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Mapping the Sea and Its Mysteries
By WILLIAM J. BROAD

In 1953, when Sylvia A. Earle began studying algae, the marine plants and related microbes were often considered weeds or worse. Boaters ridiculed them as scum that turned patches of sea into pea soup.

Today, Dr. Earle notes that just one type -- *Prochlorococcus*, so small that millions can fit in a drop of water -- has achieved fame as perhaps the most abundant photosynthetic organism on the planet. It daily releases countless tons of oxygen into the atmosphere.

The tiny organism is estimated to provide the oxygen in "one in every five breaths we take," Dr. Earle said in an interview. And it is just one of thousands of types of marine algae and photosynthetic microbes -- everything from invisible cells to plantlike growths to kelp forests.

A student of the big and the small, Dr. Earle is a co-author of "Ocean: An Illustrated Atlas," published recently by National Geographic. Its maps and graphs, prose and pictures detail how discoveries like the surprising ubiquity of *Prochlorococcus* are illuminating the sea, its immense impact on the planet and its habitability.

Dr. Earle, an oceanographer and former chief scientist of the National Oceanic and Atmospheric Administration, has participated in more than a half-century of ocean exploration and protection. She has done pioneering research on algae, probed the ecology of coral reefs, set records for deep diving, tracked marine mammals and lobbied for the creation of marine sanctuaries.

She had a hand in President Bush's designation last week of vast parts of the American-controlled Pacific Ocean as marine monuments. The new protected areas -- including the ocean's deepest spot, down nearly seven miles -- are bigger than California.

Dr. Earle's passion extends to the far horizon. In the atlas, she reports that some 90 percent of deep-sea creatures use bioluminescence in their life strategies and that the eerie glows may turn out to constitute the planet's most common form of communication.

"So many things have been discovered," she mused. "But then you turn around and -- there's another breakthrough. We'll probably have to update the atlas in five years."

Her knowledge makes her well qualified to reflect on what is still unknown, as she does repeatedly in the atlas. For instance, she describes how sunlight filters through seawater to surprising depths (its blue component penetrating to at least 250 meters, or 820 feet) but notes that scientists have yet to determine the maximum depth at which sea life can engage in photosynthesis.

One algae, she notes, thrives more than 650 feet down -- far deeper than scuba divers go.

"What's astonishing to me is how fast the insights are coming," she said in the interview. "It's the greatest era of planetary exploration in all of human history. And we've tried to cram it between two covers."

She and her atlas have many fans. “There’s no one else like Sylvia,” said Marcia K. McNutt, director of the Monterey Bay Aquarium Research Institute in California. “She’s one of these rare combinations of energy, passion and eloquence.”

Robert B. Gagosian, president of the Consortium for Ocean Leadership, a private group in Washington that represents the nation’s top ocean institutions, called her a kind of global insurance policy. “I don’t know anyone who is as passionate and committed,” he said. “She wants to make sure people understand the importance of the ocean for the future of humanity.”

Sylvia Alice Earle, 73, grew up on a small farm in southern New Jersey and spent summers at the shore. For college, she went to Florida and fell head over heels for ocean research, her mentor an algae specialist. She graduated in 1966 with a Ph.D. from Duke University.

Her love of plant life is reflected in the atlas’s portrayals of algae as well as a beautiful map that reveals the ocean’s highly variable concentrations of chlorophyll -- the green pigments that power most photosynthetic organisms. Remarkably, the satellite map shows chlorophyll hot spots in the icy waters around the north and south poles.

Beyond Florida, much of her early research focused on coral reefs, which live in symbiosis with tiny algae. On a 1964 voyage, she studied the western Indian Ocean. “We went to places where nobody had dived before,” she said. “There aren’t many like that today.”

The atlas showcases a distinctive reef in Aldabra, one of the Indian isles Dr. Earle visited. The reef looks like a large mushroom, with only its stalk in the water. Aldabra, one of the world’s most isolated ecosystems, is now considered a natural laboratory for coral study and is protected as a World Heritage Site.

In the 1970s, Dr. Earle traveled the globe to study the behavior of humpback whales, going to Alaska, Hawaii, Australia, Bermuda, New Zealand and South Africa. She learned how industrial whaling had decimated whale populations and vowed to help protect the marine mammals and their home.

“I started to realize the magnitude of the problem,” she said. “It’s like a tiger. How do you save it? You protect the forest. How do you save a whale? You have to protect the ocean.”

The atlas, in addition to maps, satellite images and diagrams, features a stunning portrait of a humpback mother and calf, the youngster seeming to caress its parent with an extended flipper.

Dr. Earle said she felt increasingly frustrated during her early research because equipment limitations meant that she and her colleagues, with few exceptions, could only skim the sea’s surface. Crushing pressures and inky darkness made the ocean depths incredibly difficult to explore.

In the 1980s, she helped found two companies to make innovative vehicles that could open the sea's dark recesses to human exploration, and ever since has sought to illuminate the abyss.

So, too, the atlas looks at giant mountain chains of the seabed that spew hot lava and power bizarre ecosystems. The wonders include "Lost City," an area of the Atlantic where volcanic geysers form ghostly spires up to 180 feet high.

While the maps reveal much hidden terrain, the atlas notes that the seabed "is still not as well imaged or mapped as the Moon or the surface of Mars."

Over the decades, Dr. Earle has increasingly moved beyond exploration to spend time on issues of oceanic destruction and conservation. The atlas documents the devastation that humans have visited on the sea, as well as the threat of greater harm.

Dead California sea lions dangle topsy-turvy from a gill net in a gruesome photo. The caption notes that more than 300,000 marine mammals are estimated to die annually in fishing gear. A mosaic shows the scores of debris (cigarette lighters, toy parts, bottle tops) removed from the digestive tract of an albatross chick after its diet proved fatal.

Another photo shows what a haul of orange roughy looks like -- a mountain of flesh on a heaving deck. The deep-sea fish reproduces very slowly and lives up to 250 years, prompting warnings that industrial fishing threatens to drive it to extinction.

Recent events, Dr. Earle and her co-author, Linda K. Glover, write in the atlas, "have shattered the notion that the ocean is so vast, so resilient, there is little humans can do to alter its nature."

Echoing the arc of her career, the atlas details the growing efforts to create marine sanctuaries and protected areas around the globe. Research, it notes, reveals that fully protected areas can produce greater numbers of larger fish and greater diversity in only five years.

The problem, Dr. Earle said in the interview, is that the protected zones add up to a very small part of the global ocean, which covers more than 70 percent of the planet's surface.

"It's alarming how few they are compared to the size," she said. "They're a tiny fraction of 1 percent. On land, across the world, about 12 percent is off limits for development, in parks or preserves."

The protected areas in the western Pacific that Mr. Bush designated as national monuments a week ago encircle the Northern Mariana Islands (including the Mariana Trench, the deepest canyon on Earth) and parts of a sprawling collection of reefs and atolls known as the Line Islands.

The explorer in Dr. Earle lives on, and she dreams of a vehicle that will carry her to the trench's depths. "If you can go to the deepest place, you can go anywhere," she said, clearly taken with the thought. "I want to see if we can go deep and learn more about the heart of the ocean."

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