How do Polyps Build Reefs?

Coral Reefs (Grade 7)

Lesson Overview

Students will simulate the process that occurs when a coral polyp forms its skeleton. The demonstration will help students understand where polyps get the limestone they need to build their skeletons and the reefs.

Key Concept:

The source of coral rock, calcium carbonate, originates from its dissolved form in seawater.

Lesson Rationale

A coral reef is the only marine biological community, which resists waves and continually grows and aids in maintaining the shoreline. As the reefs are built many small environments are formed.

Teacher's Notes

This activity uses a chemistry demonstration by the teacher to demonstrate the production of coral skeletons.

Time Required:

Two 45-minute class periods, on day apart.

My Notes

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From "Coral Reef Teaching Kit," World Wildlife Fund

ACTIVITY 3

HOW DO POLYPS BUILD REEFS?

GOAL: To help students understand that the source of coral rock, calcium carbonate, originates from its dissolved form in seawater.

OBJECTIVES:

1. Students will be able to explain the role of polyps in transforming calcium carbonate from seawater to coral reef skeletons.

2. Students will be able to define the terms: solid, liquid, gas, and solution.

3. Students will be able to name at least two other coral reef organisms that extract calcium carbonate (limestone) from seawater.

TIME: This activity requires two 45-minute to one-hour periods, a day apart.

MATERIALS REQUIRED:

- Two glasses or jars
- One tablespoon each of flour and sugar
- Spoon, or stirrer or some kind
- Balloon
- One cup, or 250 ml vinegar
- One stick white chalk
- Six teaspoons baking soda
- Two clear glass containers, 250-300 ml (one cup)
- One clear glass container, 500 ml (two cups)
- Coral Reef Coloring book, pages 5-6
- Small paper bag and hammer (or flat rock)
- Marker for glasses (grease pencil, magic marker, or paper labels)
- Blackboard and chalk

TEACHER BACKGROUND:

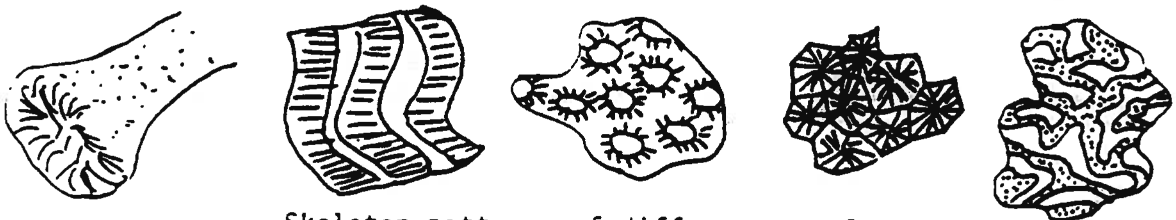
This activity uses a chemistry demonstration to teach about the production of coral skeletons. The demonstration shows students that under certain conditions, solid materials can be extracted from solutions. The source of coral reef skeletons, and therefore reef rocks themselves, is material (calcium and carbonate ions) dissolved in seawater.

The chemical reaction demonstrated here is not the same reaction that occurs in the coral polyp, especially within the algae of its stomach lining. The only purpose of the demonstration is to show that solids can be produced from dissolved substances--as happens in coralpolyps. We imitate rather than duplicate the events in coral. The actual events within coral involve a subtle series of equilibrium reactions:

--Ocean water bears enormous amounts of dissolved limestone (calcium carbonate, or $CaCO_x$), just as we know that it also carries enormous amounts of table salt (sodium chloride, or $NaCl$).

Unlike sodium, calcium combines with carbonate ions to form a relatively insoluble substance, calcium carbonate. This happens only when slight acidity is present.

--Within coraline algae, the correct acid conditions occur for the formation of calcium carbonate. Calcium carbonate is relatively insoluble in water, so it forms a solid and precipitates out. Within the polyp, calcium carbonate is transported from the algae to the polyp's base. There it is laid down in the particular pattern characteristic of that species of coral.



Skeleton patterns of different corals

This reaction is extremely important. Many animal shells, bones and teeth consist primarily of limestone. Major rock formations at the bottom of the sea consist of the same substance. Important limestone beds on land once originated in this way.

Human teeth and bones also consist of calcium carbonate. In fact, a parallel of this activity's demonstration takes place when we do not brush our teeth. Bacteria build up in food deposits on our teeth. They produce mild acids which dissolve the calcium carbonate--just as in the demonstration, vinegar dissolves chalk. The result in our case: dental cavities.

Your students may notice that chalk, teeth, and coral possess different textures, despite being of the same chemical. The students would be correct; calcium carbonate solids are deposited in several ways. Geologists say that each of these is a different mineral, and call each by a different name. Collectively, though, all are forms of calcium carbonate, or limestone. But each mineral acquires its particular texture, hardness, and crystal structure under particular pressures, water availability, and other factors. The limestone mineral we are talking about here is called aragonite.

STUDENT BACKGROUND:

Without its skeleton, a coral polyp would be just a soft, fleshy little animal. But with its skeleton, the polyp is something like a turtle--an animal with a sturdy, built-in shelter. Millions of these rocky shelters eventually add up to tonnes and tonnes of coral reef rock. How, you may wonder, does the polyp build its skeleton? And where does the material to build the rocky skeletons come from?

If you have seen coral rocks, perhaps on the beach, you probably remember that they are white, and harder than cement. You know where cement comes from--a builder mixes it with water and then pours it to harden into bricks, foundations, and other parts of buildings or roads. You also know that nobody took cement out to any coral reef. So where does the rock come from?

Coral reefs grow through two processes. First, baby polyps grow from mature polyps. To learn about how this is done, let us read Page 5 of your coloring book, and look at the drawings on the next page. (Ask one student to read this material aloud.)

The second process of coral reef growth is the slow build-up of rock underneath the polyps. To understand how this is done, first think about the types of substances around us--and reefs.

There are four types of substances: solids, liquids, gases, and solutions.

You probably know about solids. These are "hard" substances--they stay in one place, have a definite shapes, and take up a definite amount of space most of the time. Can you point to a solid? (Pick one, and pass it around. Discuss how it matches the description.)

The second kind of substance is liquids. These are fluid substances. They occupy a definite amount of space, but take the shape of whatever container they happen to be in. Can you name some liquids? (Discuss.)

Then there are gases. Gases fill up their containers--taking all the space they can get. They do not have any particular shape either.

The air we breathe is a mixture of several gases. Oxygen, nitrogen, and carbon dioxide are the most important. (Dip a piece of cloth in liquid ammonia. Wave the cloth around. Tell students that ammonia gas is mixing with air gases. Ask students to raise their hands when they smell the ammonia. Explain that the ammonia will continue to expand until they are all over the room--filling up their container.)

Finally, there are combinations of different solids with solids, liquids with liquids, and gases with gases. These we call solutions. We are most familiar with solutions of solids in liquids. What happen when you stir sugar into water? Or salt in your soup? (Discuss.) Unless you put in too much, the sugar or salt--which are solids--just disappear, don't they? We call this process dissolving.

You know the sugar or salt are still in the water somewhere, because you can still taste them. But you cannot see them any more. Dissolving sugar and water is very different from mixing flour and water. With flour, no matter how much water you add, you will still be able to see tiny white specs of flour--each consisting of millions of molecules of flour solids-- in the water. What you have is just a mixture.

(Demonstrate with tablespoon of flour in a jar of water, and a tablespoon of sugar in another. Ask two students to stir or shake or stir the jars for one minute. Then pass the jars around. Discuss the differences observed in the two jars.

Ask whether the flour specs tend to settle to the bottom. They will. Note that in the sugar solution, the sugar does not settle out.)

The sugar and water jar contains a solution--the product of two or more substances truly dissolving.

Now imagine that you could see the smallest possible "pieces" of water--scientists call them water molecules. If you could see water molecules, they would be moving about, with empty spaces among them. When you put sugar in water, the sugar molecules slip into these empty spaces. They become part of the liquid, unlike the flour.

Now, let us go back to the original question of how coral polyps build reef rock. Sea water has many substances dissolved in it. You know one of them probably, by the taste of seawater. Can anyone name this solid?.....(question) Yes, salt.

Another substance dissolved in sea water is a type of rock called limestone--a chemical called calcium carbonate. Inside coral polyps, something happens to this dissolved limestone. Algae living inside the polyp can change limestone from being dissolved in a liquid to being a solid. The polyp takes this solid and lays it down underneath its body, thus creating its skeleton.

Many plants and animals use limestone in their bodies. You do too. Do you know where? (Discuss) If you said your teeth and your bones are made of calcium carbonate, you are right. On a reef, snails, and clams also use calcium carbonate to build their shells, while fish use it in their bones.

Coral reefs build up tonnes and tonnes of limestone, sometimes building whole islands, and lining the ocean bottom near the shore. Millions of years later, these deposits of limestone may rise and become land. Today, limestone is a valuable mineral, used for the construction of buildings and for many other processes. The creation of limestone is a very important process in nature.

Today's science demonstration will show you the change of dissolved limestone into solid limestone--something like the process that happens when a coral polyp forms its skeleton. The process you will see is much simpler than what really happens in a polyp. But it will help you understand where polyps get the limestone they need to build their skeletons and coral reefs.

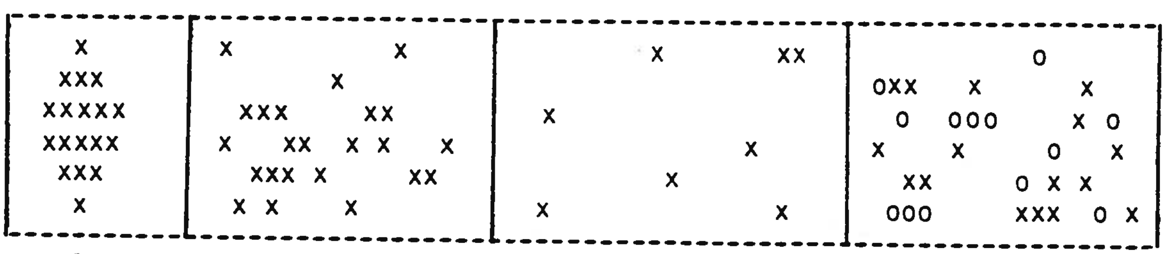
PROCEDURE:

Part 1

1. At the beginning of class, write on the blackboard, "Where does coral reef rock come from? Tell the class that this is the problem for the day. Ask students to speculate as to some answers. Write their ideas on one side of the blackboard.

2. Write four words on the blackboard: Solid, Liquid, Gas, Solution. Read Student Background aloud, discussing as you go along. To illustrate the differences among solids, liquids, and gases, it could helpful to draw these sketches on the blackboard:

(The x's and o's represent molecules of a substance.)



solid iquid gas solution

3. Begin the demonstration by breaking the piece of chalk into pieces. Ask a student volunteer to help. He or she should put the chalk in a paper bag and bang it gently with a hammer. The student should do this until the chalk is reduced to small pieces and powder.

4. Explain that chalk is limestone, or calcium carbonate. Unlike sugar, it dissolves very slowly in water. You are going to dissolve it in vinegar to speed up the dissolving process. (Vinegar is a solution of water and the weak acid, acetic acid.)

5. Pour 250 ml vinegar into a glass. Pour the chalk pieces into the vinegar and stir.

6. Tell the class that you will let the chalk/vinegar preparation sit overnight. (Meanwhile, stir the chalk/vinegar preparation occasionally.)

Part 2

7. When you return to the demonstration, show students that much of the chalk has disappeared. It has dissolved in the liquid. Tell students that sea water is much like this solution, except that seawater has dozens of dissolved solids in it. They already know that salt is one, but others, even gold are dissolved in the sea.

8. Label two clear glasses. The 500 ml (two cup) glass should be "dissolved limestone," and the 250 ml (one cup) glass should be "dissolved baking soda."

9. Into the glass marked " dissolved limestone" carefully pour off the clear liquid from the chalk/vinegar solution.

10. Into an unlabeled glass, pour 250 ml (one cup) water. In it, dissolve the 6 teaspoons of baking soda. Ask a student to stir it for about 15 minutes, or until no trace of solid remains. While doing this, tell students that you are dissolving sodium bicarbonate in this glass of water. Let any remaining solid settle for a few minutes, then pour the clear liquid into the glass labeled "dissolved baking soda."

11. Ask a student volunteer to mix the two solutions. Alert the class to watch closely. What they see will be similar to what happens to seawater when it comes in contact with algae in coral polyps. The student should slowly pour the dissolved baking soda into the dissolved limestone.

12. Students will observe white particles of solid calcium carbonate appear in the clear liquid. Pass the glass around, so that students can see the fine, white powder at the bottom of the glass.

13. Discuss the process with students, making sure that they understand what they have just seen.

14. Explain to students that once the calcium carbonate is formed by algae within the polyp, the polyp's body transports it downward and secretes it as skeleton already lying below. However, the mineral is laid down in a tight crystal formation, rather than as loose particles--as they saw in the demonstration. Also, each type of coral lays down limestone in different shaped skeleton "cups."

In this way, layer upon layer of calcium carbonate build up over the years. Corals build one to two centimeters of skeleton per year.

15. Without algae inside their bodies, polyps would be unable to build up enough skeleton. Explain this to students. Ask them what would happen if a coral polyp settled in very deep water, below the depth reached by sunlight. (They could not build reefs because algae, like all plants, must have sunlight.)

16. Ask students to write two or three paragraphs summarizing (1) what they saw in the demonstration, and (2) how the demonstration resembles the skeleton-building process of corals.

How Do Corals Grow?

A single polyp builds a cup-shaped skeleton around its soft body. This polyp can multiply and eventually form a large mass of coral rock. In most corals, new polyps form by branching off from old polyps. They bud off from their parent much as a bud sprouts from the side of a tree.

As the polyps grow, they build new cup skeletons on top of the old ones. Polyps always grow at the surface of the colony. Below them, layer upon layer of old skeletons make up the coral rock.

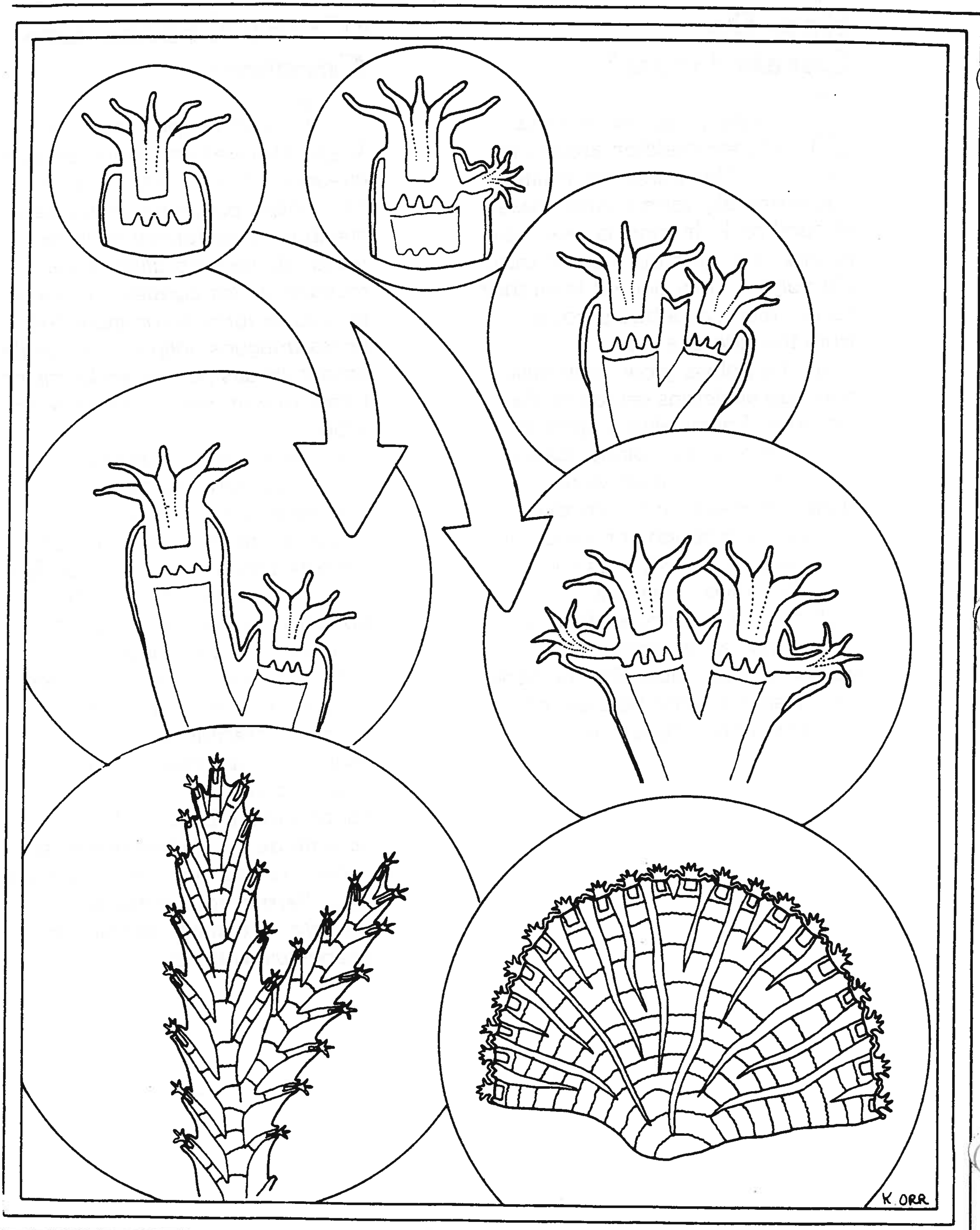
If we cut through coral rock, we see skeleton growth lines showing how the polyps grew and multiplied. The living surface of a hard coral can be green, pink yellow, or even blue. But the coral rock inside is white because only the living polyps have color.

¿Cómo Crecen Los Corales?

Un solo pólipo construye un esqueleto en forma de copa alrededor de su cuerpo blando. Este pólipo puede multiplicarse y eventualmente formar grandes masas de roca coralina. En la mayoría de los corales, los nuevos pólipos se forman ramificándose de los antiguos pólipos. Los corales brotan de sus padres en la misma forma que un retoño brota de un árbol.

A medida que los pólipos crecen, construyen nuevos esqueletos en forma de copa sobre los otros viejos. Los pólipos siempre crecen hacia la superficie de la colonia. Debajo de ellos, capa por capa de esqueletos ayuda a constituir la roca coralina.

Si hacemos un corte a través de la roca coralina, podemos ver líneas de crecimiento de los esqueletos que muestran cómo los pólipos crecieron y se multiplicaron. La superficie viviente de coral duro puede ser verde, rosada, amarillo o inclusive azul. Pero la roca coralina adentro es blanca, porque sólo los pólipos vivos tienen color.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