BIOLOGY

Sequencing Sea World

A GENETIC CENSUS OF THE OCEAN'S PRIMARY PREDATORS BY CHRISTINA REED

When biologists from the University of Connecticut wanted to take their laboratory's $85,000 DNA sequencer out to the Sargasso Sea in the Atlantic, the manufacturer, Applied Biosystems, balked. The warranty did not cover oceanographic expeditions. Even J. Craig Venter, famous for his role in decoding the human genome, had frozen his microbial samples from the Sargasso Sea for sequencing back on shore. His results showed that the surface water in the balmy sea around Bermuda teems with genetic material. The biologists from Connecticut wanted to go deeper into the ocean—and go beyond microbes—to test for diversity among the animals at the base of the food web. Working with a sequencer at sea would give them the best results.

The researchers are part of the Census of Marine Life, an international network of marine scientists that began a mission in 2000 to identify every living creature in the ocean by 2010. To this end, Peter Wiebe of the Woods Hole Oceanographic Institution designed a filter system of fine-mesh nets on a deepwater trawl. Onboard the National Oceanic and Atmospheric Administration's *Ronald H. Brown,* Wiebe, the chief scientist, and his team used the net device to scour the Sargasso Sea. Lashed down with a bungee cord in an air-conditioned room sat a brand-new, 140-kilogram DNA sequencer. Theirs was the first expedition to identify marine animals from 5,000 meters deep and sequence their gene markers, or "bar codes," while on the ship.

Ann Bucklin, director of the Marine Sciences and Technology Center at the University of Connecticut, presented the preliminary results in Amsterdam on May 15. She says this research will provide a baseline for measuring how pollution, overfishing, climate change and other human activity affect zooplankton and their environment.

During the 20-day expedition, 28 experts from 14 nations collected 1,000 individual specimens, including 120 species of fish, some new to science, and hundreds of species of zooplankton. Zooplankton are

JELLYFISH RELATIVE siphonophore is actually a colony of animals. Some individuals attract and sting prey; others propel the colony. The genes of this and all marine creatures may be sequenced by 2010.

LARRY MADIN *Woods Hole Oceanographic Institution*

the drifting and swimming animals first in line to eat algae and other plant life, called phytoplankton. They also eat one another, and some can even take down small fish. Many organisms that spend their adult life stuck on the bottom of the seafloor start out as zooplankton in their larval stage. Whatever happens to zooplankton in the ocean has an immediate impact on the rest of the marine food web.

To examine the collected critters, marine scientists immediately rinsed the gooey and translucent mess of life-forms from the filters into buckets of cold water to keep as many animals as possible alive for visual identification. Change in pressure is not a problem for most of these grazers, which can descend hundreds of meters deep during the day. At night they rise back up near the surface to feed, treading carefully near the thermocline, the distinct boundary between the deeper, colder water and the warmer surface water. A change in temperature from near freezing to bathtub-water warm can kill the temperature-sensitive creatures.

NEED TO KNOW: GAS ATTACK

The increase in carbon dioxide in the atmosphere can alter ocean life. But just how much of an impact it will have is unknown. In the "deep open-ocean ecosystem, we have no idea how much is taking place," says Peter Wiebe of the Woods Hole Oceanographic Institution. A significant number of zooplankton and other sea life rely on very thin calcium carbonate shells, and changes in the pH caused by carbon dioxide, which is slightly acidic, can have severe consequences. "We need a good catalogue to see if something has changed," Wiebe adds. "We are charting the plankton in the sea like astronomers chart the stars in the sky."

When the animals die, they turn opaque and lose color as their proteins and DNA break down. Most zooplankton species are known from samples collected less than 1,000 meters deep. During this expedition, the scientists started at the surface and continued collecting throughout the water column at every 1,000 meters of depth.

The expedition was unique in having taxonomists working over the microscopes side by side with the molecular biologists preparing the species for sequencing. "These historically non-overlapping skill sets mean that organisms collected for identification often aren't preserved in a way that permits DNA extraction," says Rob Jennings, a postdoctoral fellow at the University of Connecticut. This expedition changed that. "Training scientists to be adept at both taxonomic identification and DNA-based analysis is one of the top goals" of the project, he adds.

By the time they returned to port on April 30, the scientists had catalogued 500 animals and genetically bar-coded 220 of them. By 2010 the Census of Marine Life scientists expect to have bar-coded all 6,800 known species of zooplankton and potentially that many as yet undiscovered species as well.

Christina Reed, a freelance science journalist based in Seattle, writes frequently about ocean science.

ASTRONOMY

Venus de Seismo

NEW ORBITER BEGINS TO LISTEN FOR VENUSQUAKES BY GEORGE MUSSER

Around 500 million years ago, something awful seems to have happened on Venus. Maybe in spurts or maybe all at once, a fury of volcanism paved over nearly the entire surface. Some scientists think Earth's planetary sister could have supported life for billions of years, yet scarcely a trace now remains of that lost world. To fathom why a planet would have done such a thing to itself, researchers need to know its inner torment.

"Unraveling the mystery of why terrestrial planets evolve the way they do really requires that we understand the interior structure of Venus," says planetary scientist Ellen Stofan of Proxemy Research, an institute based in Laytonsville, Md. "This question links strongly back to the whole issue of why Earth is habitable and Venus apparently not."

At first glance, the European Space Agency's Venus Express orbiter (VEx), which arrived in April and began taking data in June, appears utterly unsuited to the task. It is little more than a copy of the Mars Express orbiter, with instruments originally designed for the Red Planet and sent to study Venus's atmosphere, all but neglecting the solid body. Last year, though, three planetary scientists argued that VEx could fill in an essential piece of the geologic puzzle, one that scientists had thought would take an expensive network of landers to detect: venusquakes.

Raphaël Garcia, Philippe Lognonné and Xavier Bonnin of the CNRS in Paris proposed to look for the low-frequency sound waves set off by tremors. On Earth, such waves make themselves felt in various ways, ranging from radio interference created as they ripple through the ionosphere to the infrasound that some scientists think animals perceive during quakes. It goes the other way, too: seismometers have registered deep bass notes from atmospheric turbulence and volcanic eruptions, as if the surface were acting as a giant microphone.

The dense Venusian atmosphere, usually a hindrance for observers, is a boon for aeroseismology. Not only