Shape of Life

Shell Shocked

Middle School Student Edition

Lab Activity: Gastropods vs. Shell-breaking Predators

Lesson by Kevin Goff

Few things in nature are as beautiful and fascinating as seashells, with their graceful spirals, marvelous shapes, and dazzling colors. However, the handsome homes of snails (gastropods) are built only at great cost. Creating a shell requires a huge investment of energy and building materials, so there must be a big payoff for the snail. That payoff, of course, is protection. Snails build their expensive shells not for beauty, but to defend their soft bodies against the sharp claws of hungry crabs and lobsters, and the strong jaws of predatory fish.

VIDEOS TO WATCH

- **"Geerat Vermeij, Evolutionary Biologist: Reading A Shell's Story" (7.5 min; on the "Scientists" page)**
- **"Mollusc Animation: Shell Repair" (1.5 min; on the "Animation" page). A quick piece on how molluscs manufacture and repair their shells.**
- **"Molluscs: The Survival Game" (15 min; on the "Phyla" page)**

Here are some good shell designs and traits for thwarting predators:

- **Thick walls** – stout, heavy armor is the most basic defense, but costly to build
- **Protrusions** – spikes and spines, flanges and fronds: these extensions are an economical way to distance claws and jaws from the central cockpit where the soft animal resides; they also make for an uncomfortable mouthful
- **High Spires** – the shells of most snails are twisted, but some are "flat" coils whereas others spiral out to a tall point like soft-serve ice cream; the latter are harder to swallow and also put some distance between the attacker and the wider part of the shell that houses the snail
- **Narrow Aperture** – the shell's opening is the place most vulnerable to attacks; a slit-like opening is tougher for predators to infiltrate
- **Long Siphonal Canal** – Many snails posses a **siphon**, a snorkel that sticks out into the water through a **siphonal canal** in the shell. They use the siphon to bring water in over their gills and also to taste the water. A long, slender siphonal canal is less vulnerable to entry by predators, and also permits the snail to burrow without suffocating
- **Thickened aperture margins** – the outer rim or "lip" of the aperture is especially vulnerable to the shell-breaking grip of attackers; the thicker the better

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Your Mission: Study the armor from different species of gastropods. Grade each one (A, B, C, D, F) on each of the six defensive traits and fill out the report card below.

Species	Shell Thickness	Protrusions	High Spire	Narrow Aperture	Long Canal	Thickened Margins	**GPA**

Who's the valedictorian (top of the class)?

The salutatorian (2nd highest)?

Sweat hogs (bottom of the class)?

Class clown (weirdest)?

Homecoming queen (prettiest)?

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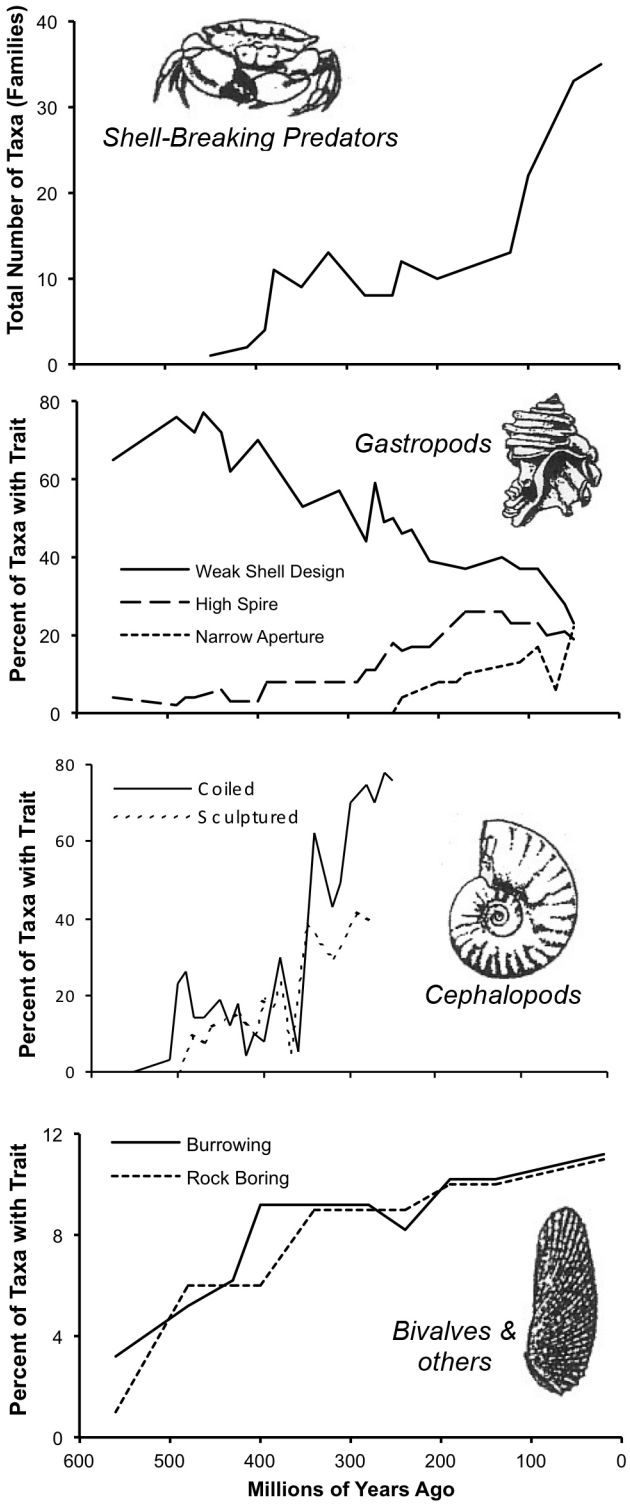

One nice thing about seashells is that they preserve well as fossils. So do the hard claws, jaws, and teeth of shell-breaking predators.

Geerat Vermeij (say “ver-MAY”) is probably the paleontologist who has done the most careful surveys of fossilized seashells. His renowned studies are especially remarkable because he’s been blind since birth. He collected all his data (tons of it) by studying the fossils with his hands!

The graphs on page 3 show data from Vermeij’s research. All four graphs share the same x-axis at the very bottom: Vermeij studied fossils spanning over 500 million years! Analyze the graphs carefully and answer the following questions.

The first graph (Shell-breaking Predators) shows the number of fossilized predators that had claws or jaws powerful enough to break seashells. ***How long ago did predators first develop shell-breaking traits? Since then, what has happened to the frequency of these traits in the fossil record?***

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The next three graphs (Gastropods, Cephalopods, Bivalves) show three different groups of soft-bodied, shell-making animals. **Gastropods** were snails that crept on the seafloor. **Cephalopods** were swimmers: By collecting gas inside their shells, they could float above the seafloor and swim! **Bivalves** have two hinged shells that open and close like a jewelry box. Modern bivalves include clams and oysters.

Over the past 500 million years, what gradually happened to the design of gastropod shells?

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A coiled shell gives a soft animal a bigger space to retreat into. “Sculptured” shells have ribs and ridges that reinforce the shell, or bumps and spines that make it hard to swallow. For cephalopods, what pattern do we see in the fossil record?

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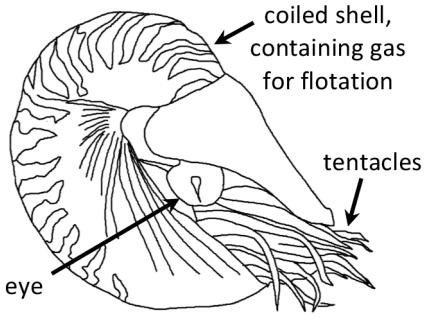
(NOTE: On the graph it looks like cephalopods suddenly went extinct 250 million years ago. This graph represents a group that went extinct 250 million years. Other groups continued. The ancestors of the squid and octopi won the day by evolving into the modern day animals. An exception is the living chambered nautilus, which has a squid-like body with eyes and arms, yet has kept its coiled shell and sluggish lifestyle.)



Chambered Nautilus, a modern cephalopod

Some modern bivalves – like clams – burrow into the seafloor. Others – like oysters – do not. Over the past 500 million years, what trend do we see in such behaviors?

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What do you think prompted all these changes in the bodies and behaviors of gastropods, cephalopods, and bivalves over the past 500 million years? Back up your hypothesis with evidence from the four graphs.

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