Phylum Mollusca: Shell Shocked

High School Student Edition

Lab Activity: Gastropods vs. Shell-breaking Predators

Lesson by Kevin Goff

Shape of Life

Few things in nature are more beautiful or more fascinating than the elaborately whorled, sculpted, and ornamented shells of gastropods. As with all attractive real estate, however, the handsome homes of snails are built only at great expense. The building of a shell requires a substantial investment of caloric and chemical resources – something natural selection would not allow unless there were some payoff. That payoff, of course, is protection. The graceful beauty of seashells disguises their real function: their sophisticated shapes have evolved for defense against the shell-breaking claws of crabs and lobsters; the shell-crushing jaws of fish; and the shell-drilling radulas of other snails.

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 foiling would-be 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 possess 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. 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?

The salutatorian?

Sweat hogs (bottom of the class)?

Class clown (weirdest)?

Homecoming queen (prettiest)?

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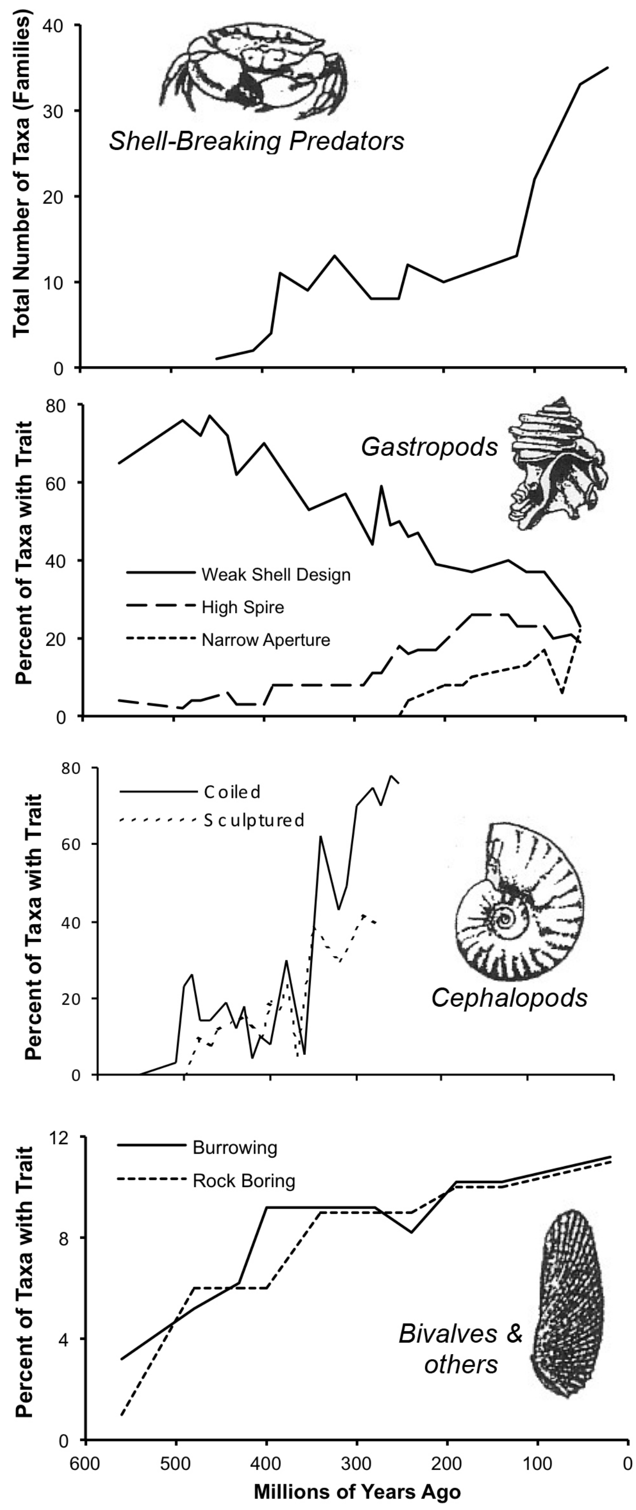

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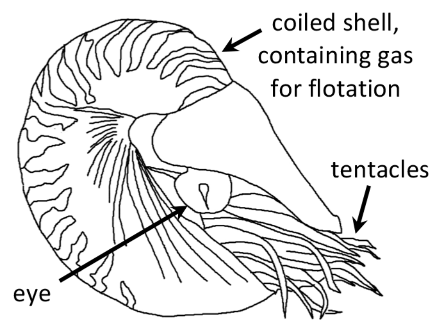
One nice thing about seashells is that they preserve well as fossils. So do the hard claws, jaws, and teeth of shell-breaking predators. Geerat Vermeij (say "ver-MAY"), of the University of California at Davis, is probably the paleontologist who has done the most careful and thorough surveys of fossilized shells. 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 and offer a thorough, thoughtful interpretation of Vermeij's results. Write your answer on the page below this section as a meaty paragraph in complete sentences. A good answer will describe the long-term trends for all four groups of fossils and propose an explanation for them. What do you think prompted the changes? Back up your ideas with evidence from the four graphs.

Gastropods were snails that crept along the seafloor, foraging for food.

Cephalopods were close relatives of snails, but many became swimmers: By collecting gas inside their shells, they could float above the seafloor and swim! 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. (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

Bivalves were also close relatives of snails, but with two hinged shells that open and close like a jewelry box. Some modern bivalves – like clams – burrow into the seafloor. Others – like oysters – do not.

One of the "big patterns" we often see in evolution is a phenomenon known as Coevolution (others include divergent, convergent, and parallel evolution). **Coevolution** occurs when different species interact with one another in a way that results in reciprocal adaptation. That is, they impose natural selection on each other. How does Vermeij's data exhibit this phenomenon (hint: think "arms race")?

Your Answer (paragraph form with complete sentences, please):