"The Physics of Bras: Overcoming Newton's second law with better bra technology" by Anne Casselman, Discover, 22 November, 2005.
http://discovermagazine.com/2005/nov/physics-of-bras/

'One side effect of the obesity epidemic in America is rarely noted: Women's chests are expanding nearly as fast as their bellies. Poor eating habits, as well as breast implants and the estrogens in birth-control pills, have led to an increase in the past 15 years of more than one bra size for the average American woman—from a 34B to a 36C. For many women, this has been a burdensome trend. A pair of D-cup breasts weighs between 15 and 23 pounds—the equivalent of carrying around two small turkeys. The larger the breasts, the more they move and the greater the discomfort. In one study, 56 percent of women suffered from breast pain when jogging.

'Women will limit themselves from doing exercise because of their breasts,' says Deirdre McGhee, a sports physiotherapist and graduate student in biomechanics at the University of Wollongong in Australia. 'They actually deprive themselves.'

For most women, a good bra is still the best remedy. According to the American Apparel and Footwear Association, nearly 500 million bras were sold in the United States in 2001; last year, sales totaled more than $5 billion. As breasts have grown, so have the demands of customers, the scientific sophistication of bra design, and the competition among bra manufacturers. 'Women like their bras to be sexy and sensual and comfy and supportive,' McGhee says. 'And to get all that is rare.' Yet after nearly a century of experimentation, the perfect bra may well be in sight."

Climate Change Hitting the Sea's Little Guys Too
Graeme Stemp-Morlock
for National Geographic News
February 29, 2008

When it comes to climate change, polar bears and sharks may grab the bulk of the headlines—but it's the threat to the sea's tiniest creatures that has some marine scientists most concerned. Malformed seashells show that climate change is affecting even the most basic rungs of the marine food chain—a hint of looming disaster for all ocean creatures—experts say.

Climate change could drastically reduce sea urchin populations in particular, according to Gretchen Hofmann, a marine biologist at the University of California, Santa Barbara.

The purple sea urchin is commonly found off the coast of Australia and Antarctica. It is an essential food source for many marine animals such as cod or lobster, as well as a common ingredient in sushi.

Hofmann is concerned because increasing amounts of atmospheric carbon dioxide are also raising the amount of the gas dissolved in ocean water. This makes the seas more acidic, decreasing the available amount of shell-forming calcium carbonate.

Future Ocean in a Box
To test the theory, Hofmann tested sea urchins in highly acidic water similar to what is predicted for the oceans.

"We checked if they can make the skeleton that forms their bodies, and yes it is formed," Hofmann said. "But it was shorter and stumpier—not the same shape—so they swim and move differently. Plus it comes at a cost, which is they are more sensitive to temperature."

Hofmann refers to this malformed skeleton and sensitivity to heat as "double jeopardy."

She went further than any previous research by analyzing the recently sequenced sea urchin genome to find out what genes were turning off and on under this new environmental stress.

"We wanted to ask them how they were doing and get a sense of their health and physiology," Hofmann said. "We found it caused their shell-forming genes to go up threefold, so their developing system was having to put more energy into making the skeleton and less into other things."

Hofmann presented her findings at the recent meeting of the American Association for the Advancement of Science in Boston, Massachusetts.

"Sea Butterflies" Next?
Scott Doney, a chemical oceanographer at Woods Hole Oceanographic Institute, said that Hofmann may have done "the same type of experiments [as previous researchers], but went beyond looking at the physiological impact of acidification on organisms.

"[Hofmann] used molecular biological tools to see what proteins are turned on or off as they experienced stress if the waters become really acidic," Doney said. "It is a validation in many ways of the physiological experiments others had done."

Doney compared sea urchins to homeowners who use all their cash to build the dwellings but don't leave any money for furniture.

"From the short-term experiments that have been running, the best indication is that likely the population as a whole will suffer dramatically," Doney said. "But, in addition to being a food source for things we eat, [sea urchins] are a harbinger of the damage we do to ecosystems."

Hofmann also pointed out that she just returned from Antarctica, where she was collecting samples of another first-rung-in-the-food-chain creature, the pteropod.

These miniscule creatures—which resemble snails flying through water—are sometimes referred to as sea butterflies.

They are an essential food source for many fish such as salmon, which feed penguins, seals, and other animals.

Hofmann plans to get a quick scan of the pteropod DNA sequence and then use that information to predict the impact climate change will have on these organisms.

"Pteropods are one of our lead organisms for understanding and predicting the effects of climate change. But they are a very unknown organism," she said.

"Pteropods are cold-adapted, so while we haven't tested it yet, we suspect their ability to tolerate temperature increases could be very narrow," Hofmann added.

"And they can't migrate anywhere to find colder water, so the pteropods situation could be even more dire than with sea urchins."

↑ Carbon Dioxide = ↑ Acidic Ocean = ↓ Marine Life

The buildup of carbon dioxide in the atmosphere not only warms the planet, it also leads to ocean acidification. That threatens to corrode the shells of corals and of tiny marine organisms that provide essential food for fish, whales, and other ocean life.

“We’ve increased the carbon dioxide in the atmosphere, and that’s driving it into the ocean and changing the ocean's chemistry,” said Scott Doney, a marine geochemist and Fellow of the WHOI Ocean and Climate Change Institute. Chemically, the carbon dioxide (CO2) reacts with water (H2O) to form carbonic acid (H2CO3).

“A large number of marine plants and animals, including corals, sea urchins, phytoplankton, and tiny snails called pteropods use calcium carbonate to build shells,” he said. “When the ocean gets more acidic, they have a harder time building those shells.”

Doney was part of an international team of 27 marine chemists and biologists who analyzed recently compiled global ocean carbon data and computer models to study potential carbon-dioxide-related changes in the ocean. In a report published in the Sept. 29, 2005, issue of the journal Nature, the team predicted that the oceans—especially in fertile high-latitude regions—will become more acidic “within decades.” That is much sooner than expected and too fast for marine organisms to adapt to the new ocean chemistry.

Polar pteropods are a diet staple of animals ranging from zooplankton to commercial fish like salmon and baleen whales. A decline or relocation of the pteropod population could spark a calamitous chain reaction throughout marine ecosystems.

Tree from 2,000-year-old seed is doing well

By RANDOLPH E. SCHMID, AP Science Writer /1 hour, 34 minutes ago/

WASHINGTON - Just over three years old and about four-feet tall, Methuselah is growing well. "It's lovely," Dr. Sarah Sallon said of the date palm, whose parents may have provided food for the besieged Jews at Masada some 2,000 years ago.

The little tree was sprouted in 2005 from a seed recovered from Masada, where rebelling Jews committed suicide rather than surrender to Roman attackers.

Radiocarbon dating of seed fragments clinging to its root, as well as other seeds found with it that didn't sprout, indicate they were about 2,000 years old — the oldest seed known to have been sprouted and grown. Sallon, director of the Louis L. Borick Natural Medicine Research

Center at Hadassah Medical Organization in Israel, updates the saga of Methuselah in Friday's edition of the journal Science.

One thing they don't know yet is whether it's a boy or girl. Date palms differ by sex, but experts can't tell the difference until the tree is six or seven years old, Sallon said.

She hopes there's a chance to use it to restore the extinct Judean date palm, once prized not only for its fruit but also for medicinal uses. The researchers have had a look at the plant's DNA, however, and found it shares just over half its genes with modern date cultivars. "Part of our project is to preserve ancient knowledge of how plants were used," Sallon said in a telephone interview. "To domesticate them so we have a ready source of raw material."

Her Middle Eastern Medicinal Plant Project is working to conserve and reintroduce plants to the region where they once lived. "Many species are endangered and becoming extinct. Raising the dead is very difficult, so it's better to preserve them before they become extinct," she said.

The oldest documented seed to be grown previously was a 1,300-year-old lotus, Sallon said.

PZ Myers on the process that prompts the growth of all vertebrates from embryos to unspecialized segments to multicellular animals.

by PZ Myers • Posted October 17, 2007 06:33 PM
Seed Magazine

One of the fundamental features of the organization of multicellular animals is segmentation: We are initially built by subdividing a relatively undifferentiated embryonic tissue into smaller, repeated elements, like a stack of mostly identical building blocks. Look at an earthworm or a caterpillar or a maggot, and the organization is clear, with the wormlike animal showing the obvious seams and subdivisions that constitute its assembly from rings of similar chunks of tissue. Another property of this pattern of organization is that individual segments can then acquire specializations. In a caterpillar, the front end is modified with mouthparts and sense organs to form a head, while other segments will bear stubby limbs or be festooned with bristles or colored spots and patterns. Specialization is carried further when a maggot becomes a fly. Segments become much more obscure, retaining their visible identity in the abdomen, but are otherwise fused, elaborated upon, and display new features, such as wings or legs or mouthparts, that make the segments, ultimately, look very different from one another.

We vertebrates were also overtly segmented animals early in our embryonic development. As with the fly, the nature of our construction from similar blocks of tissue has been obscured by later additions in development, with limbs patched on and some segments (like human tails) reduced to near invisibility. Others (like significant portions of our brains) have been telescoped, contorted, and fused so that the boundaries between the original segments are detectable only to sensitive molecular probes. As with the fly's abdomen, we also retain some still apparent vestiges: the chain of vertebrae in our backs and the muscles of our torsos.

Before those specializations intruded, however, there was an early period in development when all was simple, and the only job the embryo had to do was to set up partitions, segregate small

sections of tissue that were all nearly identical, and let local developmental programs proceed within them. The most obvious expression of the process of segmentation is seen in the mesoderm—the embryonic tissue that will form bone and muscle—which begins as a long strip of cells in a continuous mass stretching the length of the embryo, and ends with the mass clumping into a chain of small segments of mesoderm, called somites. One somite (or a few) forms early, and then another coalesces just behind it, and a little later another one behind that, until the entire chain is constructed sequentially, from the front of the animal to the back. We can even watch this happen. I've put a short time-lapse recording of the process in a zebrafish embryo at http://scienceblogs.com/pharyngula/zebrafish. The movie covers about two hours of the embryo's life, but has been sped up 1200 times so that you can easily see the events. At the beginning, four lozenge-shaped somites are visible on the left, and to the right is a ribbon of tissue. As the movie proceeds, portions of the ribbon are pinched off and added to the stack of new formed somites. The zebrafish continues to pinch off new somites until it reaches a total of 30 to 34. Some animals, such as snakes, may continue to form as many as 400.

One prediction from this observation is that there must be a molecular signal that sweeps in a progressive wave down the length of an animal to regulate the addition of these segments. Another marvelous property of this process is that it is clocklike. The new somites form with a predictable, regular rhythm. It's so regular that developmental biologists can use the number of somites present in the segmentation period to figure out exactly how old an embryo is. In a zebrafish, for instance, since we know when segmentation begins and the rate at which new segments form (one every 30 minutes at 28° C), we can confidently state that if an embryo has 20 somites, it must be 19 hours old, plus or minus 15 minutes. The segmentation clock is species-specific—the chick takes 90 minutes to do the same thing that takes mice two hours, and humans eight. The additions are so regular and uniform, that one other thing we can predict about the mechanism is that it must involve an oscillator or clock with a period equal to the time it takes to add a new somite.

Thanks to the work of Olivier Pourquié and many other researchers, we're beginning to puzzle out the underlying molecular mechanisms of the clock and wave front that generate vertebrate somites. The wave is provided by two molecules, the fibroblast growth factor fgf8 and the signaling molecule Wnt3a. Both of these molecules are expressed in a gradient, highest in the tail and lowest at front end of the animal, and this gradient slowly recedes backwards at the same rate that new somites are added. This wave represents the determination front; as cells lose the fgf8/Wnt3a signal, they organize themselves into somites.

The clock is more complicated, and it turns out that what vertebrates may have is a collection of little clocks that work together to generate a rhythm. All of them belong to a family of what are called Notch-related cyclic genes. Notch is a receptor protein that turns up again and again in development and evolution and is, to describe it in the most general terms, often involved in boundary formation. This makes it a natural to turn up in a process where we need to set up a series of segmental boundaries.

The simple explanation (there are more complicated interactions that I'll set aside for now) for how these clock molecules work is that they are all transcription factors that exhibit auto-repression. That is, these genes are expressed to make a protein that binds to DNA and binds to its own gene, turning it off. What happens then is that the gene product accumulates, turns off the gene that makes it, and then the protein is slowly degraded by natural cellular processes. When

the protein is sufficiently depleted, the gene is released from repression and is expressed again. The cycle continues over and over again.

The fgf8/Wnt3a wave front and the Notch-related cyclic clock work together to elegantly generate a precise spatial pattern over time. One way to picture this is to imagine standing at the shore, with waves lapping at the beach; as each wave rolls in, it leaves a little line of sea foam at its farthest reach. The waves are regular and clocklike, and with no other factors involved, would produce that line of sea foam at the same place every time.

But now we add another idea: The tide is going out. Each succeeding wave travels a little less far up the beach, and each one leaves its line of sea foam a little farther back toward the sea. Over time, what you'd see is a series of periodic lines of sea foam receding with the ebbing tide. In this example, the ebbing tide is like the receding gradient of fgf8/Wnt3a, while the individual waves are cycles of the Notch-related cyclic genes. Working together, two time-related processes can generate a regular spatial pattern of gene expression.

Meet the Intraterrestrials

Some weeks ago, I wrote about microbes in the air and their possible role in helping clouds form, in causing rain and in altering the chemistry of the high atmosphere. This week, I want to go in the opposite direction and plunge down into the earth. For many bacteria live deep in the oceans and deep in the earth, far from light, far from what we normally think of as good, comfortable places to live.

For example: the bottom of the Mariana Trench. This is a seam on the sea floor in the northwestern Pacific, not far from the island of Guam; it’s where the Pacific plate is sliding under the Philippine plate. The ocean is deeper here than anywhere else in the world: the seabed is 11 kilometers (almost 7 miles) below the surface of the sea. Yet even here, where the pressure of the water would crush you or me, there are bacteria. Some of them won’t grow at all unless the atmospheric pressure is at least 50 megapascals (around 7,000 pounds per square inch), and they grow better if the pressure is greater — 70 megapascals (more than 10,000 pounds per square inch). For comparison, the pressure at sea level — the pressure we have evolved to bear — is 700 times less.

Then there are the “intraterrestrials” — the organisms that live in rocks deep in the earth, the creatures of the “deep subsurface biosphere.” Bacteria have been found in rock samples taken several hundred meters below the sea floor, even when the sea floor itself is 4 kilometers (2.5 miles) below sea level.

We don’t know how many organisms are living in this (to us) alien environment. But based on what’s been found in rock samples so far, the numbers are likely to be gigantic. One recent study found between 1 million and 1 billion bacteria per gram of rock (a gram is 1/28 of an ounce). It may be that a large proportion — perhaps as many as a third — of all bacteria on Earth live in rocks below the floor of the sea. That would be a lot of bacteria.

Until recently, it was assumed that the chemical alteration and decomposition of rocks in the ocean crust was due purely to elemental forces — the circulation of seawater, the grinding of

rocks against one another. But increasingly, intraterrestrial bacteria are suspected of making a contribution, too. Shards of volcanic glass from basaltic rocks hundreds of meters beneath the seabed show grooves and etchings that appear to have been made by bacteria.

Volcanic glass? When molten basaltic rock wells up from deep in the earth and meets cold water at the bottom of the ocean, the heat is quenched and the rock hardens. As it does so, it forms a characteristic shape known as a pillow basalt — for it looks as though someone has stacked up a pile of rocky pillows. (Every year, around 20 cubic kilometers — around 5 cubic miles — of new basalt forms at the mid-ocean ridges — the places where the sea floor is spreading apart as tectonic plates move away from each other.) Glass forms when the rock cools so fast that crystals don't have time to take shape. Thus the edges and rims of pillow basalts are often highly glassy; indeed basaltic glass is an important component of the top layers of the oceanic crust.

Bacteria of the deep biosphere can't get energy directly from sunlight, but they can get energy from a surprising array of other sources, including iron, manganese, sulfur or nitrogen compounds, methane and hydrogen. Indeed, bacteria collected from the deep biosphere show an enormous diversity of metabolic activities. And in chiseling away at rocks, in leaching out minerals to consume, and by excreting waste products, they alter the chemical composition of rocks — and also the composition of the seawater that circulates through the pores and fractures in them. Perhaps — though no one yet knows for sure — they do so on a grand scale, contributing substantially to the composition of rocks and oceans. Experiments suggest that deep biosphere bacteria may accelerate the weathering of basalt rocks by a factor of six compared to physical or chemical forces, especially at the low temperatures that prevail in much of the seabed.

And here's something nifty. By altering the chemical composition of rocks, the bacteria may alter the magnetic properties of rocks as well.

Basaltic rocks newly arrived at the sea floor give off a strong magnetic signal. This is due to titanomagnetites — iron oxides that contain some titanium — that are present in the rocks. As a result, the mid-ocean ridges often feature a zone of high magnetization known as the central anomaly magnetization high. The strength of the magnetic signal fades as you move away from the newest rocks — as you move from the mid-ocean ridges towards the coasts. (The new rocks are gradually pulled away from the ridge by the spreading apart of the ocean plates; a rock's distance from the ridge is thus a reflection of its age.) Soon after basalts arrive at the sea floor, then, they lose some of their magnetism. Why?

A recent series of experiments that looked at the loss of magnetism of young basaltic rocks shows that bacteria may greatly accelerate the loss. Rock slices were kept for 355 days in vials of seawater with or without bacteria. The bacteria in question were strains of Desulfovibrio — bacteria that give off hydrogen sulfide much as we give off carbon dioxide. Hydrogen sulfide interacts with the iron in the rocks to form iron sulfide; in doing so, it destroys the magnetic signal. And after 355 days, the rocks kept with bacteria gave off a lower signal than the rocks kept in seawater alone. Bacteria, it seems, can efficiently reduce the magnetic signal of young rocks.

No one knows, yet, how significant such effects are. Moreover, we're only beginning to make an inventory of who's down there — the identity of most intraterrestrials remains mysterious. But given their vast numbers, and the range of their activities, these small organisms from the weird

world of the rocks below the sea will probably turn out to have a big-time influence on the composition of the oceans and the rocks of the seabed.

Climate change to create African 'water refugees' - scientists
22 Mar 2006
Megan Rowling

REUTERS/Antony Njuguna LONDON - Climate change is expected to shrink many African rivers dramatically, triggering massive refugee movements and even war, according to scientists at the Africa Earth Observatory Network.

Researchers calculate that a predicted drop in rainfall will significantly reduce water supplies across a quarter of Africa by the end of this century, in a study published in the journal Science.

"Future climate change poses one of the greatest threats to poverty eradication on this continent, and related changes in surface water supply will exacerbate this," they warn.

Some 300 million Africans have no access to safe drinking water, and 313 million lack basic sanitation. Africa has an estimated population of over 800 million. The United Nations said on Sunday that, with the exception of Uganda and South Africa, sub-Saharan Africa is failing to meet U.N. targets set at the start of the millennium to halve the number of people without access to clean water or sanitation by 2015.

The AEON study - the first to examine the impact of climate change on Africa's rivers in such detail - points out that 75 percent of African countries fall at least partly into a rainfall band where changes in precipitation have a surprisingly large impact on surface drainage.

The research found that, in regions receiving 500mm of rain per year, a 10 percent fall in precipitation would cut surface water by 50 percent.

WATER REFUGEES AND WARS
Maarten de Wit, a University of Cape Town professor and co-author of the study, said: "For those who already walk to rivers to get water, the question will be: should I move to another village? This is going to cause mass migration - in some cases across national borders - and it is going to have huge political implications."

He added that the potential number of "water refugees" could not yet be estimated, but the problem would be serious enough to require a co-ordinated response by African governments.

De Wit also warned that, with all major African rivers crossing international boundaries, there is a potential for conflicts over water resources to erupt into wars.

To reduce that risk, the study recommends that African countries that share river basins must address the issue of future access to water. It also proposes that states should focus their responses on rural areas where the risk of water loss is high and more likely to create scarcity.

"Politicians really need to focus on these issues now. If you put the numbers on the table, as we have done, then there will have to be some serious thinking about measures such as water basin management. This has to happen on a regional basis," de Wit told AlertNet.

CAPE TOWN AT RISK
The study highlights two areas likely to suffer most from reduced access to water: southern Africa and the Sahel strip stretching from Senegal to Sudan.

In southern Africa, areas near Cape Town are predicted to be hit hardest by an expected 20 percent drop in rainfall by 2070, reducing perennial water supply by nearly 60 percent.

"This region is South Africa's bread basket. People in Cape Town have not seen figures like this before, and I think they are quite frightened," said de Wit.

The upper reaches of the Orange River in southeast Africa are also forecast to experience strong to moderate decreases in water supply.

This would have a knock-on effect in southwest Africa, because the river is one of the area's key sources of water. Today this region is experiencing its biggest drought in over 100 years.

According to de Wit, a reduction in water supplies in the Sahel area is likely to have a major impact on the rural population. "There are already women having to walk around 25km to fetch water - maybe they'll have to walk 50-60km in 50 years' time. Are they going to decide to move elsewhere instead?"

In East Africa, however, climate change models suggest rainfall could actually increase, and water supplies may improve. Somalia, for example, is expected to see a 20 percent rise in precipitation, boosting the water it receives from rivers by ten times.

One negative impact of higher rainfall may be that it creates the conditions for mosquitoes to breed, exacerbating the incidence of malaria.

Scientist using ferry for sea research*
Author: AARON GOUVEIA
Estimated printed pages: 2
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WOODS HOLE - The Katama is no longer simply a ferry from Woods Hole to Martha's Vineyard. It's a lean, mean, 235-foot data-gathering machine.

The freight ferry has been outfitted with sensors by Woods Hole Oceanographic Institution scientists to measure water quality and photograph plankton.

The ferries are perfect for the task because they make several trips a day through Nantucket Sound on a year-round basis, said Scott Gallager, associate scientist of biology at WHOI.

Scientists will soon mount similar sensors on another ferry, the Eagle, so the waters between Hyannis and Nantucket can be monitored as well.

The Nantucket Sound Ferry Scientific Environmental Monitoring System began in May. By studying the results over many years, Gallager hopes scientists can better understand how water quality and ocean life change.

The sensors, which cost $18,000 and can fit into a suitcase, are placed in a cavity in the hull of the ship. They collect water samples and take photographs of plankton 30 times per second.

The data is transferred back to WHOI via an onboard computer stored in the engine room, and results are released in real time on the Internet.

The sensors measure water temperature, salinity, oxygen, chlorophyll and water clarity.

Gallager is especially interested in nutrients from coastal embayments and their impact on plankton in Nantucket Sound.

Nutrients are known as primary producers and are necessary for algae to grow. Zooplankton, a secondary producer, feeds off the algae, then fish and shellfish dine on the zooplankton.

Since the availability of plankton could mean the difference between healthy or undernourished commercial fishing stock, Gallager wants to quantify nutrient sources so he can see how much is coming from onshore run-off and what's generated within the water column.

"This is the basis for the entire food chain," Gallager said.

Nantucket Sound, the triangular area of coastal ocean between Cape Cod, Martha's Vineyard and Nantucket, is known for variable water conditions and diverse marine life. As water shifts with the winds and tides, warm- and cold-water species are forced to share the same space.

This study, Gallager said, will help build an understanding of the area and how the sound changes over time.

The project has been approved by the Woods Hole, Martha's Vineyard and Nantucket Steamship Authority and does not negatively affect the operation of the ship, Gallager said.

Scientists will spend 15 minutes once a week cleaning the microbial film and algae from the sensors.

Although he is funded by the Woods Hole Sea Grant program for sensors on two ships over two years, Gallager hopes to put more sensors on ferries going from Boston to Provincetown and New Bedford to Martha's Vineyard.

"We're looking for long-term trends because issues like these can't be solved in one, two or three years, but a minimum of 10 or 50 years," Gallager said. "The reason for making lots of measurements over a long period of time is to understand the source of variability."

Military Supercomputer Sets Record

Article Tools Sponsored By
By JOHN MARKOFF
Published: June 9, 2008

SAN FRANCISCO — An American military supercomputer, assembled from components originally designed for video game machines, has reached a long-sought-after computing milestone by processing more than 1.026 quadrillion calculations per second.

The new machine is more than twice as fast as the previous fastest supercomputer, the I.B.M. BlueGene/L, which is based at Lawrence Livermore National Laboratory in California.

The new $133 million supercomputer, called Roadrunner in a reference to the state bird of New Mexico, was devised and built by engineers and scientists at I.B.M. and Los Alamos National Laboratory, based in Los Alamos, N.M. It will be used principally to solve classified military problems to ensure that the nation's stockpile of nuclear weapons will continue to work correctly as they age. The Roadrunner will simulate the behavior of the weapons in the first fraction of a second during an explosion.

Before it is placed in a classified environment, it will also be used to explore scientific problems like climate change. The greater speed of the Roadrunner will make it possible for scientists to test global climate models with higher accuracy.

To put the performance of the machine in perspective, Thomas P. D'Agostino, the administrator of the National Nuclear Security Administration, said that if all six billion people on earth used hand calculators and performed calculations 24 hours a day and seven days a week, it would take them 46 years to do what the Roadrunner can in one day.

The machine is an unusual blend of chips used in consumer products and advanced parallel computing technologies. The lessons that computer scientists learn by making it calculate even faster are seen as essential to the future of both personal and mobile consumer computing.

The high-performance computing goal, known as a petaflop — one thousand trillion calculations per second — has long been viewed as a crucial milestone by military, technical and scientific organizations in the United States, as well as a growing group including Japan, China and the European Union. All view supercomputing technology as a symbol of national economic competitiveness.

By running programs that find a solution in hours or even less time — compared with as long as three months on older generations of computers — petaflop machines like Roadrunner have the potential to fundamentally alter science and engineering, supercomputer experts say. Researchers can ask questions and receive answers virtually interactively and can perform experiments that would previously have been impractical.

"This is equivalent to the four-minute mile of supercomputing," said Jack Dongarra, a computer scientist at the University of Tennessee who for several decades has tracked the performance of the fastest computers.

Each new supercomputing generation has brought scientists a step closer to faithfully simulating physical reality. It has also produced software and hardware technologies that have rapidly spilled out into the rest of the computer industry for consumer and business products.

Technology is flowing in the opposite direction as well. Consumer-oriented computing began dominating research and development spending on technology shortly after the cold war ended in the late 1980s, and that trend is evident in the design of the world's fastest computers.

The Roadrunner is based on a radical design that includes 12,960 chips that are an improved version of an I.B.M. Cell microprocessor, a parallel processing chip originally created for Sony's PlayStation 3 video-game machine. The Sony chips are used as accelerators, or turbochargers, for portions of calculations.

The Roadrunner also includes a smaller number of more conventional Opteron processors, made by Advanced Micro Devices, which are already widely used in corporate servers.

"Roadrunner tells us about what will happen in the next decade," said Horst Simon, associate laboratory director for computer science at the Lawrence Berkeley National Laboratory. "Technology is coming from the consumer electronics market and the innovation is happening first in terms of cellphones and embedded electronics."

The innovations flowing from this generation of high-speed computers will most likely result from the way computer scientists manage the complexity of the system's hardware.

Roadrunner, which consumes roughly three megawatts of power, or about the power required by a large suburban shopping center, requires three separate programming tools because it has three types of processors. Programmers have to figure out how to keep all of the 116,640 processor cores in the machine occupied simultaneously in order for it to run effectively.

"We've proved some skeptics wrong," said Michael R. Anastasio, a physicist who is director of the Los Alamos National Laboratory. "This gives us a window into a whole new way of computing. We can look at phenomena we have never seen before."

Solving that programming problem is important because in just a few years personal computers will have microprocessor chips with dozens or even hundreds of processor cores. The industry is now hunting for new techniques for making use of the new computing power. Some experts, however, are skeptical that the most powerful supercomputers will provide useful examples.

"If Chevy wins the Daytona 500, they try to convince you the Chevy Malibu you're driving will benefit from this," said Steve Wallach, a supercomputer designer who is chief scientist of Convey Computer, a start-up firm based in Richardson, Tex.

Those who work with weapons might not have much to offer the video gamers of the world, he suggested.

Many executives and scientists see Roadrunner as an example of the resurgence of the United States in supercomputing.

Although American companies had dominated the field since its inception in the 1960s, in 2002 the Japanese Earth Simulator briefly claimed the title of the world's fastest by executing more than 35 trillion mathematical calculations per second. Two years later, a supercomputer created by I.B.M. reclaimed the speed record for the United States. The Japanese challenge, however, led Congress and the Bush administration to reinvest in high-performance computing.

"It's a sign that we are maintaining our position," said Peter J. Ungaro, chief executive of Cray, a maker of supercomputers. He noted, however, that "the real competitiveness is based on the discoveries that are based on the machines."

Having surpassed the petaflop barrier, I.B.M. is already looking toward the next generation of supercomputing. "You do these record-setting things because you know that in the end we will push on to the next generation and the one who is there first will be the leader," said Nicholas M. Donofrio, an I.B.M. executive vice president.

By breaking the petaflop barrier sooner than had been generally expected, the United States' supercomputer industry has been able to sustain a pace of continuous performance increases, improving a thousandfold in processing power in 11 years. The next thousandfold goal is the exaflop, which is a quintillion calculations per second, followed by the zettaflop, the yottaflop and the xeraflop.

The Global Fish Crisis: Still Waters

Republished from the pages of National Geographic magazine
Written by Fen Montaigne
April 2007

No more magnificent fish swims the world's oceans than the giant bluefin tuna, which can grow to 12 feet (3.7 meters) in length, weigh 1,500 pounds (680 kilograms), and live for 30 years. Once, giant bluefin migrated by the millions throughout the Atlantic Basin and the Mediterranean Sea, their flesh so important to the people of the ancient world that they painted the tuna's likeness on cave walls and minted its image on coins.

The giant, or Atlantic, bluefin possesses another extraordinary attribute, one that may prove to be its undoing: Its buttery belly meat, liberally layered with fat, is considered the finest sushi in the world. Over the past decade, a high-tech armada, often guided by spotter planes, has pursued giant bluefin from one end of the Mediterranean to the other, annually netting tens of thousands of fish, many of them illegally. The bluefin are fattened offshore in sea cages before being shot and butchered for the sushi and steak markets in Japan, America, and Europe. So many giant bluefin have been hauled out of the Mediterranean that the population is in danger of collapse. Meanwhile, European and North African officials have done little to stop the slaughter.

"My big fear is that it may be too late," said Sergi Tudela, a Spanish marine biologist with the World Wildlife Fund, which has led the struggle to rein in the bluefin fishery. "I have a very graphic image in my mind. It is of the migration of so many buffalo in the American West in the early 19th century. It was the same with bluefin tuna in the Mediterranean, a migration of a massive number of animals. And now we are witnessing the same phenomenon happening to

giant bluefin tuna that we saw happen with America's buffalo. We are witnessing this, right now, right before our eyes."

The decimation of giant bluefin is emblematic of everything wrong with global fisheries today: the vastly increased killing power of new fishing technology, the shadowy network of international companies making huge profits from the trade, negligent fisheries management and enforcement, and consumers' indifference to the fate of the fish they choose to buy.

The world's oceans are a shadow of what they once were. With a few notable exceptions, such as well-managed fisheries in Alaska, Iceland, and New Zealand, the number of fish swimming the seas is a fraction of what it was a century ago. Marine biologists differ on the extent of the decline. Some argue that stocks of many large oceangoing fish have fallen by 80 to 90 percent, while others say the declines have been less steep. But all agree that, in most places, too many boats are chasing too few fish.

Popular species such as cod have plummeted from the North Sea to Georges Bank off New England. In the Mediterranean, 12 species of shark are commercially extinct, and swordfish there, which should grow as thick as a telephone pole, are now caught as juveniles and eaten when no bigger than a baseball bat. With many Northern Hemisphere waters fished out, commercial fleets have steamed south, overexploiting once teeming fishing grounds. Off West Africa, poorly regulated fleets, both local and foreign, are wiping out fish stocks from the productive waters of the continental shelf, depriving subsistence fishermen in Senegal, Ghana, Angola, and other countries of their families' main source of protein. In Asia, so many boats have fished the waters of the Gulf of Thailand and the Java Sea that stocks are close to exhaustion. "The oceans are suffering from a lot of things, but the one that overshadows everything else is fishing," said Joshua S. Reichert of the Pew Charitable Trusts. "And unless we get a handle on the extraction of fish and marine resources, we will lose much of the list that remains in the seas.

"Cruel" may seem a harsh indictment of the age-old profession of fishing—and certainly does not apply to all who practice the trade—but how else to portray the world's shark fishermen, who kill tends of millions of sharks a year, large numbers finned alive for shark-fin soup and allowed to sink to the bottom to die? How else to characterize the incalculable number of fish and other sea creatures scooped up in nets, allowed to suffocate, and dumped overboard as useless bycatch? Or the longline fisheries, whose miles and miles of baited hooks attract—and drown—creatures such as the loggerhead turtle and wandering albatross?

Do we countenance such loss because fish live in a world we cannot see? Would it be different if, as one conservationist fantasized, the fish wailed as we lifted them out of the water in nets? If the giant bluefin lived on land, its size, speed, and epic migrations would ensure its legendary status, with tourists flocking to photograph it in national parks. But because it lives in the sea, its majesty—comparable to that of a lion—lies largely beyond comprehension.

One of the ironies—and tragedies—of the Mediterranean bluefin hunt is that the very act of procreation now puts the fish at the mercy of the fleets. In the spring and summer, as the water warms, schools of bluefin rise to the surface to spawn. Slashing through the sea, planing on their sides and exposing their massive silver-colored flanks, the large females each expel tens of millions of eggs, and the males emit clouds of milt. From the air, on a calm day, this turmoil of reproduction—the flashing fish, the disturbed sea, the slick of spawn and sperm—can be seen from miles away by spotter plans, which call in the fleet.

On a warm July morning, in the sapphire-colored waters west of the Spanish Island of Ibiza, six purse-seine boats from three competing companies searched for giant bluefin tuna. The purse seiners—named for their conical, purse-like nets, which are drawn closed from the bottom—were guided by three spotter aircraft that crisscrossed the sky like vultures.

In the center of the action was Txema Galaz Ugalde, a Basque marine biologist, diver, and fisherman who helps run Ecolofish, one of 69 tuna ranching, or fattening, operations that have sprung up through the Mediterranean. A small company, Ecolofish owns five purse-seiners. Its main rival that morning was the tuna baron of the Mediterranean, Francisco Fuentes of Ricardo Fuentes and Sons, whose industrial scale operations have been chewing up giant bluefin stocks.

I was with Galaz on La Viveta Segunda—a 72-foot (22-meter) support vessel that was part of the fleet of dive boats and cage-towing tugs following the purse seiners. Around 11 a.m., the spotter planes spied a school, setting the purse seiners on a 19-knot dash. The stakes were high. Even a small school of 200 bluefin can fetch more than half a million dollars on the Japanese market. Galaz watched through binoculars as an Ecolofish seiner reached the school first and began encircling it with a mile-long net.
"He's fishing!" Galaz shouted. "He's shooting the net!"

It was not an unalloyed victory. Before Ecolofish's boat could complete its circle, a Fuentes seiner rushed forward and stopped just short of the unfurling net. Under one of the few rules that exist in the free-for-all for Mediterranean bluefin, this symbolic touch entitled the competing boat to split the catch fifty-fifty.

Over the next several hours, Galaz and his divers transferred the fish—163 bluefin, averaging about 300 pounds (135 kilograms)—from the purse-seine net into the sea cage, a large holding pen about 160 feet (50 meters) in diameter, with a sturdy plastic frame supporting a heavy mesh net. As the pen, already brimming with a thousand bluefish caught in the days before, was aligned with the purse-seine net, Galaz invited me into the water.

Swimming with the tuna was mesmerizing but unsettling. Giant bluefin are, as Galaz put it, "like missiles, prepared for speed and power." Their backs were battleship gray topped with a saw-toothed line of small yellow dorsal fins. Their sides had the look of battered chrome and steel; some bore the streak of an electric blue line. The larger fish, weighing more than 500 pounds (225 kilograms), were at least eight feet long (2.4 meters).

One giant bluefin—some 300 pounds (135 kilograms) heavier and two feet (.6 meter) longer than most of the others—caught my eye. It was not swimming endlessly with the school in a clockwise gyre. Instead, it darted in different directions, sullen and aggressive, nearly brushing against me as it scanned me with large, black, disk-shaped eyes. There was something else: a stainless-steel hook embedded in its mouth, trailing a long strand of monofilament line. In recent weeks, this fish had lunged at one of the thousands of baited hooks set by a longline vessel. Somehow, it had broken free.

After untying the large mesh gates on the pen, Galaz and his divers began herding fish. Peeling off from their gyre, the bluefin whizzed into the cage like torpedoes. The fish with the hook in its mouth was one of the last to leave, but eventually it shot up from the depths and into the cage, dragging a diver who had hitched a ride on the line.

Ecolofish's catch was part of an annual legal take of 32,000 tons (29,000 metric tons) in the Mediterranean and eastern Atlantic. The true quantity, however, is closer to between 50,000 and 60,000 tons (45,000 and 55,000 metric tons). The group charged with managing bluefin tuna stocks, the International Commission for the Conservation of Atlantic Tuna (ICCAT), has acknowledged that the fleet has been violating quotas egregiously. Scientists estimate that if fishing continues at current levels, stocks are bound to collapse. But despite strong warnings from its own biologists, ICCAT—with 43 member states—refused to reduce quotas significantly last November, over the objections of delegations from the U.S., Canada, and a handful of other nations. Because bluefin sometimes migrate across the Atlantic, American scientists, and bluefin fisherman who abide by small quotas off their coasts, have long been calling for a large reduction in the Mediterranean catch.

"The Mediterranean is at the point that if bluefin stocks are not actually collapsing, they are approaching collapse," said William T. Hogarth, ICCAT's recently appointed chairman who also serves as director of the U.S. National Marine Fisheries Service. "I was really disappointed—when it got to the bluefin, science just seemed to go out the window. The bottom line was that, as chairman, I felt I was sort of presiding over the demise of one of the most magnificent fish that swims the ocean."

The story of giant bluefin tuna began with unfathomable abundance, as they surged through the Straits of Gibraltar each spring, fanning out across the Mediterranean to spawn. Over millennia, fisherman devised a method of extending nets from shore to intercept the fish and funnel them into chambers, where they were slaughtered. By the mid-1800s, a hundred tuna traps—known as tonnara in Italy and almadraba in Spain—harvested up to 15,000 tons (13,600 metric tons) of bluefin annually. The fishery was sustainable, supporting thousands of workers and their families.

Today, all but a dozen or so of the trap fisheries have closed, primarily for lack of fish but also because of coastal development and pollution. One of the few that remains is the renowned tonnara on the island of Favignana off Sicily. In 1864, Favignana's fishermen took a record 14,020 bluefin, averaging 425 pounds (195 kilograms). Last year, so few fish were caught—about 100, averaging 65 pounds (30 kilograms)—that Favignana held only one mattanza, which occurs when the tuna are channeled into a netted chamber and lifted to the surface by fishermen who kill them with gaffs. One sign of the Favignana tonnara's diminishment is that it is run by a Rome marketing executive, Chiara Zarlocco, whose plan for the future is to dress the fishermen in historic costumes as they reenact the mattanza.

The big trouble for Atlantic bluefin began in the mid-1990s. By then, stocks of southern bluefin tuna—which, along with Pacific bluefin and Atlantic bluefin, compose the world's three bluefin species, all treasured for sushi—had been fished to between 6 and 12 percent of the original numbers in the South Pacific and Indian Oceans. As the Japanese searched for new sources, they turned to the Mediterranean, where bluefin reserves were still large.

In 1996, Croatians who had developed techniques for fattening southern bluefin in Australia established the first Mediterranean tuna ranch, in the Adriatic. The process is simple. Newly caught bluefin are transferred to coastal sea cages where—for months, even years—they are fed oily fish such as anchovies or sardines to give their flesh the high fat content so prized in Japan.

The prospect of producing a steady—and highly profitable—supply of fatty Mediterranean bluefin set off a cascade of events that has proved disastrous. The Mediterranean fleet has increased its fishing effort threefold, with the bluefin flotilla now totaling 1,700 vessels, including 314 purse seiners. Compounding the problem, the advent of tuna ranching made it difficult for the European Union and national governments to enforce quotas. Bluefin are netted at sea, fattened offshore, killed offshore, and flash-frozen on Japanese ships. As Masanori Miyahara of the Fisheries Agency of Japan, and a former ICCAT chairman, told me: "It's kind of a black box."

The spread of tuna ranching means that bluefin are being wiped out at all stages of their life cycle. In Croatia, for instance, the industry is based almost entirely on fattening juveniles for two to three years, which means fish are killed before they spawn. Elsewhere, in places such as the Balearic Islands, large females, capable of producing 40 million eggs, are being wiped out. In just ten years, bluefin populations have been driven down sharply.

"What's happening is a bit like what happened to cod," said Jean-Marc Fromentin, a marine biologist and bluefin expert with IFREMER, the French Research Institute for the Exploitation of the Seas. "You don't see the decrease right away because you have had a huge accumulation of biomass. But it's like having a bank account, and you keep taking much more out than you're putting in."

At the heart of the fishing activity is Francisco Fuentes and his Cartegena-based company, Ricardo Fuentes & Sons, which, according to industry experts, controls 60 percent of the giant bluefin ranching business in the Mediterranean, generating revenues of more than 220 million dollars a year, according to industry sources. (A Fuentes spokesman said revenues are roughly half that.) In partnership with the Japanese giants Mitsui, Mitsubishi, and Maruha, the Fuentes Group—with the help of EU and Spanish subsidies—has bought sea cages, tugs, and support boats needed for large-scale fattening operations. Fuentes & Sons also formed partnerships with French and Spanish companies that owned 20 purse seiners—five-million-dollar vessels equipped with powerful sonar systems and nets that can encircle 3,000 adult bluefin.

With the Fuentes Group and its partners leading the way, the bluefin fleet methodically targets fish in the spawning grounds close to Europe, then turned its attention to untouched areas. The richest of these de facto reserves was Libya's Gulf of Sidra. "It was the tuna aquarium of the Mediterranean," recalled Roberto Mielgo Bregazzi, a tuna ranching consultant who first visited the Gulf of Sidra six years ago. "I've never seen anything like it. The average size of bluefin was over 600 pounds (270 kilograms). It was one of the last tuna Shangri-Las."

Mielgo Bregazzi, a dapper Spaniard and former professional divert who heads Advanced Tuna Ranching Technologies, has been on a mission to expose IUU—illegal, unreported, and unregulated—bluefin fishing. Drawing on a wide network of inside sources, as well as published information, he was written lengthy reports detailing the IUU bluefin business. Using arcane data such as the capacity and schedules of Japanese freezer vessels, he has shown that the Mediterranean tuna fleet has been seizing almost double its annual legal quota.

Mielgo Bregazzi said Ricardo Fuentes & Sons and a French partner have worked with a Libyan company, Ras el Hillal, to catch giant bluefin in Libyan waters. Mielgo Bregazzi said that Seif al Islam Qaddafi, the son of Libyan leader Muammer Qaddafi, has a financial interest in Ras el Hillal and has earned millions of dollars from the bluefin fishery. Mielgo Bregazzi calculates

that, for the past four years, bluefin fleets netted more than 10,000 tons (9,000 metric tons) of bluefin annually in Libyan waters. Some of the catch is legal under quotas for Libyan, Spanish, and French boats, but much of it appears to be caught illegally.

David Martinez Cañabate, assistant manager of the Fuentes Group, said the company has "absolutely" no connection to the Qaddafi family and that all bluefin tuna it catches, buys, or ranches have been legally caught and properly documented with ICCAT and Spanish authorities. He conceded that bluefin have been overfished, mainly by companies that do not ranch tuna but sell the fish soon after netting them. Fleets from other countries also catch bluefin without an ICCA quota and ranch them illegally, Martinez said. He said much of Mielgo Bregazzi's information is "incorrect or, worse, bad intentioned" and that the Fuentes group has supported stricter conservation measures. "We are more interested than anyone in the future of the tuna," Martinez said. "We live off this resource."

Actually, Libyan and other Mediterranean bluefin have so flooded the market that Japanese companies have stockpiled 20,000 tons (18,000 metric tons) in giant freezers. The glut halved prices for fishermen in the past few years, to between three and four dollars a pound. Still, the value of the bluefin caught annually in Libya, then fattened for several months, is roughly 400 million dollars on the Japanese market.

"They're slaughtering everything," Mielgo Bregazzi said. "The fish don't stand a chance."

The extent to which giant bluefin fleets flout regulations became evident during a visit to the Italian island of Lampedusa, south of Sicily. To give the tuna a reprieve during peak spawning season, EU and ICCAT rules prohibit spotter aircraft from flying in June. The regulation is often ignored.

I flew one June morning with Eduardo Domaniewicz, an Argentine-American pilot who has spotted for tuna for French and Italian purse seiners since 2003. Riding shotgun was Domaniewicz's spotter, Alfonso Consiglio. They were combing the waters between Lampedusa and Tunisia, and they were not alone: Three other spotter aircraft were prowling illegally, relaying tuna sightings to some of the 20 purse seiners in the water below. (After two hours, high winds and choppy seas, which make it difficult both to see and net the first, forced the planes to return to Lampedusa and Malta.

Domaniewicz was conflicted. He loved to fly and was well paid. He believed his June flights were legal, because Italy never agreed to the ban. But after three years of spotting for the bluefin fleet, he was fed up with the uncontrolled fishing. Just before I arrived on Lampedusa, he had watched two purse-seine fleets net 835,000 pounds (380,000 kilograms) of bluefin, sharing more than two million dollars.

"There is no way for the fish to escape—everything is high-tech," Domaniewicz said. Speaking of the French purse-seine fishermen he worked for in Libya, he said, "I am an environmentalist, and I couldn't stand the way they fished with no care for the quotas. I saw these people taking everything. They catch whatever they want. They just see money on the sea. They don't think what will be there in ten years."

Alfonso Consiglio, whose family owns a fleet of purse seiners, also is torn. "The price is cheap because more and more tuna are being caught," he said. "My only weapon is to catch more fish.

It's a vicious circle. If I catch my quota of a thousand tuna, I can't live because the price is very cheap. I want to respect the quota, but I can't because I need to live. If boats of all countries respect the rules, tuna will not be fished. If only few countries respect the rules, and others don't respect the rules, the fisherman who respects rules is finished."

How can this endless cycle of overfishing be stopped? How can the world's fleets be prevented from committing ecological and economic suicide by depleting the oceans of bluefish tuna, shark, cod, haddock, sea bass, hake, red snapper, orange roughy, grouper, grenadier, sturgeon, plaice, rockfish, skate, and other species?

Experts agree that, first, the world's oceans must be managed as ecosystems, not simply as larders from which the fishing industry can extract protein at will. Second, the management councils that oversee fisheries, such as ICCAT, long dominated by commercial fishing interests, must share power with scientists and conservationists.

Further, governments must cut back the world's four million fishing vessels—nearly double what is needed to fish the ocean sustainably—and slash the estimated 25 billion dollars in government subsidies bestowed annually on the fishing industry.

In addition, fisheries agencies will have to set tough quotas and enforce them. For giant bluefin in the Mediterranean, that may mean shutting down the fishery during the spawning season and substantially increasing the minimum catch weight. ICCAT recently failed to decrease quotas significantly or close the fishery at peaks spawn, although it did to increase the minimum catch weight in most areas to 66 pounds (30 kilograms) and ban spotter aircraft. But without inspection and enforcement, the commission's new rules will, like the old ones, mean little.

Another crucial step, both in the Mediterranean and around the world, would be the creation of large marine protected areas. Also important are campaigns by such groups as the Marine Stewardship Council, which is working with consumers as well as retail giants to promote trade in sustainably caught fish.

The news from the fisheries front is not unremittingly grim. Indeed, where sound fisheries management exists, fish populations—and the fishing industry—are healthy. A prime example is Alaska, where stocks of Pacific salmon and pollock are bountiful. Iceland's cod fishery is thriving, because it, too, follows a cardinal conservation rule: Limit the number of boats that can pursue fish.

But all agree that the fundamental reform that must precede all others is not a change in regulations but a change in people's minds. The world must begin viewing the creatures that inhabit the sea much as it looks at wildlife on land. Only when fish are seen as wild things deserving of protection, only when the Mediterranean bluefin is thought to be as magnificent as the Alaska grizzly or the African leopard, will depletion of the world's oceans come to an end.

The New York Times

February 19, 2008
Revealed: Secrets of the Camouflage Masters
By CARL ZIMMER

WOODS HOLE, Mass. — The cuttlefish in Roger Hanlon's laboratory were in fine form. Their skin was taking on new colors and patterns faster than the digital signs in Times Square.

Dr. Hanlon inspected the squidlike animals as he walked past their shallow tubs, stopping from time to time to ask, "Whoa, did you see that?"

One cuttlefish added a pair of eye spots to its back, a strategy cuttlefish use to fool predators. The spots lingered a few seconds, then vanished.

When Dr. Hanlon stuck his finger into another tub, three squirrel-size cuttlefish turned to chocolate, and one streaked its back and arms with wavy white stripes.

"Look at the pattern on that guy," he said with a smile as they lunged for his finger.

In other tubs, the cuttlefish put on subtler but no less sophisticated displays. Dr. Hanlon's students had put sand in some tubs, and there the cuttlefish assumed a smooth beige. On top of gravel, their skins were busy fields of light and dark.

Dr. Hanlon likes to see how far he can push their powers of camouflage. He sometimes put black and white checkerboards in the tubs. The cuttlefish respond by forming astonishingly sharp-edged blocks of white.

"We can give them any hideous background," he said, "and they will try to camouflage."

Cuttlefish and their relatives octopus and squid are the world's camouflage champions. But Dr. Hanlon and his colleagues have just a rough understanding of how these animals, collectively known as cephalopods, disguise themselves so well.

Dr. Hanlon, a senior scientist at the Marine Biological Laboratory here, has spent much of the last three decades studying them in his laboratory and on thousands of ocean dives. He said he believed that he finally had a theory for how they achieve their magic.

In fact, he said it could account for all the camouflage patterns made by animals like katydids and pandas. For all the variety in the world of camouflage, there may be a limited number of ways to fool the eye.

Dr. Hanlon's scientific career was a foregone conclusion. At age 18, he took his first dive in Panama and spotted an octopus hiding on a coral reef. After serving as an Army lieutenant for two years, he entered graduate school at the University of Miami, where he began to study cephalopod camouflage.

He has spent much of his career underwater, swimming around coastal reefs and rocky coastal waters from the Caribbean to South Africa to Australia.

Typically, Dr. Hanlon and his colleagues follow a single cephalopod, filming for hours as it shifts its skin. On some dives, Dr. Hanlon uses a spectrometer to obtain precise measurements of the light in the water and the reflections from the animal. The tedium is interrupted now and then by acts of spectacular deception. Cephalopods do not just mimic the colors of the sea floor or coral reefs. Sometimes, they make their arms flat and crinkled and wave them like seaweed.

Dr. Hanlon has watched octopuses perform what he calls the Moving Rock Trick. They assume the shape of a rock and move in plain sight across the sea floor. But they move no faster than the ripples of light around them, so they never seem to move.

Dr. Hanlon's jaw-dropping footage has appeared on a number of documentaries. One pirated segment has wound up on YouTube, where it has been viewed hundreds of thousands of times.

Dr. Hanlon approaches normal-looking coral at Grand Cayman Island. When he is a few inches away, half the coral suddenly becomes smooth and white. An eye pops open, and an octopus that has been clinging to the coral shoots away.

Despite thousands of dives, Dr. Hanlon still considers himself a novice in spotting cephalopods. Once, after following an octopus for an hour and a half, he looked away a moment to switch cameras. When he looked back, the animal was gone.

He and his colleagues swam for 20 minutes before realizing it was right in front of them, exactly where they had seen it before. "I was really angry," Dr. Hanlon said. "They still fool me, even though I think I know what I'm looking at."

In recent years, Dr. Hanlon has been spending much of his time diving along southern Australia, where a colleague discovered the only major spawning grounds for cuttlefish ever found. Every year, hundreds of thousands of Australian giant cuttlefish gather there to mate and lay eggs. "I'd been searching for a place like that for 25 years," he said. "The first time I stuck my head in the water, I said, 'I've died and gone to cuttlefish heaven.' "

In his cuttlefish heaven, Dr. Hanlon has discovered new dimensions to camouflage. Curious to observe the animals at night, he and his colleagues used an underwater robot to film them in dim red light. The footage revealed something never seen before, cephalopods disguising themselves at night.

"This was stunning to us," Dr. Hanlon said. "They were perfectly camouflaged no matter where they were."

Evidently, they have to hide even in darkness from dolphins and other predators.

Cuttlefish can also use camouflage to deceive other cuttlefish, Dr. Hanlon and his colleagues have found. A male cuttlefish will typically guard several females from other challengers. He does not often have physical fights. It is enough for him to put on a powerful visual display.

But if another male disguises its skin to look female, he can sneak up to the guarded female and mate. The sneaky male's disguise may be so good that the other male may try to guard him as part of his harem.

Beyond documenting the varieties of camouflage, Dr. Hanlon also wants to understand how the animals produce them. At his lab, he studies the powerful visual system of cuttlefish. Cephalopods have huge eyes, and much of their brain is dedicated to processing visual information. They use this information to control their disguises through a dense network of nerves running from the brain to the skin.

The animals use a number of strategies to alter appearances. The skin layers can swell and contract, changing the reflected colors. At the same time, the cuttlefish can also control millions of pigment-filled organs, causing them to flatten like pancakes to add patterns to their skin.

“It’s smart skin,” Dr. Hanlon said. “It’s all wired up.”

Edwin Thomas, an engineer at the Massachusetts Institute of Technology, was so impressed by Dr. Hanlon’s work on cuttlefish skin that he decided to mimic it. Dr. Thomas and his colleagues created a thin layer of gel that changes colors when it swells with water and shrinks. “Roger’s animals can also do that,” Dr. Thomas said, “but they’re doing it without scientists involved.”

For all the complexity of their skin, Dr. Hanlon suspects that the cephalopods also use mental shortcuts. “They don’t have time to analyze all this visual information,” he said.

A clue to how cephalopods disguise themselves so quickly came to Dr. Hanlon when he and his colleagues reviewed thousands of images of cuttlefish, trying to sort their patterns into categories. “It finally dawned on me there aren’t dozens of camouflage patterns,” he said. “I can squeeze them into three categories.”

One category is a uniform color. Cephalopods take on this camouflage to match a smooth-textured background. The second category consists of mottled patterns that help them hide in busier environments. Dr. Hanlon calls the third category disruptive patterning. A cuttlefish creates large blocks of light and dark on its skin. This camouflage disrupts the body outlines.

To test this hypothesis, Dr. Hanlon and his colleagues have been giving cuttlefish carefully controlled background patterns to match, natural patterns like sand and gravel as well as artificial ones like checkerboards. The researchers film the cuttlefish and classify them with image-processing software.

The three-category hypothesis has been holding up, Dr. Hanlon said. He illustrates it in spectacular fashion with a cuttlefish sitting on sand. If he drops a few white rocks into the water, the cuttlefish immediately inspects them and adds what looks like a white rock to its skin, disrupting its outline.

Innes Cuthill, an expert on camouflage at the University of Bristol, called Dr. Hanlon’s research fascinating and inspiring. Dr. Cuthill agreed that cuttlefish had limits to its camouflage. “It can’t reproduce the Mona Lisa on its back,” he said.

But he still considers it an open question how much the constraints come from cuttlefish brain wiring and how much from the limited range of backgrounds that cuttlefish encounter.

What he learned from cephalopods may apply throughout the animal kingdom. The fact that cephalopods may need just three camouflage categories could mean that there are just a few basic ways to fool predators.

Recently, Dr. Hanlon and students sorted through thousands of pictures of other camouflaged animals and found that they appeared to fall into the same three categories. A frog may have drab skin to blend into the drab forest floor. A bird may have mottled plumage, so that it matches the leaf and branch pattern surrounding it.

Dr. Hanlon argues that the black and white patches on a giant panda are a form of disruptive camouflage. If a panda is up in a tree, the chunks of black and white blend into the sunlight and shadows. It may be able to hide on a snowy landscape this way, as well.

Cephalopods are singular for changing quickly among all three categories. Chameleons can change between them, too, but they shift slowly, as hormones spread across their skin.

Dr. Hanlon is looking for more evidence for his three categories by figuring out the rules that cuttlefish use to decide how to hide themselves. Although he says he has found some rules, there is much to figure out.

To use disruptive patterning, cuttlefish need to make sure that their color blocks are on the same scale as the objects around them. Dr. Hanlon has yet to figure out how they measure that.

“They’re doing it in some magical way we don’t yet understand,” he said.

Dr. Hanlon and his colleagues are also puzzled by the many camouflage colors of the cuttlefish, which have a single type of pigment in their eyes. Humans have three.

Experiments in Dr. Hanlon’s lab have shown that they are color blind. They see a world without color, but their skin changes rapidly to any hue in the rainbow. How is that possible?

“That’s a vexing question,” he said. “We don’t know how it works.”

Despite opposition, ocean iron fertilization forging ahead
June 10, 2008 - Exclusive
By Carli Ghelfi, Cleantech Group

In the face of continued international opposition toward ocean iron fertilization (OIF), advocates are apparently damning the torpedoes.

Those advocates include San Francisco-based Climos, which today reaffirmed it plans to continue with its controversial stated business goals of testing and commercially developing OIF to assist in carbon sequestration.

Delegates to both the U.N. conference on biological diversity (CBD) and the London Convention, a group which oversees dumping at sea and is part of the International Maritime Organization (IMO), have been vocal in calling for more research before companies, such as

Climos and Australia's Ocean Nourishment, move forward with ocean carbon sequestration projects.

At respective meetings in recent weeks, countries pursuing a moratorium on OIF at CBD's meeting in Bonn, Germany didn't quite achieve one, despite reports, but resolved that OIF should only continue on the level of small scale, coastal operations for now.

Separately, the London Convention requested nations pay attention to a statement the IMO is to release later this year on the topic.

While these two groups represent almost three hundred countries formally expressing caution about OIF (CBC: 191, London Convention: 88) [ed.: and note the U.S. is not one of them], American startup Climos says it's undeterred.

"Our plans haven't changed at all," Climos CEO Dan Whaley told Cleantech Group today. "Our goals have always been to fund a demonstration of this technique with some of the leading oceanographers and a world-class research vessel in an open and transparent way."

While Whaley reiterated he understands the concerns of the greater international scientific community, he said Climos' plans to obtain a permit and to continue to seek funding are still on course, and he expects to execute a demonstration in the next year and a half.

"I don't want to be flip with my answer in terms of our actions," said Whaley. "We'll seek a permit under the [London Convention]. This statement does not affect us not doing that."

Discovered almost 20 years ago by scientist John Martin, ocean iron fertilization uses photo plankton as a conduit for sequestering carbon. In the process, the plankton bloom, mature and die, and then supposedly sink to the ocean, carrying carbon with them.

Critics worry that seeding the ocean with large volumes of iron could have unintended consequences. In a special report, the Intergovernmental Panel on Climate Change (IPCC) called OIF 'speculative and unproven, and with the risk of unknown side effects.'

According to Ken Buesseler, a senior scientist of marine chemistry and geochemistry at Woods Hole Oceanographic Institution in Massachusetts, scientists have been clear on the fact that the next experiments need to be bigger and larger, regardless if they are commercially funded.

Buesseler is the main scientist who organized meeting last November to provide an update on the science of OIF. Buesseler said he was trying to be a neutral ground to discuss the issues.

As a scientist, Buesseler is interested in how the scientific community can play its part and help reduce uncertainties of technology like OIF. "As a scientist, we can answer these questions. There's potential," he told the Cleantech Group.

"Some people seem philosophically opposed form the start," continued Buesseler. "I think it's an open question."

According to Buesseler, so far there have been 12 open ocean experiments, ranging from 1-4 weeks, with 1-2 tons of elemental iron, and over approximately 10 x 10 km in the ocean.

Buesseler said the scientific community would like to expand the experiments to 100 x 100 km, using 10-20 tons of iron so they can see the full growth cycle of plankton and find out where the carbon actually ends up (the bottom of the ocean, or at the surface).

When asked who the people are who have voiced their opposition to OIF, Buesseler said they are the ones who are fundamentally opposed to doing anything to the ocean, which is something he personally disagrees with.

“We’re already changing the ocean,” said Buesseler. “You can’t avoid altering the ocean by continuing to drive cars and emitting CO2. The ocean will change no matter what.”

“One argument against OIF is if you take to the extreme and take every square inch of the ocean and alter it. That’s unacceptable.”

Conversely, Buesseler said he wouldn’t argue that we shouldn’t take any fish out of the ocean to explore the possibilities, but there are still people who are fundamentally opposed to this.

“There’s no evidence either way, but the next large experiments won’t likely [take fish out of the ocean] either.”

Buesseler said he fears that if we don’t explore all the possibilities for reducing emissions, we’ll continue on the carbon heavy path we’re already on. “We know we’re already changing the ocean. That’s not acceptable.”

Buesseler reiterated the likely disagreement from the IMO is the immediate granting of carbon credits based on experiments. “What concerned people was that there were companies that didn’t have any interest in real science. That’s some of the negative view.”

“You can’t sell offsets until you measure the risk and the benefits.”

In an interview with Cleantech Group this January, Climos' Whaley said he believes the carbon trading markets can finance fertilization projects (see Plankton to the rescue).

In the meantime though, Whaley said Climos is set on finding private funding and will continue with its plans of another round of funding in 2009.

Now-defunct Planktos was pursuing a business plan similar to Climos

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Salty Mars Looking Bad for Life

By Richard A. Kerr
ScienceNOW Daily News
29 May 2008
NASA's "follow the water" approach to exploring Mars has led to tantalizing clues that microbial life may have existed at some point on the Red Planet. But any organisms would have to have

been extremely hardy to survive, according to new calculations. At the places visited so far, at least, it may have been too salty for any Earth-like life at all.

Here on Earth, life seems to have permeated every nook and cranny, from temperate oceans to million-year-old permafrost. But not every environment is hospitable. Curiously enough, it is the food industry that has explored these most extreme conditions. Cram the maximum amount of salt or sugar into a water solution--as in salting meat or making strawberry preserves--and microbes are hard-pressed to survive, much less grow. That's because the ions of dissolved salt hold on to so many water molecules that few are left to support microbial life.

So was early Mars a warm bath or salt pork? Geochemist Nicholas Tosca of Harvard University and his colleagues calculated the salinity of long-gone waters from the composition of the salts left behind both at Meridiani Planum, where the Opportunity rover found the remains of salty groundwater, and at Gusev crater, where Spirit found volcano-related hydrothermal deposits. They also looked at subsurface rocks blasted off Mars that became meteorites collected on Earth.

Even the most salt-loving organisms of Earth couldn't handle the most concentrated martian brines of 4 billion years ago, Tosca and his colleagues report tomorrow in Science. By then, martian waters were 10 to 100 times more saline than Earth's seawater, they found. What's more, the high acidity and chemically oxidizing conditions of the time--previously inferred from mineral compositions--made these waters even more inhospitable. "Our paper compresses the window of opportunity [for life] to a very short span very early in Mars's history," says Tosca, when water may have been far fresher.

"Tosca et al. are making some very good points," writes planetary geochemist Jeffrey Kargel of the University of Arizona, Tucson, in an e-mail, but "they carry it too far." Perhaps early exploration has been drawn to the most saline and therefore most obvious sites, he writes, missing more hospitable places. Microbiologist Kenneth Nealson of the University of Southern California in Los Angeles also holds out hope for life. Faced with greater challenges, martian life may have evolved even better ways to cope with salty water than Earth's microbes have devised. "Keep on following the water" is the message, say these optimists--and the Phoenix lander is doing just that (ScienceNOW, 27 May). Within weeks, it will be analyzing far younger and presumably far fresher water in the martian arctic.

(A different take on the Methuselah tree story. For a third, see June 17 New York Times: http://www.nytimes.com/2008/06/17/science/17obseed.html?_r=1&ref=science&oref=slogin)

'Methuselah' tree grows from ages-old seed

By Kelli Whitlock Burton, Globe Correspondent | June 16, 2008

The 4-foot-tall sapling looks just like any other young date palm. But the tree, growing in a laboratory in Jerusalem, is anything but ordinary. Named "Methuselah" by one of its cultivators, the sapling grew from a 2,000-year-old seed - the oldest scientifically dated seed to ever be germinated.

In a study reported last week in the journal Science, a team of Israeli researchers confirmed the seed's age using radiocarbon dating, which determines age by measuring levels of a type of carbon found in all living organisms that decays at a specific rate.

The Methuselah seed, named after the oldest person in the Bible, was recovered 40 years ago, along with other seeds, from an archeological dig at Masada, an ancient stronghold where nearly 1,000 Jewish zealots are said to have committed suicide rather than be captured by Roman soldiers around AD 70.

The seeds sat in a drawer until 2005, when Israeli scientist Dr. Sarah Sallon procured them for study. She and botanist Elaine Solowey planted three seeds and held their breath. Eight weeks later, the first shoots poked through the soil.

"Elaine called and said, 'The earth has cracked in one of the flower pots. Something is growing,' " recalls Sallon, a pediatric gastroenterologist who led the study. Sallon also serves as director of the Louis L. Borick Natural Medicine Research Center, which she started 13 years ago after becoming ill in India with a severe intestinal illness that only an herbal potion from a local doctor could cure.

The herbs did more than restore Sallon's health. Since then, she has spent more than a decade studying the medicinal properties of plants, most of which are found in the Middle East. Many of the region's plants historically noted for healing properties are extinct. Such was the case with the Judea date palm, until Methuselah. Sallon and her colleagues are waiting now to see whether the tree will produce fruit in another few years. If Methuselah turns out to be female, the scientists could use it to grow more Judea date palms.

"That this plant is doing so well is wonderful," says Jane Shen-Miller, a research biologist at the University of California, Los Angeles. Until this latest study, the oldest germinated seed was a sacred lotus tree grown by Shen-Miller, which in 2005 was reported to be 1,300 years old.

Studies of ancient seeds such as these could give scientists a look at mechanisms that protect the seeds for thousands of years. Shen-Miller is particularly interested in understanding how these ancient seeds repair age-related cellular damage, which they must do to sprout.

Beyond the scientific advances that studies of ancient seeds might provide, Sallon notes the potential for medicinal uses of plants grown from these seeds. That was, after all, what inspired Sallon to start this research in the first place.

She and her colleagues have a plantation of about 300 plant species that they hope will yield remedies for malaria, bacterial infections, even cancer. History has recorded many instances of these and other plants' use for medical treatment, Sallon says, noting that religious tomes such as the Bible, Koran and Talmud offer some of the best evidence of plants' medicinal uses over the ages. These texts are also a reminder of the spiritual meaning many plants hold for cultures around the world. Take, for example, the Judea palm now growing in her lab.

"This tree once had enormous significance as a symbol of life and peace," Sallon says. "And it can again."