

The leafy green sea slug is a bit more complicated than scientists thought

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Pictured is the emerald sea slug, *Elysia chlorotica*. EOL Learning and Education Group, via Flickr

Nature is full of thieves. Robber bees raid the hives of other bees and steal their honey. Some ant species kidnap and enslave members of neighboring colonies. Large frigate birds — also called pirate birds — swoop down on smaller seabirds and snatch the fish right out of their beaks.

The sea slugs known as sacoglossans are some of the most remarkable biological burglars on the planet. The animals are about the length of a postage stamp or two. They feed on simple underwater plants known as algae, which have no stems, roots or leaves, but which do contain green-colored chlorophyll.

Chloroplasts Top Sea Slug's Menu

Chlorophyll is used in photosynthesis, a process by which plants capture the sun's energy and combine it with carbon dioxide and water to make food. Oxygen is produced as a result of photosynthesis.

The part of the algae that contains chlorophyll is a jelly bean-shaped structure known as a chloroplast. Most sea slugs digest the chloroplasts right away. However, some species store them for weeks to months in large transparent digestive glands, turning the animals bright green.

For many years, scientists have thought the slugs store chloroplasts in order to become solar-powered combinations of animal and plant. The theory made a lot of sense. Experiments confirmed that, when placed in the light, the slugs actively absorbed carbon dioxide, just like leaves. Furthermore, some of the slugs could stay alive in a well-lit laboratory for months with no food. Besides, why else would the animals go to the trouble of preserving the chloroplasts, if not as a long-term energy source?

A recent study is forcing scientists to completely rethink this idea, however.

Experiment Supports Hibernation Theory

Scientist Sven Gould and his team ran an experiment involving six sacoglossans. None of the slugs were given any food at all for 55 days. Two were given 12 hours of light followed by 12 hours of darkness each day; two lived with the same cycle, but received a drug that prevented photosynthesis; and the remaining two slugs lived in continuous darkness.

At the end of the starvation period, all the slugs were still alive. They were all equally pale and all had lost about the same amount of weight. It was clear that their health and ability to survive did not depend on whether they could photosynthesize.

"It's very appealing to think that here you have an animal slowly turning into plant," Gould said. However, he says, his experiment proves that nothing like that is going on.

Gould's theory is that the slugs are just doing something lots of critters do: saving some of the food they collect for times of hardship.

Some sacoglossans hibernate in the winter, after burrowing into the bottom of the ocean floor. Sunlight would not help them endure this subterranean slumber. A digestive sac full of chloroplasts would do the trick, however.

If that is what is going on it would explain how the slugs in Gould's experiment made it through nearly two months of perpetual night without being given any food. It would also explain why all the slugs ended up pale and shrunken.

Many Shades Of Green

Even if these slugs are not relying on photosynthesis for nutrition, they might be using some of the oxygen produced by the process. If so, they would resemble the spotted salamander.

A species of algae lives inside the eggs of the spotted salamander. Over time, the animal and plant have evolved a symbiotic relationship, in which each needs the other. Inside the eggs, developing salamanders breathe in the oxygen the algae release, while the plants take in the carbon dioxide the salamanders breathe out.

There are several other possible explanations for the slugs' green coloration. Perhaps some of the slugs are camouflaging themselves — after all, they spend a lot of time sitting on green plants. Or maybe the green coloring is used to attract mates.

The relationship between sacoglossans and chloroplasts could also be much more symbiotic than it appears. Perhaps, once consumed, the chloroplasts continue to behave the way they would inside an alga. The slugs could be taking advantage of this to get a few weeks or months of free oxygen. For their part, the chloroplasts might be getting carbon dioxide out of the deal, until the slugs double-cross them and digest them properly.

Research Uncovers More Questions

Research by scientist Mary Rumpho raises further questions about just what is going on. Rumpho studies *E. chlorotica*, an emerald-green sea slug species. *E. chlorotica* seems to be so dependent on algae that if baby slugs are not exposed to it for at least seven days, they will stop growing and die.

The chloroplasts *E. chlorotica* captures from the algae it eats primarily make lipids, which provide both energy and building materials for cells. A young slug needs lipids to grow rapidly, and in most species the slug's own body has to

produce these lipids. What if *E. chlorotica* has handed over its lipid production to chloroplasts? If so, captive chloroplasts would be so much more than stored food. They would be almost a part of a slug's body, as important as its heart or brain.

Quiz

1 Which two of the following sentences contain ideas that should be included in a summary of the article?

1. *The sea slugs known as sacoglossans are some of the most remarkable biological burglars on the planet.*
2. *Chlorophyll is used in photosynthesis, a process by which plants capture the sun's energy and combine it with carbon dioxide and water to make food.*
3. *Gould's theory is that the slugs are just doing something lots of critters do: saving some of the food they collect for times of hardship.*
4. *The chloroplasts *E. chlorotica* captures from the algae it eats primarily make lipids, which provide both energy and building materials for cells.*

- (A) 1 and 2
(B) 3 and 4
(C) 1 and 3
(D) 2 and 4

2 Read the section "Chloroplasts Top Sea Slug's Menu." How is the CENTRAL idea developed in this section?

- (A) by explaining how chlorophyll is used in photosynthesis
(B) by describing how algae use chlorophyll to make food
(C) by describing a theory that scientists used to think explained slugs' behavior
(D) by explaining why a recent study forced scientists to rethink an theory

- 3 Read the section "Many Shades Of Green." Is the relationship between slugs and chloroplasts clearly understood?
- (A) Yes; slugs store the chloroplasts and digest them during times of hardship.
 - (B) Yes; slugs rely on oxygen released by the chloroplasts to survive.
 - (C) No; scientists have new theories on some elements of this relationship, but many aspects of it are still unknown.
 - (D) No; a recent study disproved a common theory, but little new information was discovered.
- 4 Which of the following answer choices describes the MOST significant finding of Gould's study?
- (A) All of the slugs survived 55 days without food.
 - (B) All of the slugs who received 12 hours of light per day survived.
 - (C) All of the slugs, regardless of being in dark or light, survived.
 - (D) All of the slugs lost weight but survived.