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Commodore of a Global DNA Census

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"Dinochelus ausubeli" was the name conferred earlier this year on a strange deep sea monster, a lobster discovered off the Philippine coast whose right claw is elongated into a fearsome pincer. The new species was named not after its discoverer, but in honor of the person under whose auspices a fleet of 540 ships from 80 nations has found the lobster and 6,000 other new marine species in the last 10 years.

He is Jesse H. Ausubel, a Rockefeller University environmental researcher who is also vice president of the Alfred P. Sloan Foundation of New York. With his academic hat, Mr. Ausubel, 59, writes and thinks about the environment. Under his foundation hat, he has so far started four major international programs to survey the planet and catalog its biological diversity.

He began the **Census of Marine Life** in 2000 after discussions with **Fred Grassle**, a deep-sea biologist at Rutgers University. The project began as a census of the fishes, but as more biologists got involved it expanded to include invertebrates, a wide range of habitats from shoreline to the ocean abysses, and a system for monitoring the distribution of ocean species.

The Sloan Foundation invested $75 million in the census, but all the ship time was paid for by the participating institutions. By the time the first census finished, in 2010, total investment in the project had reached $650 million. The oceans

were ascertained to brim not just with fish but also with marine microbes -- 35 elephants' worth in weight for every person on earth.

The census researchers discovered the first animal that lives without oxygen. They found species alive that were thought to have gone extinct in the Jurassic period. They detected a species of oyster that lives as long as 500 years, and tube worms 600 years old.

In 2002, while the census was still in its infancy, Mr. Ausubel attended one of its planning meetings in Nova Scotia and heard an evolutionary biologist, **Paul Hebert** of the University of Guelph in Ontario, describe a new method for identifying species based on a snippet of their DNA. No need to decode the whole genome -- analyze just the first 648 units of a particular gene, and this will identify every animal species, Dr. Hebert declared. He called the procedure DNA bar-coding, after the uniform product code that identifies each item at the supermarket checkout counter.

"Jesse came up immediately after my talk," Dr. Hebert said. "He said, 'If this is true, it will revolutionize the study of biodiversity,' and Iagreed with him."

Despite the two men's enthusiasm, DNA bar-coding was a novel and untested idea that gained detractors, particularly among taxonomists. Dr. Hebert had considerable trouble getting his first paper on it published. Biologists objected that the gene Dr. Hebert had selected would be too variable to distinguish one species from another.

To explore these concerns, Mr. Ausubel financed a small workshop on the subject at the Cold Spring Harbor Banbury Center in March 2003. But many of the assembled experts assailed the idea. "It was a bit of a rooster fight," Dr. Hebert said. "Some people thought it was theworst idea in the world. Jesse said, 'I think we need to have another meeting.' "

The second Banbury workshop, comprising those more favorable to the idea, gave a guarded approval. While Dr. Hebert was smoothing out the technical issues, Mr. Ausubel built wider support for the idea by holding conferences at the Natural History Museum in London and the Smithsonian Institution in Washington.

There is now an International **Barcode of Life** project, which has collected more than one million specimens and has defined the DNA bar codes for more than 95,732 species. The Sloan Foundation has invested $15 million in the project, and other institutions and countries have provided a further $60 million. The goal is to obtain bar codes for all 1.9 million species thought to inhabit the planet.

A third project that Mr. Ausubel is involved in is the **Encyclopedia of Life**, an online compendium that will have one page for every species on earth. The idea was proposed by the biologist Edward O. Wilson in a letter to the MacArthur Foundation, which turned to Mr. Ausubel to help carry it out. He arranged for the Sloan Foundation to contribute funds alongside the MacArthur Foundation and served as founding chairman. The **Encyclopedia of Life** now has nearly 500,000 Web pages, contributed by a host of zoological organizations, from the African Amphibian Lifedesk to the World Register of Marine Species.

The three biodiversity projects are tightly integrated. The **Census of Marine Life** furnishes specimens to the DNA bar coders, and they link their bar codes to the species Web pages of the **Encyclopedia of Life**.

"I don't know any person who's done more to foster biodiversity science," Dr. Hebert said of Mr. Ausubel. "He's not in the trenches catching the fish and killing the bugs, but he loves watching us do it."

Last week, along with Bob Dylan, Dave Brubeck, Daniel Day-Lewis and a few others, Mr. Ausubel was elected to the American Academy of Arts and Sciences.

In a recent interview in his office at Rockefeller University on the Upper East Side of Manhattan, Mr. Ausubel explained his view that the environment will be protected, not harmed, by technology. Over the long run, he notes, the economy requires more efficient forms of energy, and these are inherently sparing of the environment. Cities used to use wood for heat and hay for transport fuel. But the required volumes of wood and horse feed soon led to more compact fuels like coal and oil.

Coal in turn is giving way to natural gas in a process that Mr. Ausubel calls decarbonization, the replacement of carbon-rich fuels with hydrogen- rich ones. The ultimate fuel source, in his view, is nuclear power, with reactors set to produce electricity by day and hydrogen, thethe fuel for battery-powered cars, by night. He sees little that might thwart the mighty process of decarbonization, even

given setbacks like Japan's nuclear crisis. "The energy system absorbs shocks even as big as Fukushima," he says.

As a program officer with the National Academy of Sciences, Mr. Ausubel worked with senior scientists who had broad experience in running international environmental programs. He was involved in planning the first Intergovernmental Panel on Climate Change meeting but has viewed the panel's subsequent reports with reserve. Climate change went from being a small to a major issue. "And then the expected happened," he said. "Opportunists flowed in. By 1992 I stopped wanting to go to climate meetings."

Because of decarbonization, Mr. Ausubel believes that the growth of carbon dioxide emissions will be limited. "The computer models of the climate system aren't good enough and never will be. I tend not to be frightened because I think the natural evolution of the energy system is away from carbon," he said.

It was his belief that technology is generally relieving the pressure on the terrestrial environment that led to his interest in marine life. In the mid-'90s, he said, he came to think that "we were near the inflection points in deforestation and water use. But this was not true of the oceans." It was this consideration that led to the **Census of Marine Life**.

In 2009 Mr. Ausubel started a fourth environmental reconnaissance project, the Deep Carbon Observatory. Mr. Ausubel had long been interested in an idea developed by the Cornell University physicist Thomas Gold, who believed that oil and gas are produced by deep-earth microbes feeding on natural sources of methane. From this it followed, Dr. Gold argued, that oil wells might be naturally replenished from vast sources of carbon deep in the planet. Dr. Gold's theories also have far-reaching implications for the origins of life on earth.

Whether Dr. Gold's ideas are correct, the behavior of carbon in the deep earth is an issue of considerable scientific moment. The deep earth is full of microbes that lead a largely independent existence from those on the surface. This dark world, flourishing but largely unknown, could have been the origin of life on earth and may influence it in many other ways. There is reason to think the deep earth contains hidden reservoirs of carbon -- meteorites of the type that formed the primitive earth are 3 percent carbon, but the detectable abundance of carbon is only 0.1 percent. Discovery of a hidden carbon reservoir in the deep earth, especially if it is connected with the origins of oil and gas, could change estimates of energy supplies.

Inspired by Dr. Gold's thinking, in 2007 Mr. Ausubel asked Robert Hazen, a geologist at the Carnegie Institution of Washington, to explore setting up an international program to study deep carbon, and the Sloan Foundation financed

the project two years later. The Deep Carbon Observatory is a full-fledged big science program with an international committee that coordinates the efforts of hundreds of scientists. The program deploys ships to drill deep holes, runs a fleet of helicopters to install instruments on every volcano on earth, and develops new apparatus to test the deep physics and chemistry of carbon.

As with the Census on Marine Life, the Deep Carbon Observatory required enlisting foreign institutions all over the globe and persuading their governments to waive security concerns and contribute money and ships. "Jesse knows the science and has an incredible network of people around the world who can get things done," Dr. Hazen said.

Mr. Ausubel does not belong to the Jeremiah school of environmentalists who prophesy imminent doom unless their words are heeded. "The credibility of the environmental movement as a whole is less than its members wish it to be, and a lot of that has come from overdoing it on various issues," he says.

Forests are now growing back in many temperate countries and the worst phase of habitat destruction may be over as efficiency demandsshape better technologies and less polluting forms of energy. But the oceans lag a century behind and their remoteness has denied them the protection they need from pollution, overfishing and noise. "We can leave most life in the oceans alone," is Mr. Ausubel's hope.

"Jesse grew up in New York and he loves New York," Dr. Hebert said, "but he does spend some time thinking about life on our planet."

Illustration:
• PHOTOS: PHOTO (PHOTOGRAPH BY FRED R. CONRAD/THE NEW YORK TIMES)(D1)
• GALAPAGOS: One of Jesse H. Ausubel's projects is a compendium that will have one page for every species on earth. (PHOTOGRAPH BY SONG SUN)(D4)

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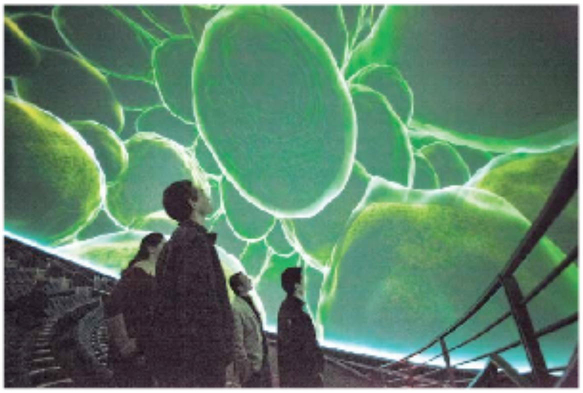


Digging Deeper, Seeing Farther: Supercomputers Alter Science

"Life: A Cosmic Journey," at the Morrison Planetarium in San Francisco, reflects new uses of digitized data as well as new technologies.

A Generation's Vanity, Heard Through Lyrics

FINDINGS John Tierney

A growing chorus of 'I' and 'me,' and an ever-angry refrain.

Commodore of a Global DNA Census

SCIENTIST AT WORK | Jesse H. Ausubel

A big fleet, and boundless ambition.

Health

Essay: Why even the best doctors manage to disappoint us.

Science

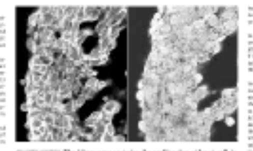
And others, like Merlin, that may play a role in heart disease.

Online

Letters

Hippo, Warts and Other Thugs of the Genetic Realm

By NICHOLAS WADE



The Hippo gene regulates the proliferation of heart cells.

A crew of genes with names like mobsters' gives up secrets that may help repair hearts.

The Commodore of a Global DNA Census Voyage

One of Jesse H. Ausubel's projects is a compendium that will have one page for every species on earth.

Cataloging species on land and in the oceans, all while searching for sources of clean energy.