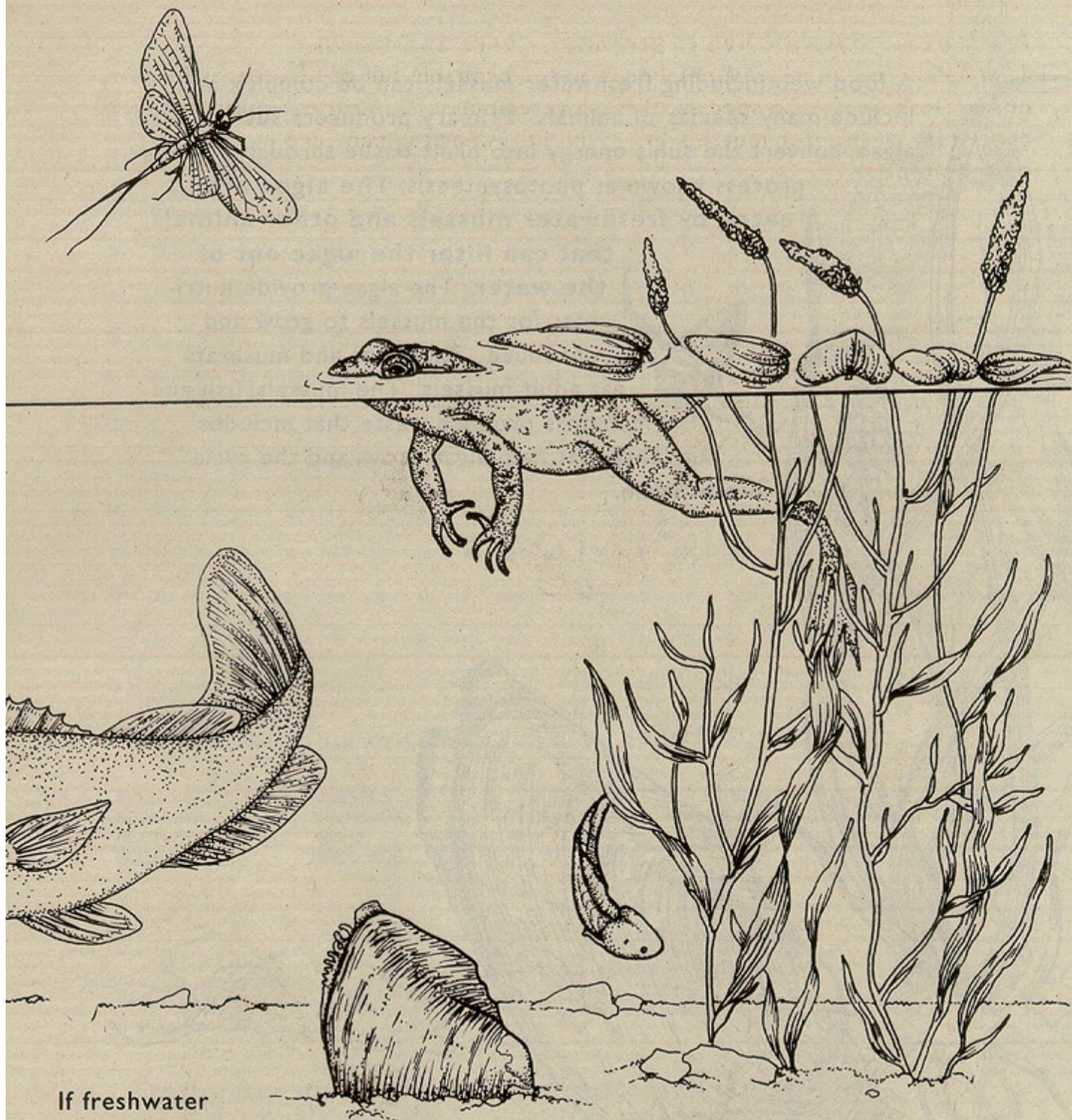
The North Carolina Freshwater Mussel Conservation Partnership was established to support research and outreach activities focused on preserving North America's remaining freshwater mussel species. The partnership is supported by the collective expertise and efforts of researchers and biologists at NC State University, the NC State Museum of Natural Sciences, The NC Department of Environment and Natural Resources Wildlife Resources Commission, The NC Department of Transportation, The US Army Corps of Engineers, and the US Fish and Wildlife Service.

The authors thank Jan Burger for creating the cartoon story line and Sharon Levine for evaluating the puzzles included in this activity book to ensure that they were kid-friendly. We also thank the teachers and environmental science educators that have reviewed the text and puzzles to ensure that they can be used to support curricular activities in the classroom. In addition, we thank Art Bogan NC State Museum of Natural Sciences for his editorial comments and suggestions and John Alderman and Judith Johnson, NC Wildlife Resources Commission, Tim Savidge, NC Department of Transportation, Greg Cope, NCSU Department of Toxicology, Tom Augsperger, and John Fridell, US Fish and Wildlife Service and the entire freshwater mussel team at the College of Veterinary Medicine for their continued support as members of the NC Freshwater Mussel Conservation Partnership. Funds supporting the development of this activity book were provided by the NC State University Extension Grant Program.

Freshwater mussels live in streams, rivers and lakes.

That small stream in your neighborhood is probably full of life. It may be the home of one or more species of freshwater mussels. Although more than 290 species of freshwater mussels live in North America, many are endangered or threatened.



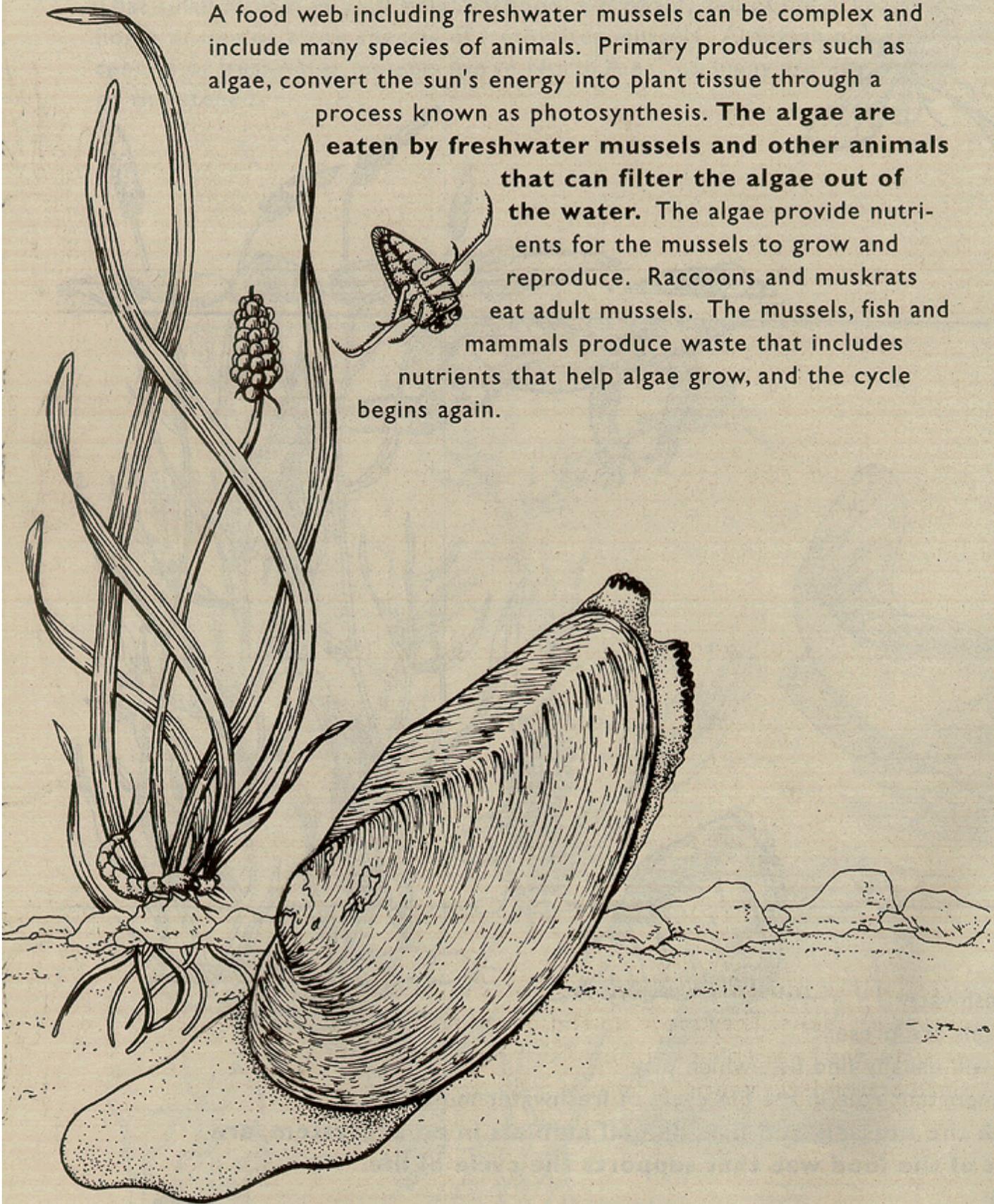


If freshwater mussels are present, you will usually find fish, which play an important role in the life cycle of freshwater mussels.

Both the mussels and fish, like all animals in an ecosystem, are part of the food web that supports the cycle of life.



A food web including freshwater mussels can be complex and include many species of animals. Primary producers such as algae, convert the sun's energy into plant tissue through a process known as photosynthesis. **The algae are eaten by freshwater mussels and other animals that can filter the algae out of the water.** The algae provide nutrients for the mussels to grow and reproduce. Raccoons and muskrats eat adult mussels. The mussels, fish and mammals produce waste that includes nutrients that help algae grow, and the cycle begins again.



A O Q X O G F Z O F Y U F R C
 E E P S P E C I E S S R P F G
 C W Y G T F M U S S E L S E R
 O N U T R I E N T S W P E I V
 S O F Y I E U T H D R D D U E
 Y P I F O O D W E B H I I P N
 S E S T E Y A S T R E A M S D
 T P H H J T O E A H E U E W A
 E E C O E Y A H E L U D N R N
 M L U R U G P O C W G E T T G
 P A G U L I J Y E A R A E O E
 T W T A K W C U W S D Y E K R
 M A T W E U R S T R I O T Y E
 U R S R I T H R E A T E N E D
 B P H O T O S Y N T H E S I S

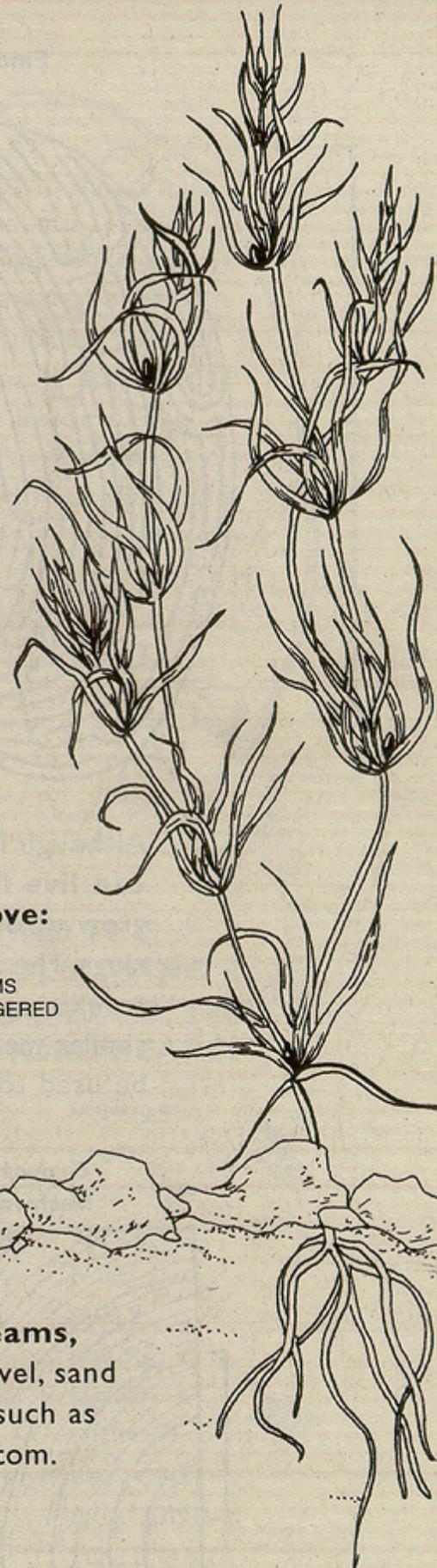
Find the following words in the word search above:

FRESHWATER
 SEDIMENT
 PHOTOSYNTHESIS
 ECOSYSTEM

MUSSELS
 NUTRIENTS
 ALGAE
 FOOD WEB

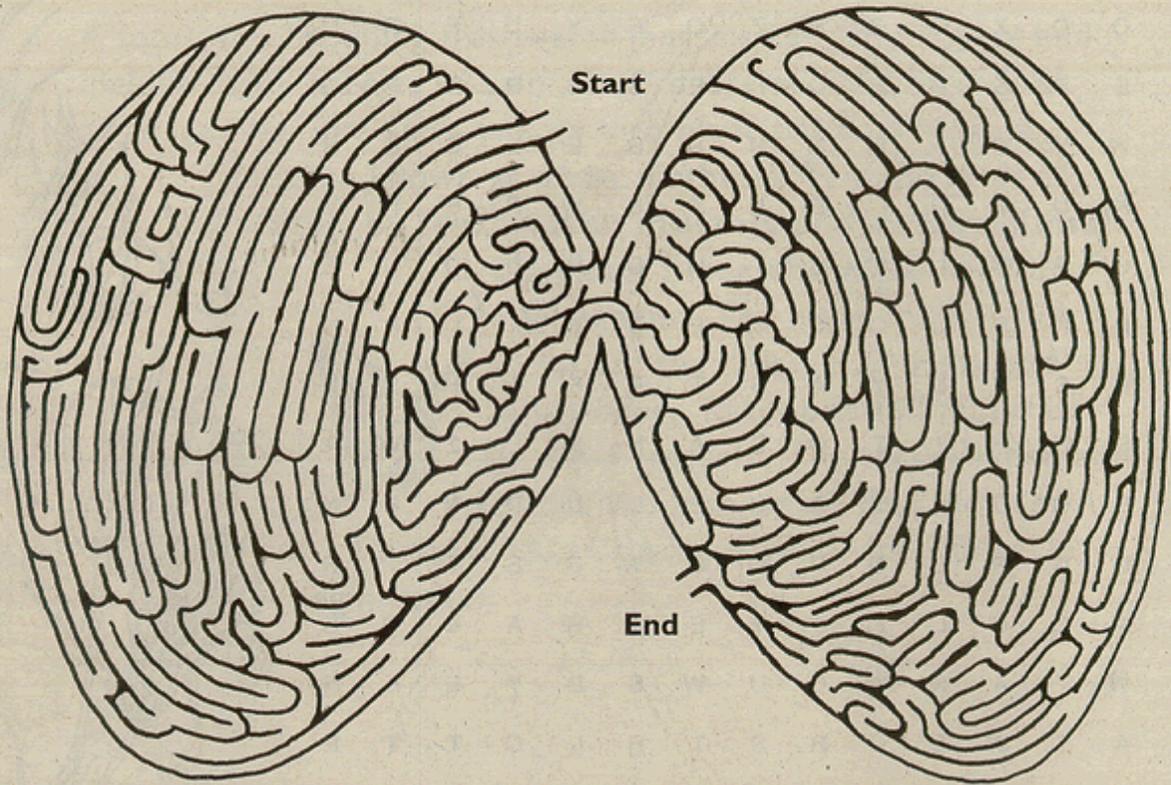
SPECIES
 THREATENED
 FISH

STREAMS
 ENDANGERED
 CYCLE



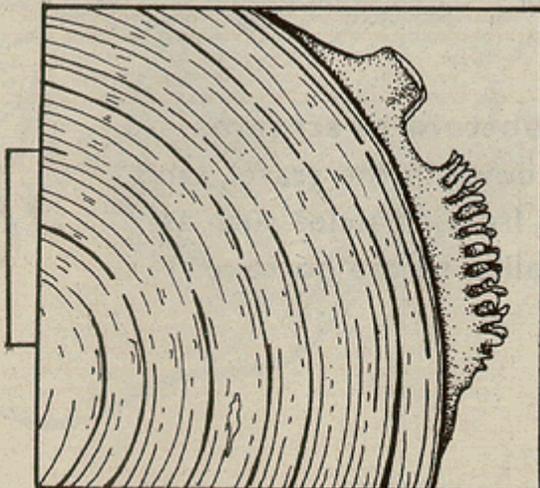
Freshwater mussels live on the bottom of streams, rivers or lakes. They move up and down in the gravel, sand or sediment. The sediment is formed from particles such as small bits of leaf material that have fallen to the bottom.

Find your way through the freshwater mussel maze!

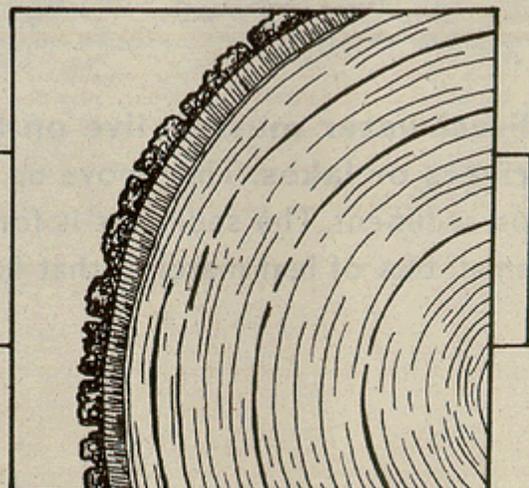


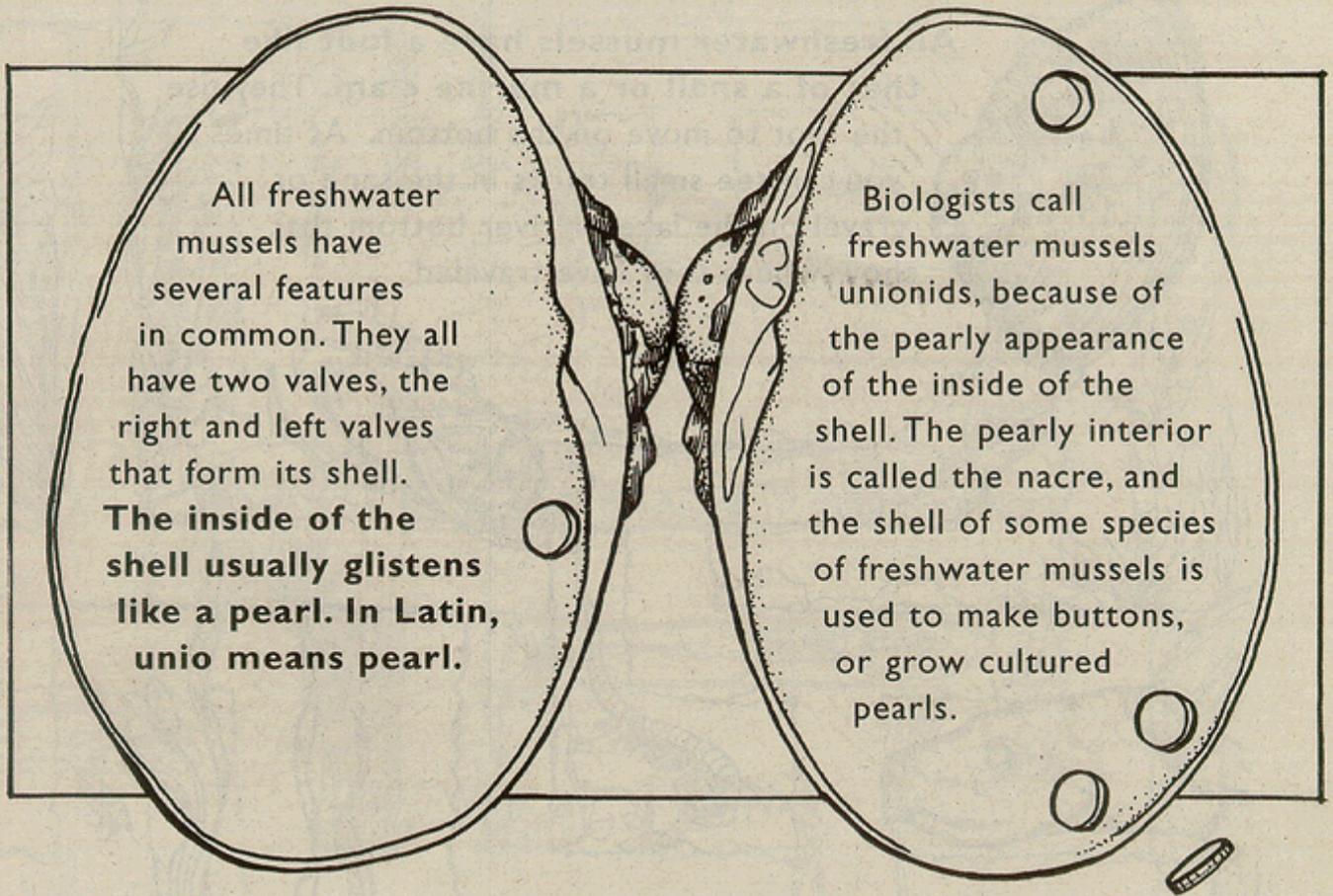
Although it's hard to believe, some **freshwater mussels can live for more than 150 years**. They continue to grow throughout life, and as they grow their shell forms rings. The rings are similar to those on the inside of a tree trunk that can be used to guess the age of the tree. In a similar manner, the rings on a freshwater mussel shell can be used to estimate the age of a freshwater mussel.

Growth rings of a freshwater mussel



Tree Trunk Rings





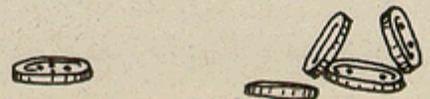
All freshwater mussels have several features in common. They all have two valves, the right and left valves that form its shell. **The inside of the shell usually glistens like a pearl. In Latin, unio means pearl.**

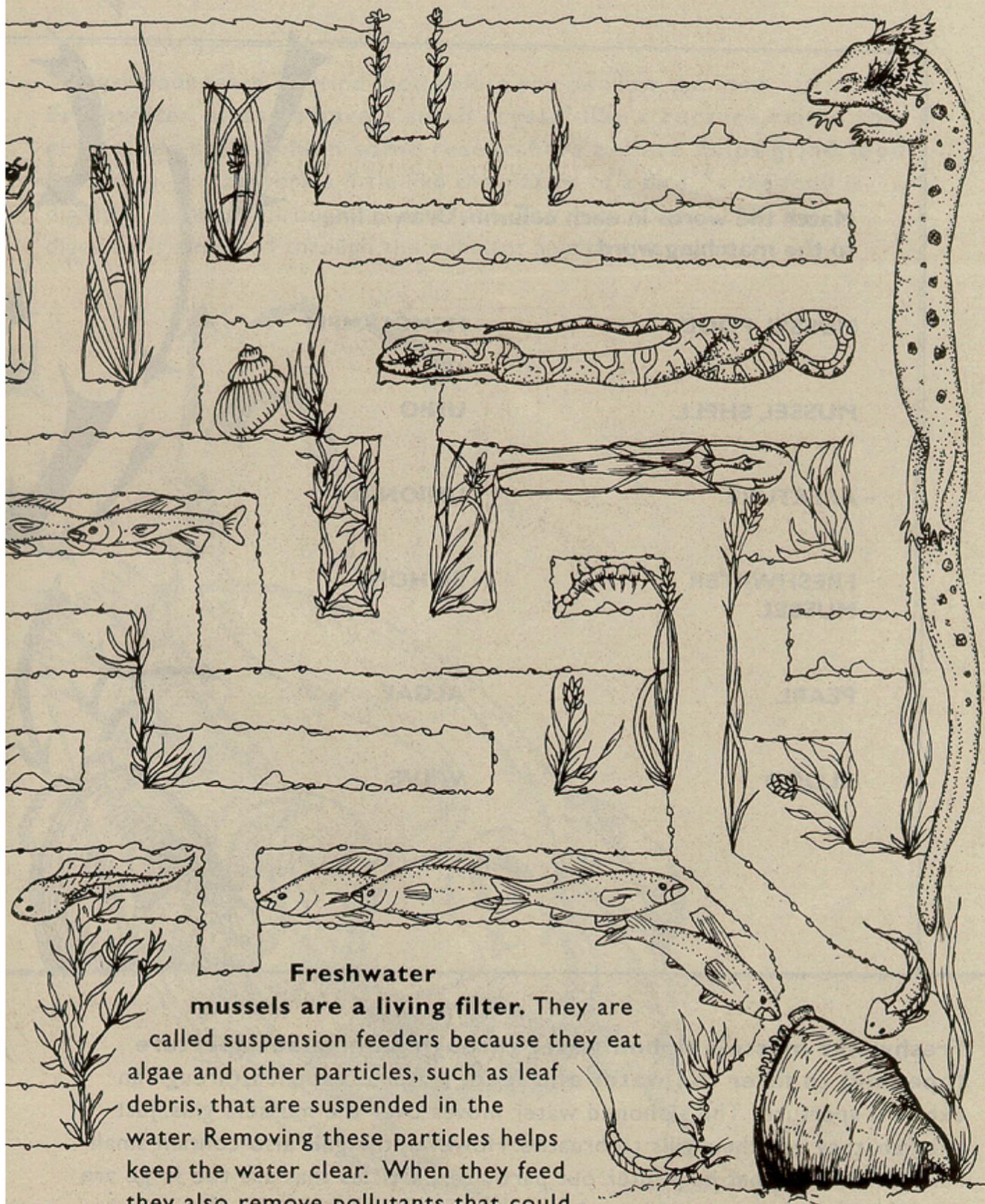
Biologists call freshwater mussels unionids, because of the pearly appearance of the inside of the shell. The pearly interior is called the nacre, and the shell of some species of freshwater mussels is used to make buttons, or grow cultured pearls.

K P S Q E K U G L S U B D H P
 V Y H W M S C V M T M T F O J
 U A E D U L J B R P E A L Y E
 H K L N S M R U F N J L O X S
 Q J L V S C S T X G U W S N T
 U N I O E R Q T I T A E H E I
 W S H V L S F O A W Q N A U M
 O N F L S A U N I O N I D S A
 Z M I A E J T S H E K T R V T
 R A L R G S R E D B Y L Y K E
 U V C O A B I O L O G I S T V
 G A F J B W N E N A F U C O G
 N D W E M D G S V L N A D O S
 R Y A G E Y S P T U O C T F R
 K B T W M G R O W T H G R L M

FIND THE FOLLOWING WORDS IN THE WORD SEARCH:

- MUSSELS
- UNIO
- UNIONIDS
- VALVES
- FOOT
- SHELL
- NACRE
- RINGS
- ESTIMATE
- BUTTONS
- BIOLOGIST
- POLLUTANTS





Freshwater
mussels are a living filter. They are called suspension feeders because they eat algae and other particles, such as leaf debris, that are suspended in the water. Removing these particles helps keep the water clear. When they feed they also remove pollutants that could potentially harm aquatic animals, birds, land dwelling animals, and people that may drink the water.

Match the words in each column. Draw a line to the matching word.

MUSSEL FOOD

HEMOLYMPH

MUSSEL SHELL

UNIO

APERTURE

UNIONID

FRESHWATER
MUSSEL

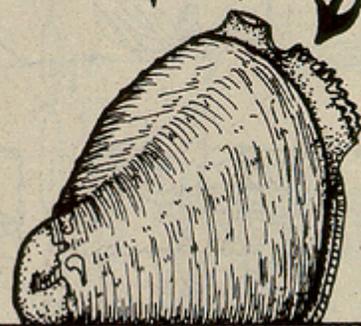
SIPHON

PEARL

ALGAE

BLOOD

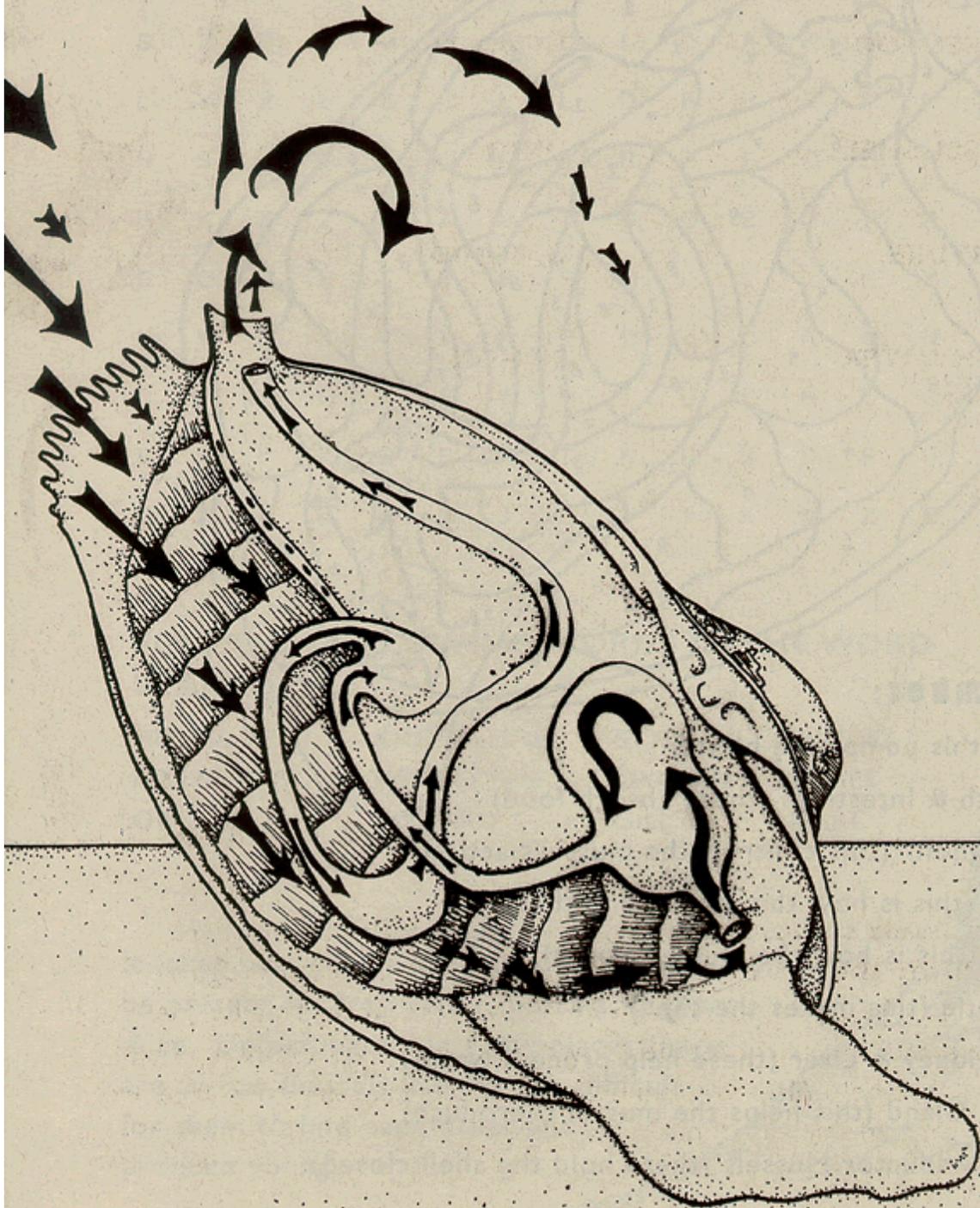
VALVE



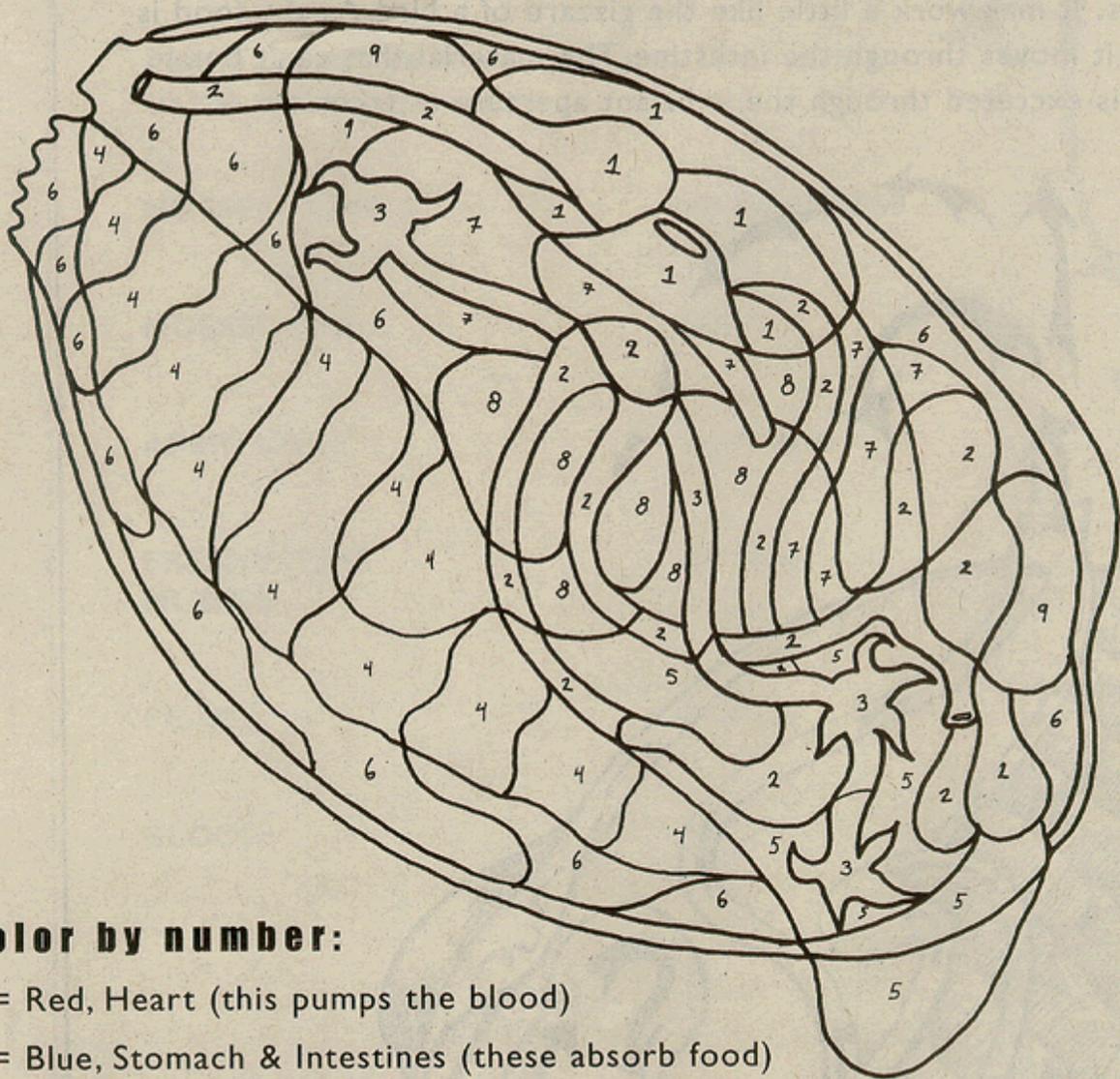
Freshwater mussels siphon water through an inhalant aperture (opening) to filter the water and feed. Water is expelled through an exhalant aperture. The siphoned water moves over the mussel's gills. Just like fish, they use their gills to breathe. However, the gills also contain small hairs called cilia that help filter out particles. Particles that are too large are coated with mucous and released back into the water, particles that are the preferred size move from the gills into the mouth.

You use your teeth to grind food before you swallow the food.

Freshwater mussels have a small crystal-like structure called the crystalline style, which some researchers believe helps grind food particles. It may work a little like the gizzard of a bird. As the food is digested, it moves through the intestine. The material that can't be digested is excreted through the exhalant aperture as feces.



If you were to look inside a freshwater mussel, you would also see a beating heart that pumps hemolymph, which is mussel blood. The hemolymph bathes all the internal organs and provides oxygen and nutrients.



Color by number:

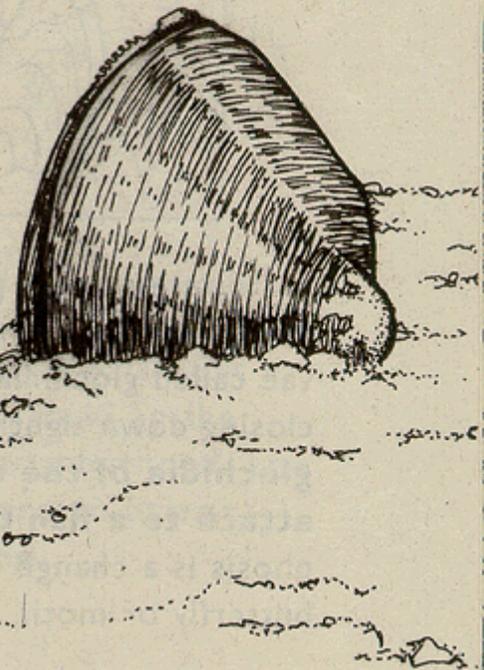
- 1 = Red, Heart (this pumps the blood)
- 2 = Blue, Stomach & Intestines (these absorb food)
- 3 = Green, "Ganglion" (this controls the mussel's actions)
- 4 = Purple, Gills (this is how the mussel breathes)
- 5 = Yellow, Foot (this is how the mussel moves)
- 6 = Orange, Mantle (this makes the shell)
- 7 = Light Blue, Kidney & Liver (these help process waste)
- 8 = Pink, Genital Gland (this helps the mussel reproduce)
- 9 = Light Green, Adductor Muscles (these hold the shell closed)

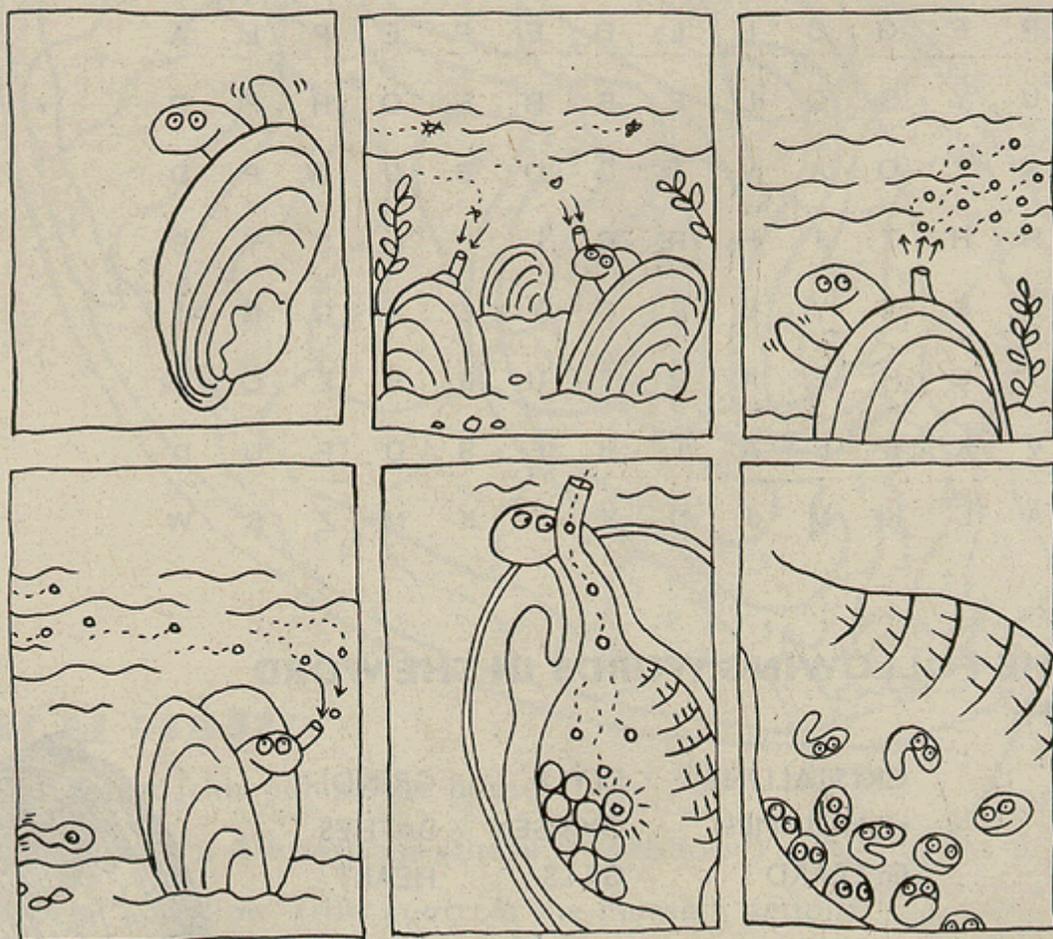
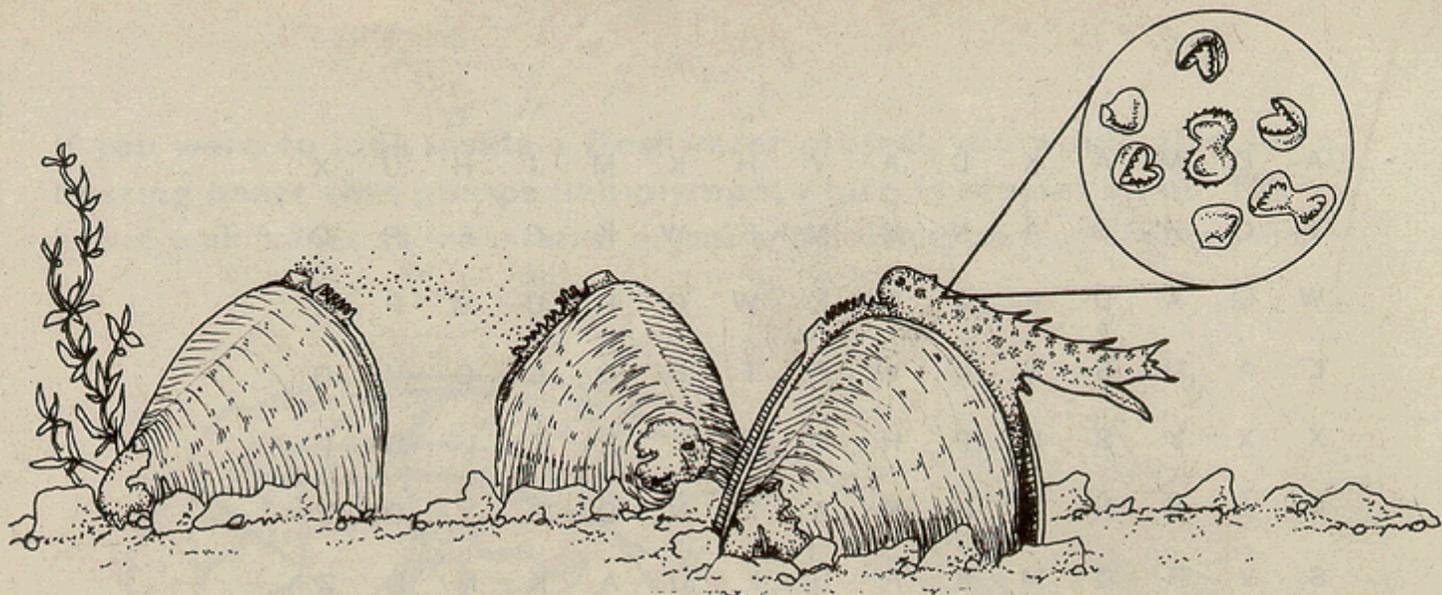
A D M A K D A V H K M J H U X
 T O R G A N S M F W K C E R O
 W M A D F J T E W G P U M P S
 L A U S N I W P T R O L O V G
 X X Y S I P H O N I E T L D I
 M J C N S H N A X N O R Y Q Z
 S V F D M E F U I D A K M D Z
 L Y R E G C L L D E P E P L A
 N S U Y S Q L E B R F O H F R
 H K X Z O A V T D O B U W P D
 E O R H T J H R G I L L S Y S
 N V R S T Y L E O Y C A O N J
 C D Y O H E A R T U P H L O P
 E R V K C B A T H E S D F U D
 C H A L K M J D Y T K M Z S W

FIND THE FOLLOWING WORDS IN THE WORD SEARCH:

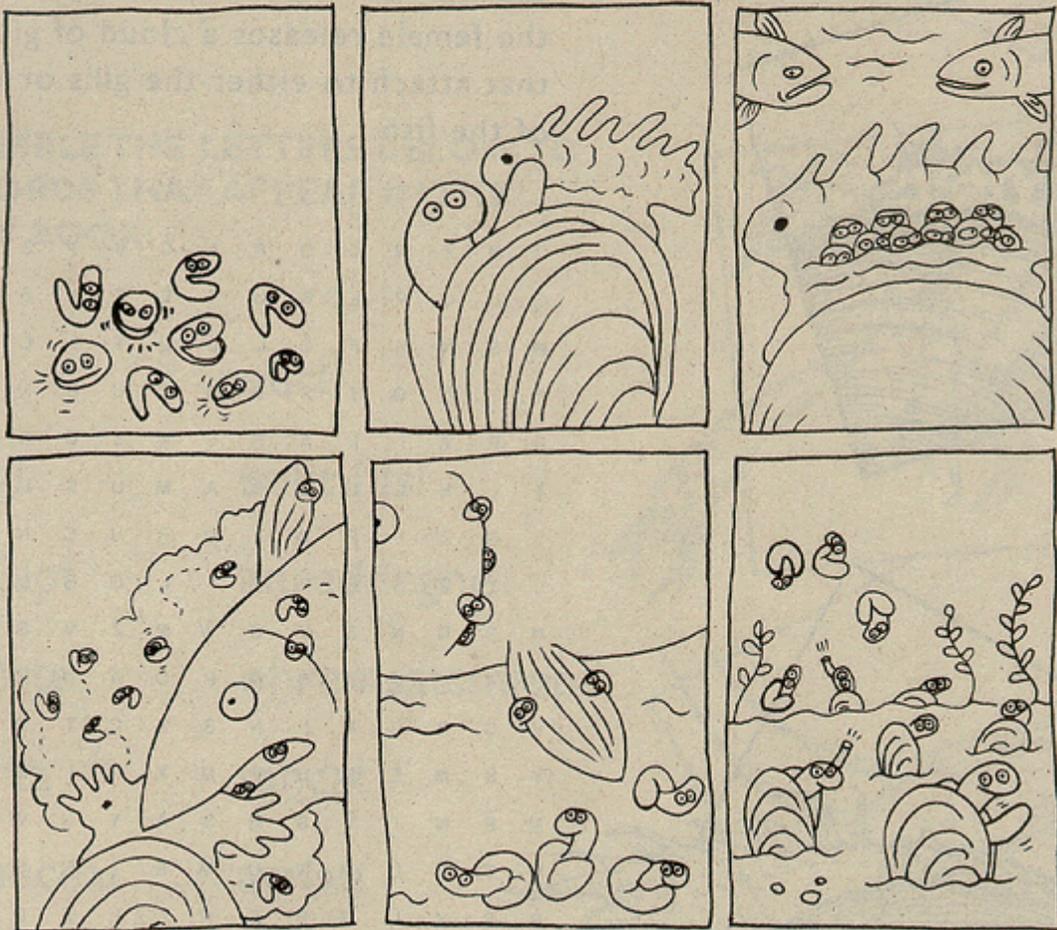
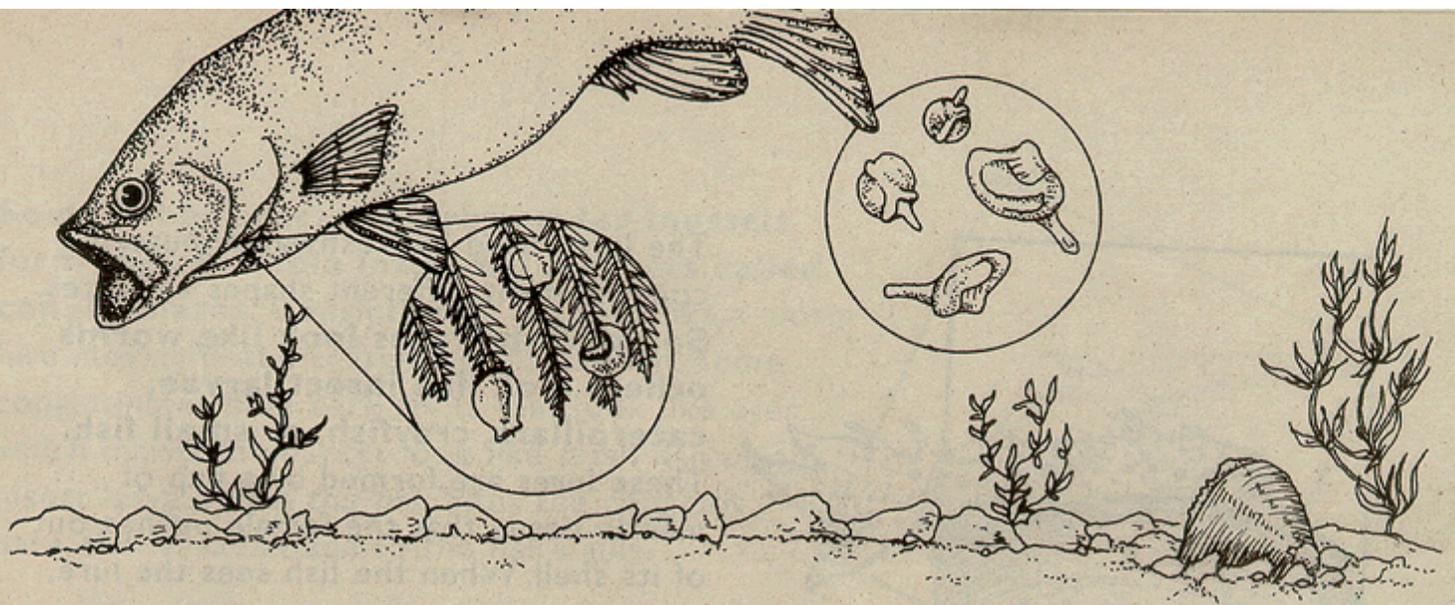
- | | | | |
|--------|-------------|--------|---------|
| MUSSEL | CRYSTALLINE | STYLE | GRINDER |
| PUMPS | HEMOLYMPH | OXYGEN | BATHES |
| ORGANS | GIZZARD | GILLS | HEART |

It takes two; both a male and female mussel must be present for freshwater mussels to reproduce. Unfortunately, in some places there are so few mussels left that it's difficult for them to find each other and produce young.

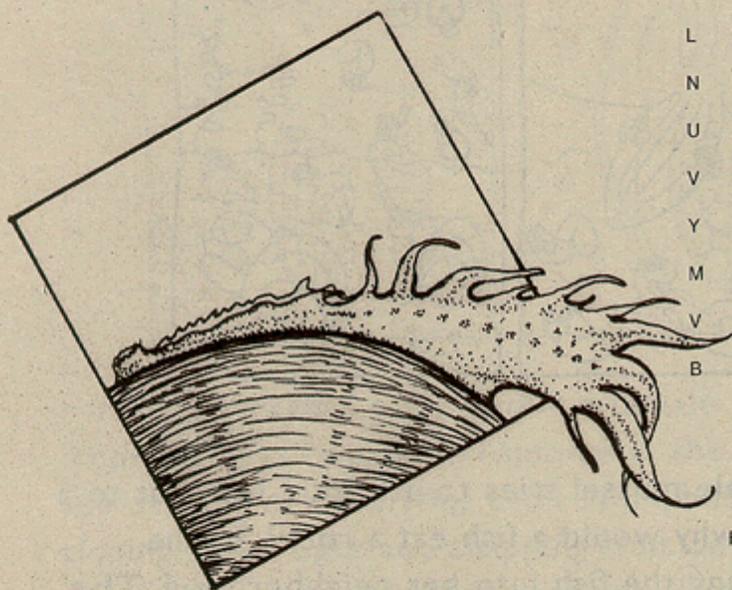
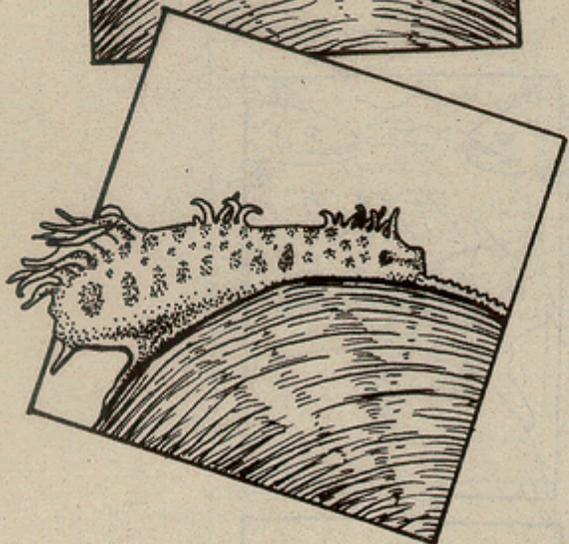
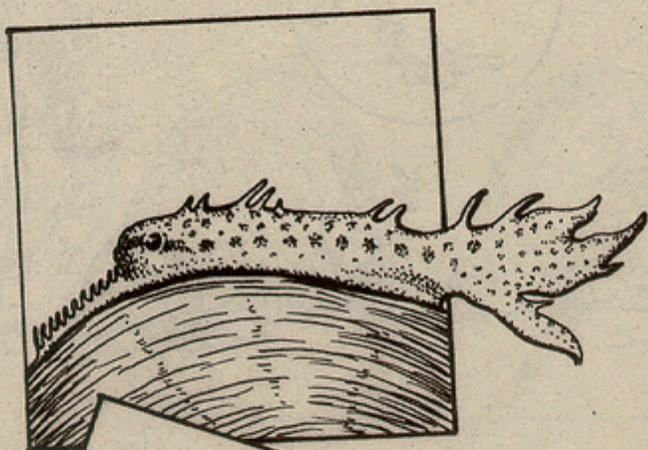




Fertilization takes place within a female mussel. A female mussel holds the fertilized eggs in brood chambers in the gills as they mature into mussel larvae called glochidia. They can't swim, but they can hitch a ride on a fish by closing down tight and snapping shut on the fish's gills or fins. **The glochidia of the majority of species of freshwater mussels must attach to a fish to metamorphose into juvenile mussels.** A metamorphosis is a change in form; similar to the change a caterpillar makes into a butterfly or moth.



When the glochidia are mature, the female mussel tries to attract a fish. But to a fish a mussel must look like a rock, and why would a fish eat a rock? So the female mussel must use something to bring the fish into her neighborhood. **The females of some species of freshwater mussels use a lure to attract fish, the same way you might use a lure if you go fishing.**



The lures used by freshwater mussels come in many different shapes and sizes. **Some of the lures look like worms others look like insect larvae, caterpillars, crayfish, or small fish.** These lures are formed by a flap of mantle tissue that the female pushes out of its shell. When the fish sees the lure, it's attracted to the mussel. When it approaches or tries to swallow the lure, the female releases a cloud of glochidia that attach to either the gills or the fins of the fish.

C N Z N C O P A C V T Z P S T
 Q U O P L B U T E F I S H B G
 W S N B P O L L U T I O N W L
 E T Q G T S E B C U B N R L O
 R P W I L A R V A E O S E T C
 T I E L U U Q A M U S L Y V H
 Y G Z L R W T U R U C N E E I
 L Y B S E R Y I L Q S M I C D
 N P U N S V S W N Z V S E F I
 U A I U P H M P O A N L E Z A
 V C R G M I N S E C T U Y L S
 Y K M E E L P M X N I E O Q S
 M E N T V S R S A Y N W S R C
 V T X L M T U M E A R S T W E
 B S Y I M P E R I L E D X O Y

FIND THE FOLLOWING WORDS IN THE WORD SEARCH ABOVE:

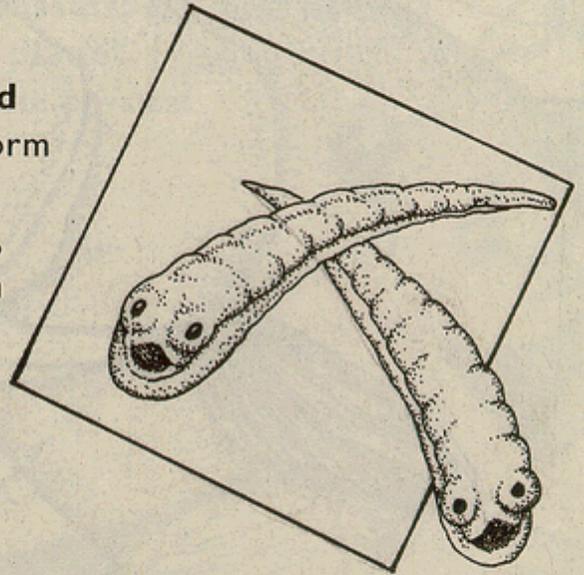
MUSSELS
 GILLS
 FISH

GLOCHIDIA
 FINS
 LURES

PACKETS
 IMPERILED
 INSECT

LARVAE
 POLLUTION
 MANTLE

Some other species of freshwater mussels form the glochidia into small packets called **conglutinates**. Conglutinates also act like a worm lure moving in the current to attract fish. Some conglutinates have dark spots that look like eyes, which makes the packet look like small fish or an insect larva. When the fish bites the conglutinate, the larvae attach to the fish's gills.



UNSCRAMBLE THE LETTERS BELOW TO FORM WORDS THAT APPEAR IN THE ACTIVITY BOOK:

selsum

eurl

ihodcalgi

soht hfsi

eamnlt lapf

anreddegne

hatenderte

ohremsatsmiop

ilareclprta

tahcat

otsntignuceal

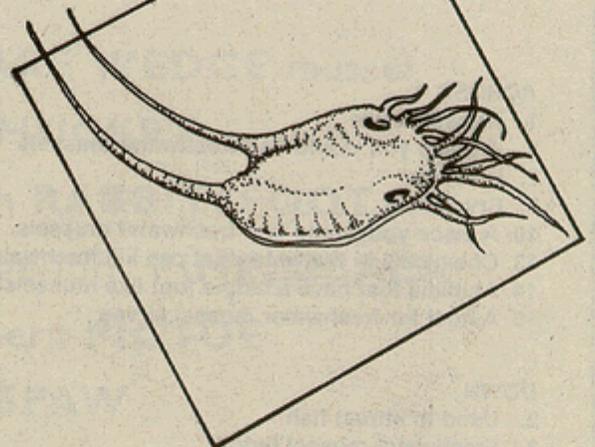
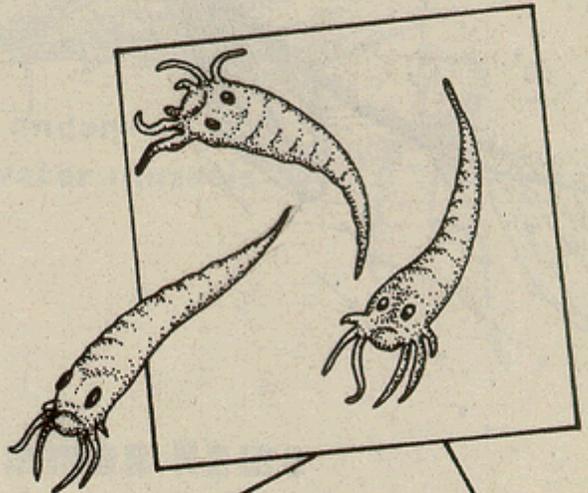
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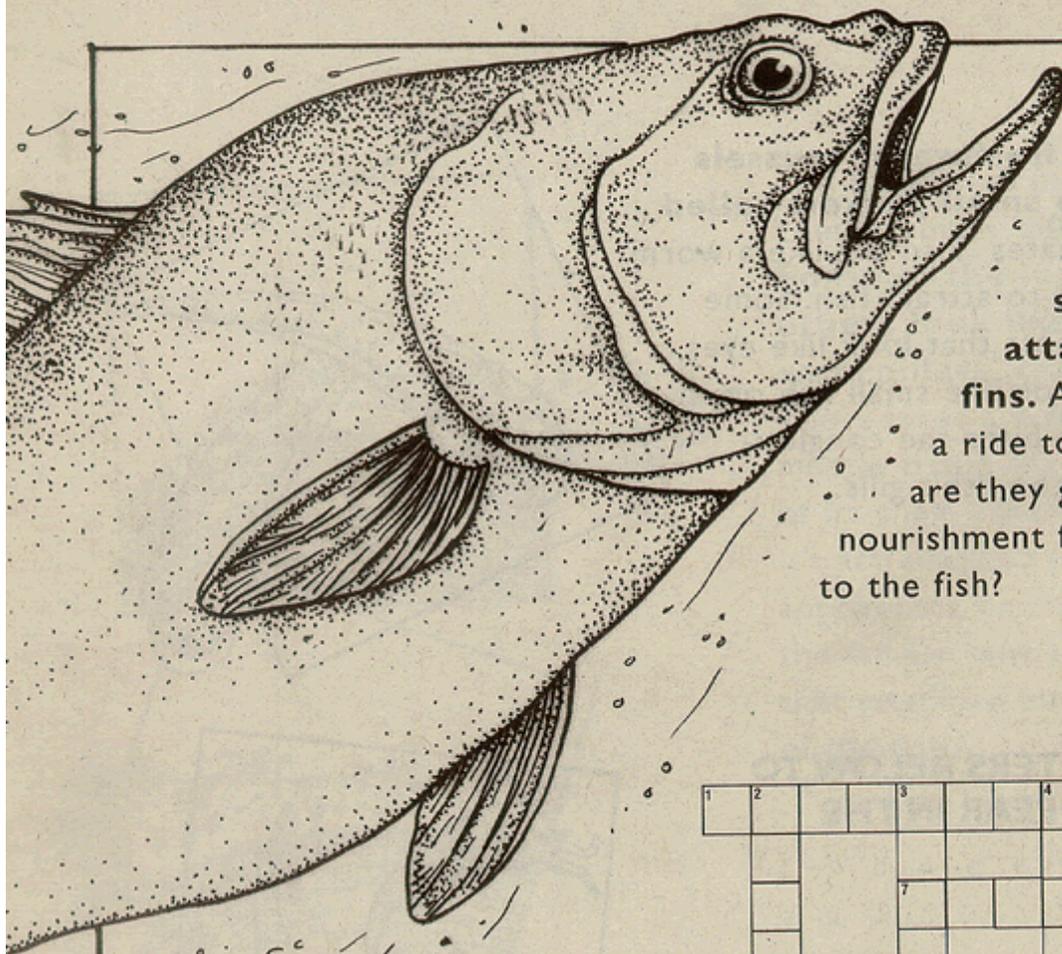
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nsoireo

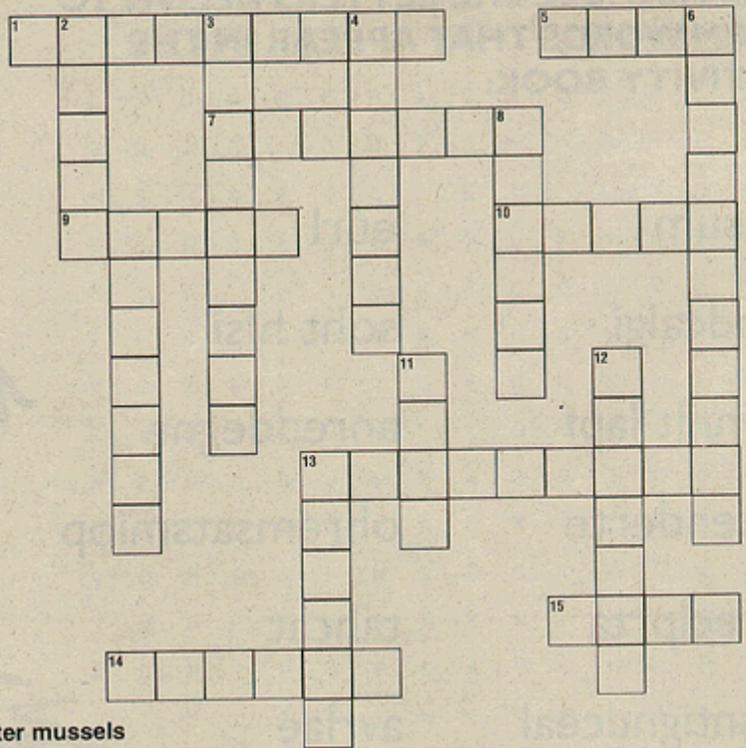
fnfour

esepisc





Nobody is really sure why glochidia attach to fish gills or fins. Are they just catching a ride to a new location? Or are they getting some form of nourishment from being attached to the fish?



ACROSS

1. Mussel larvae
5. A place you would find freshwater mussels
7. Unionids
9. Crystalline _____
10. A place you would find freshwater mussels
13. Chemicals in the water that can kill freshwater mussels
14. Animals that have a single foot like mussels
15. A host for freshwater mussel larvae

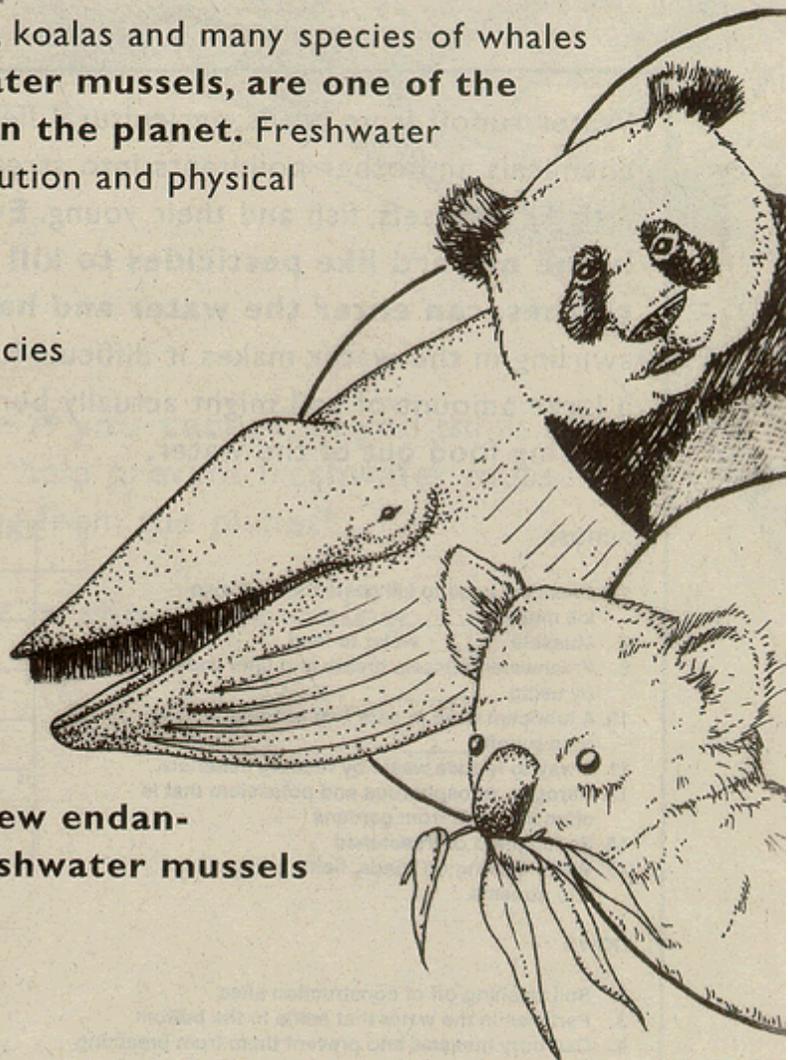
DOWN

2. Used to attract fish
3. Freshwater mussel blood
4. Animals that mussels mimic to attract fish
6. The world (surroundings) in which humans and animal live
8. A place where freshwater mussels live
11. What mussels use to filter the water
12. Another name for freshwater mussels
13. The Latin word Unio means _____ in English

You've probably read about how pandas, koalas and many species of whales are endangered. **But unionids, freshwater mussels, are one of the most imperiled groups of animals on the planet.** Freshwater mussels are disappearing because of pollution and physical changes in their habitat.

More than 70% of freshwater mussel species are imperiled.

Freshwater mussels have unusual and sometimes humorous common names based on a unique characteristic or something the mussel closely resembles. The common and scientific names of a few endangered and threatened species of freshwater mussels are named below:



Scientific Names

(Genus species)

Alasmidonta heterodon

Lampsilis abrupta

Quadrula cylindrica strigillata

Plethobasus cooperianus

Pleurobema plenum

Epioblasma obliquata obliquata

Lasmigona decorata

Elliptio steinstansana

Common Name

DWARF WEDGE mussel

Pink **MUCKET**

Rough **RABBITSFOOT**

Orange-foot **PIMPLEBACK**

Southern **PIGTOE**

CATSPAW

Carolina **HEELSPLITTER**

Tar **SPINYMUSSEL**

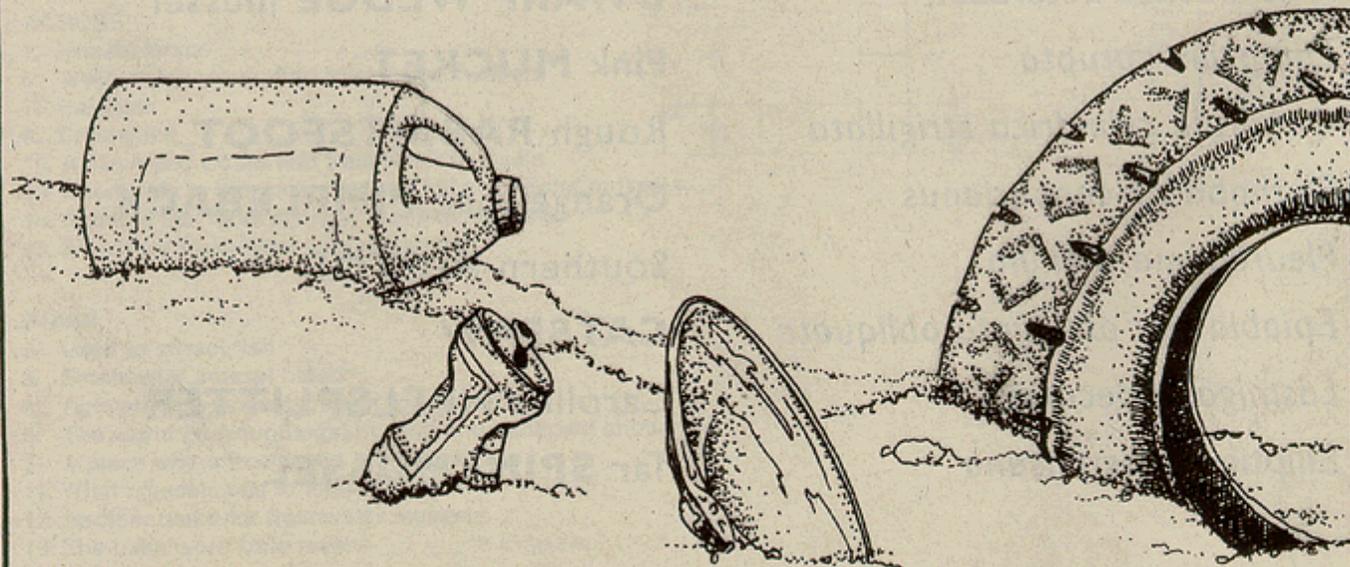
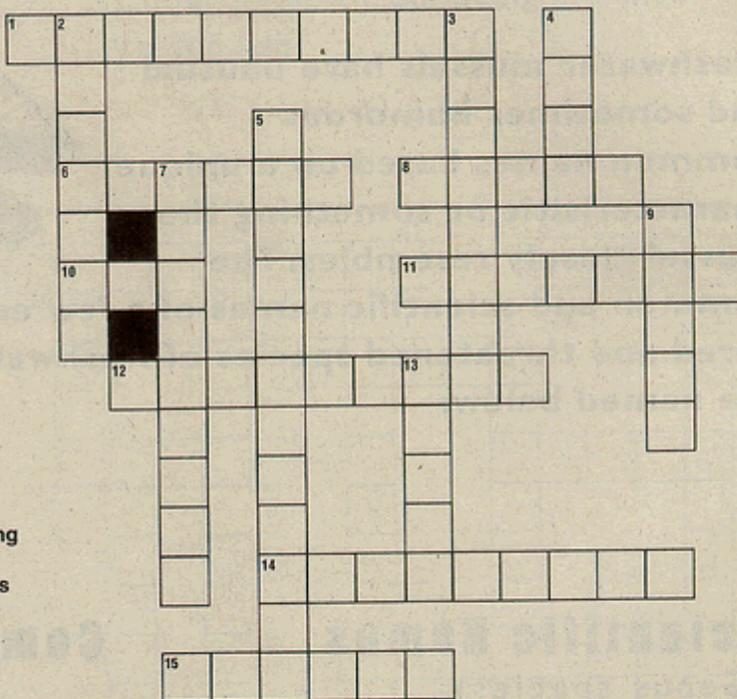
Water runoff from roads, agricultural fields, homes, and businesses often carries chemicals and other pollutants into streams, rivers and lakes. Many of these chemicals kill mussels, fish and their young. **Even chemicals we use in our own home or yard like pesticides to kill insects, or detergents to wash our clothes, can enter the water and harm freshwater mussels.** Eroded soil swirling in the water makes it difficult for mussels to breathe and feed. At times, a large amount of soil might actually bury the mussels and prevent them from filtering food out of the water.

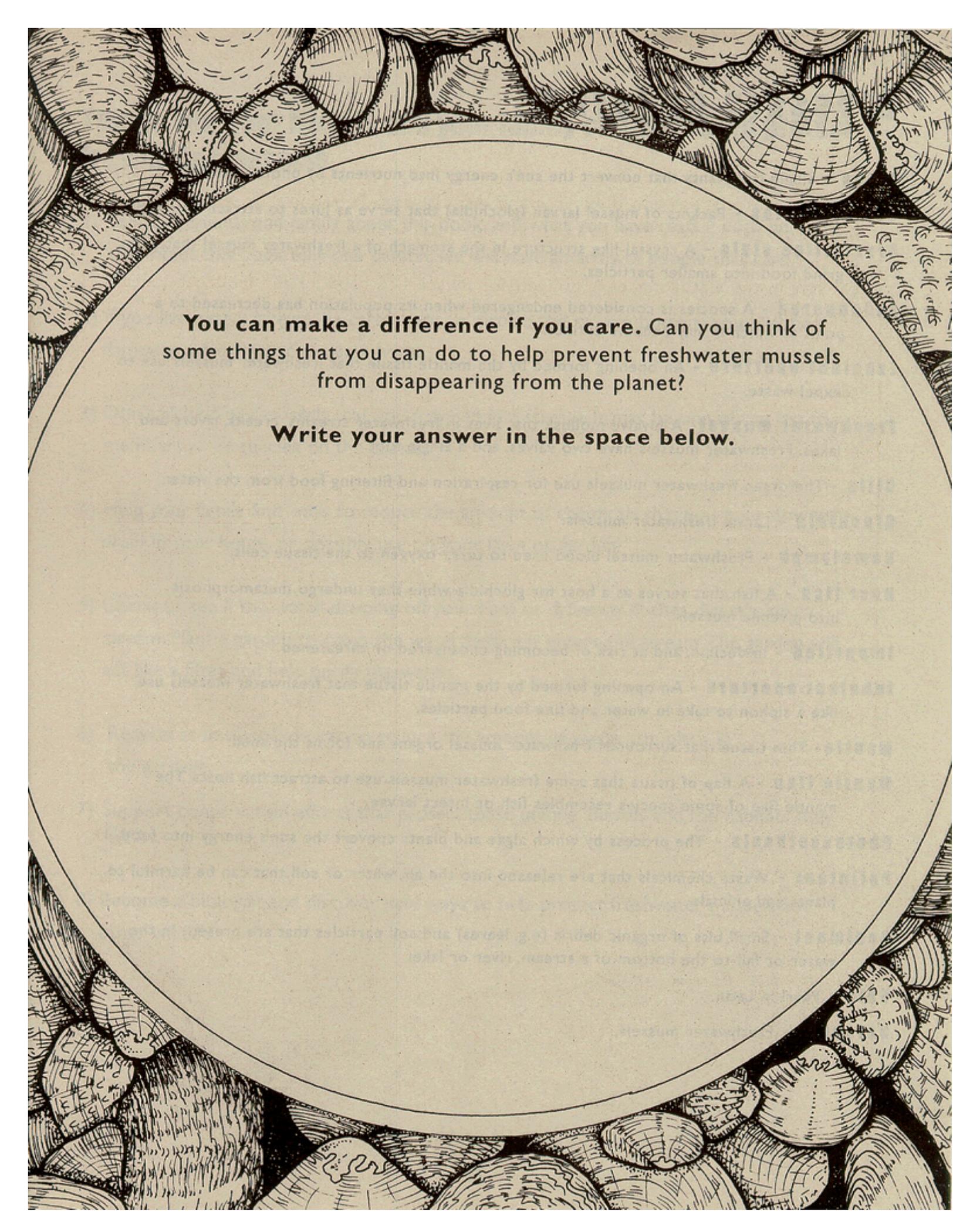
ACROSS

1. Chemical used to kill pests that can also kill mussels _____.
6. Mussels _____ water to feed
8. Freshwater mussels breath and filter water by using _____.
10. A lubricant used in cars that is sometimes in road runoff _____.
11. A way to reduce waste by reusing materials.
12. Nitrogen, phosphorous and potassium that is often in runoff from gardens
14. Endangered or threatened
15. Water moving off roads, fields and gardens into streams

DOWN

2. Soil washing off of construction sites
3. Particles in the water that settle to the bottom
4. Can bury mussels and prevent them from breathing and feeding
5. The _____ of new roads, homes and businesses and frequently causes erosion
7. Waste chemicals that get washed into streams
9. A type of food eaten by freshwater mussels and other bivalves
13. The pearly inside of a freshwater mussel shell





You can make a difference if you care. Can you think of some things that you can do to help prevent freshwater mussels from disappearing from the planet?

Write your answer in the space below.

Glossary of Terms

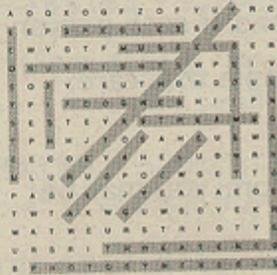
- Algae** - Single cell plants that convert the sun's energy into nutrients by photosynthesis.
- Conglutinates** - Packets of mussel larvae (glochidia) that serve as lures to attract host fish.
- Crystalline style** - A crystal-like structure in the stomach of a freshwater mussel that helps grind food into smaller particles.
- Endangered** - A species is considered endangered when its population has decreased to a point at which it may become extinct.
- Exhalant aperture** - An opening formed by the mantle tissue that freshwater mussels use to expel waste.
- Freshwater mussel** - A bivalve mollusk that lives in freshwater streams, creeks, rivers and lakes. Freshwater mussels have two valves, and a single foot.
- Gills** - The organ freshwater mussels use for respiration and filtering food from the water.
- Glochidia** - Larval freshwater mussels.
- Hemolymph** - Freshwater mussel blood used to carry oxygen to the tissue cells.
- Host fish** - A fish that serves as a host for glochidia while they undergo metamorphosis into juvenile mussels.
- Imperiled** - In decline, and at risk of becoming endangered or threatened.
- Inhalant aperture** - An opening formed by the mantle tissue that freshwater mussels use like a siphon to take in water and fine food particles.
- Mantle** - Thin tissue that surrounds freshwater mussel organs and forms the shell.
- Mantle flap** - A flap of tissue that some freshwater mussels use to attract fish hosts. The mantle flap of some species resembles fish or insect larvae.
- Photosynthesis** - The process by which algae and plants convert the sun's energy into food.
- Pollutant** - Waste chemicals that are released into the air, water or soil that can be harmful to plants and animals.
- Sediment** - Small bits of organic debris (e.g. leaves) and soil particles that are present in the water or fall to the bottom of a stream, river or lake.
- Unio** - Pearl in Latin.
- Unionids** - Freshwater mussels.

Things you, your friends and your family can do to help protect freshwater mussels.

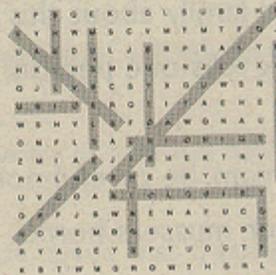
- 1) Tell your friends and family about this book, and what you have read. If each person that reads this book tells one person, we will have an army of people that care.
- 2) If you live near a stream, be careful not to disturb the stream bottom; you may be damaging a freshwater mussel's home.
- 3) Don't pick up any mussels that you may see in a stream. It may be one of the last few members of its species on the planet.
- 4) Help your family find ways to reduce the amount of chemicals that you pour down the drain in your home, or possibly use on your lawn or garden.
- 5) Check to see if the water draining off your roof or driveway flushes directly into a stream. Plant a garden to catch the water before it enters the stream. The garden will act like a filter and help purify the water.
- 6) Recycle as much as you can to reduce the amount of waste you place in the garbage.
- 7) Support conservation efforts that protect these unique animals and the habitats they live in.
- 8) Become a biologist and discover new ways to help protect freshwater mussels and other wildlife.

Key/Answers

Page 5 Answers



Page 7 Answers

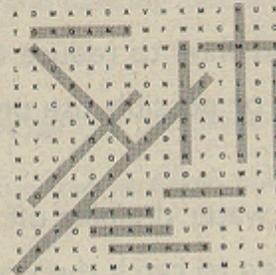


Page 10 Answers

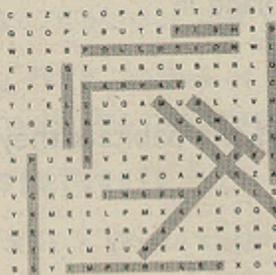
Word Match Key:

- | | |
|-------------------|----------------|
| algae | = mussel food |
| blood | = hemolymph |
| pearl | = unio |
| aperture | = siphon |
| freshwater mussel | = unionid |
| valve | = mussel shell |

Page 13 Answers



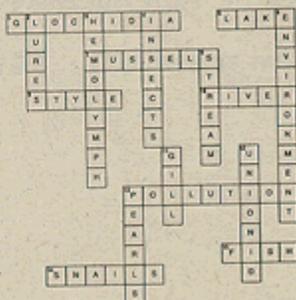
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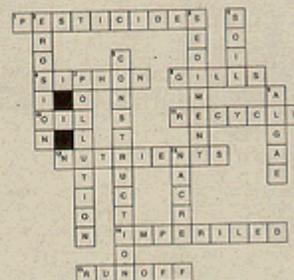
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- | | |
|---------------|---------------|
| mussel | lure |
| glochidia | fish host |
| mantle flap | endangered |
| threatened | metamorphosis |
| caterpillar | attach |
| conglutinates | larvae |
| pollution | erosion |
| runoff | species |

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Contact Info:

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Donations in support of the Partnership's research and conservation activities can be made to: NC Freshwater Mussel Conservation Partnership, NC Veterinary Medical Foundation, Box 8401, Raleigh, NC 27606.

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