Biotechnology

The shell in the soap

Glue? Maybe. Stew? Definitely. But it's hard to imagine the eastern oyster having anything to do with detergents and disposable diapers. Those two commercial applications are in the works, however, inspired by a study of how the oyster makes its shell.

Like bones and teeth, oyster shell is a structure of mineralized calcium bound with protein. Dissolve the calcium, and what's left is a gel. In the early 1980s, biologist Hap Wheeler of Clemson (S.C.) University found the gel to be a mixture of large and small proteins containing chains, or polymers, of an amino acid called aspartic acid. It's an unusual amino acid because it holds a negative charge—a particularly important property when the amino acid is linked into a polymer, says Wheeler. He spoke at a marine biotechnology briefing in Washington, D.C., earlier this month.

In the oyster, proteins that bristle with negatively charged polyaspartic acid control the growth of the shell. They attract the positively charged calcium and hold it in place. Manufacturers add similar polyanions—agents with many negative charges—to detergents to attract and hold particles of dirt. The dirt then stays suspended in the wash water "instead of landing on your clothes," says Wheeler.

Existing polymers used in laundry and dishwashing detergents and other applications don't break down easily. Polyacrylic acid, for example, has a hard-to-degrade carbon-carbon backbone. In laboratory tests, however, bacteria attacked the amino acid bonds of the oyster polymer; field tests are now underway.

"The polymer is biodegradable," declares Wheeler. That's why the oyster-inspired polymer spawned the start-up of the Donlar Corp. in Bedford Park, Ill., in 1990. The company does not harvest oyster shells for production. Instead, it begins with powdered aspartic acid, which is heated and modified to form the polymer (SN: 7/13/96, p. 22).

The oyster shell proteins also absorb water. Wheeler says this property may make the shell less brittle in the same way that collagen strengthens bone. He and his colleagues have found that polyaspartic acid can absorb up to 80 times its weight in water, making it at least modestly competitive with the nondegradable superabsorbent gels now used in disposable diapers and other products.

The search for biodegradable polymers is attracting much commercial interest, says biochemist Barry Marrs of Kennett Square, Pa., who is on an industrial biotechnology task force for the United Nations' Organization for Economic Cooperation and Development, headquartered in Paris.

"Polyaspartic acids are very nicely functional," he says, although he points out that Donlar's industrial version is not the same as the oyster's and probably is not as biodegradable. "But I do believe it is an advance" over the nondegradable commercial polymers widely used for detergents and absorbents. Hundreds of millions of tons of them find their way into household products each year, according to Wheeler.

While developing uses for its polymer in detergents and superabsorbents, Donlar began marketing it for another use—as a fertilizer additive. The polymer seems to enhance plant growth, presumably by attracting positively charged soil nutrients that the roots absorb. Polyaspartic acid has also been put to work in controlling corrosion (SN: 5/4/91, p. 287). — *C.M.*

Wheeler

The gel-like protein that cements the minerals in an oyster shell can be scraped off as the shell is slowly dissolved.

Earth Science

Deep sea not immune to climate change

Stability breeds success, or so say scientists who study the teeming creatures of the deep sea. Life in many forms thrives near the ocean bottom, according to ecological theory, because thousands of kilometers of water protect organisms there from the vicissitudes of climate at Earth's surface. Now, a new study of fossil crustaceans sinks that stability theory.

Deep-sea communities suffered dramatic declines during the ice ages, two scientists report in the Feb. 13 NATURE. Thomas M. Cronin of the U.S. Geological Survey in Reston, Va., and Maureen E. Raymo of the Massachusetts Institute of Technology studied a group of tiny crustaceans called ostracods. By analyzing cores of sediments drilled from the floor of the North Atlantic Ocean, the researchers could track how the deep-sea ostracod community fared as the ice ages waxed and waned between 2.85 and 2.40 million years ago.

Contrary to the theory of ocean floor stability, the diversity of species rose and fell in sync with the glacial cycle. While 15 to 20 ostracod species inhabited the depths during warm times, only 2 or 3 species remained during the ice ages.

Cronin and Raymo surmise that food, rather than temperature, forced the changes in the ostracod community. Ice age conditions inhibited the growth of plankton at the sea surface, reducing the amount that sank to the deep sea. Ostracods may have spent the ice ages in shallower waters and then returned to the deep sea for the warm interglacial periods.

The scientists conclude that the abyssal ocean may not be immune to the effects of future global warming, as some researchers have suggested. "It really says there's nowhere on this Earth where you will be insulated from the effects of global climate change," says Raymo. — *R.M.*

Could gas blast have warmed globe?

A little over 55 million years ago, Earth spiked a fever. In less than 1,000 years—a geologic instant—the temperature of the planet climbed markedly, allowing land creatures to migrate across formerly frigid Arctic territory. The causes of this warming at the end of the Paleocene period have remained obscure, but three scientists think that the answer lurks beneath the soft ooze of the ocean floor.

Vast deposits of frozen natural gas—known as methane hydrates—are buried in sea-bottom sediments surrounding the continents (SN: 11/9/96, p. 298). If similar methane deposits melted during the Paleocene and altered Earth's atmosphere, they could have warmed the climate, propose Gerald R. Dickens and his coworkers at the University of Michigan in Ann Arbor. The release of the methane could also explain a peculiar change in the ocean's chemistry at the time.

To test their idea, the scientists used a computer model to simulate the effects of melting 1.12 trillion tons of methane hydrates over 1,000 years. This amount equals one-tenth of the methane hydrate deposits estimated to exist today.

In the model, much of the released methane gets oxidized, forming carbon dioxide. The buildup of this heat-trapping gas in the air causes global temperatures to rise by 1.7°C to 1.9°C. In addition, the carbon chemistry of the ocean shifts. Because methane hydrate is rich in isotopically light carbon-12, the methane temporarily floods the ocean with extra carbon-12, the scientists report in the March GEOLOGY.

Seafloor sediments from the Paleocene contain evidence of a carbon-12 influx, but oceanographers have lacked a satisfactory explanation for the isotope changes, says James P. Kennett of the University of California, Santa Barbara. He views the methane hydrate theory as a good candidate for explaining the warming and the chemical changes. "I think they're on the right track," he says. — *R.M.*