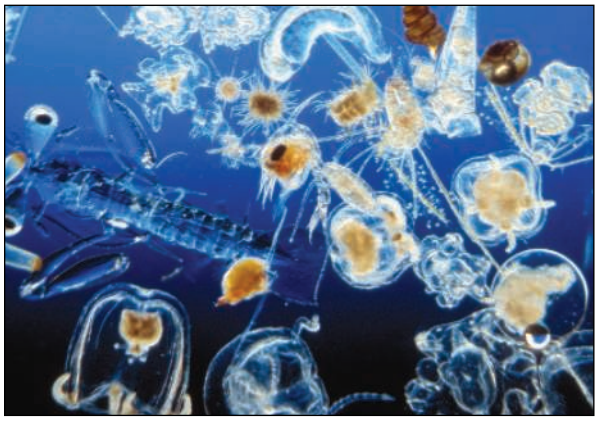
CLIMATE CHANGE

Changes in Planktonic Food Web Hint At Major Disruptions in Atlantic

Land plants and animals are already responding to global warming. Cherry trees in Japan are blossoming ever earlier in the spring, for example, and some birds in northern Europe lay their eggs sooner than they used to. The oceans appear to be warming as well, and several groups are studying how the changes might be affecting marine organisms. Now two papers provide the most comprehensive, longest-term look at the impact of rising temperatures on ocean ecosystems.

On page 1609, Anthony Richardson, a numerical ecologist at the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) in Plymouth, U.K., and marine ecologist David Schoeman of the University of Port Elizabeth in South Africa show that the abundance of plankton in the northeast Atlantic has shifted with water temperature over the past 45 years. And in the 19 August issue of *Nature*, Richardson and SAHFOS marine ecologist Martin Edwards reported that the timing of seasonal abundance of plankton has shifted in ways that already may have radically disrupted the food web. "These changes in the plankton will almost certainly have huge impacts on commercial fisheries and so will have accompanying economic implications," comments marine ecologist Graeme Hays of the University of Wales, Swansea.



In flux. Plankton communities are changing radically in the northeast Atlantic, a broad new study has found.

Both sets of findings come from a unique monitoring effort called the Continuous Plankton Recorder survey, run by SAHFOS. Since 1931, researchers have hitched small sampling devices behind freighters that ply the North Atlantic, and since 1997, in the North Pacific as well. Every unit contains a long roll of silk that collects plankton as it slowly spools into an internal chamber. Each 10 centimeters of silk harvests about 18 kilometers' worth of plankton, which are identified in the lab. More than 9 million kilometers have been towed over the past 70 years. "It's only with data sets like this that we're going to be able to understand the impact of climate change," says biological oceanographer Charles Greene of Cornell University.

Using these data, SAHFOS researchers have previously discovered biological changes, such as the northward shift of some plankton species in parts of the northeast Atlantic (*Science*, 31 May 2002, p. 1692) and changes in the abundance of a few species. The new *Science* paper expands that effort by looking at more than a hundred taxa, including phytoplankton, such as diatoms and dinoflagellates; ▶

SCIENTIFIC PUBLISHING

NIH Proposes 6-Month Public Access to Papers

The National Institutes of Health (NIH) has released a draft policy aimed at increasing public access to the results of NIH-funded research. The proposal issued 3 September in the NIH Guide* would require grantees to deposit copies of their papers in NIH's free PubMed Central archive once they have been accepted by a journal. Manuscripts would be posted online 6 months after publication.

In July, a congressional spending panel recommended that NIH post NIH-funded manuscripts within 6 months of publication, or immediately if NIH grants were used to pay publication costs. The language, part of NIH's pending 2005 budget, triggered frenzied lobbying on all sides. Librarians, patient organizations, and scientists who think taxpayers should have easier access to NIH-funded research urged NIH to follow the House language. Commercial publishers and many scientific societies lobbied against a mandatory plan, saying it could bankrupt many journals.



Timed release. NIH's Elias Zerhouni sets limit for posting papers.

NIH Director Elias Zerhouni, who has held meetings recently with interested groups, told scientists last week that 6 months was "reasonable" (*Science*, 3 September, p. 1386). The draft policy is similar to the House language: Investigators will submit their final, peer-reviewed manuscript to PubMed Central. Journals can ask NIH to replace the manuscript with the published paper, sooner than 6 months if they wish. NIH plans to take comments for 60 days and will also post the draft policy in the *Federal Register*.

"We're strongly behind it," says Richard Johnson of the Scholarly Publishing and Academic Resources Coalition. His group "would have preferred immediate access, but we see this as an important step forward."

Scientific societies had a mixed reaction. Alan Leshner, executive director of AAAS (which publishes *Science*), calls the policy "a reasonable compromise" but says it "could pose significant risk for some scientific societies." And Martin Frank, executive director of the American Physiological Society, calls the plan "an unnecessary expenditure of federal funds for a redundant repository of peer-reviewed literature." He notes that most journals already provide back articles for around $5 to $30, or for free after a certain period. Frank also wonders how PubMed Central will keep track of manuscripts submitted separately by co-authors of the same paper. "It could be chaos out there," he warns.

The Association of American Publishers (AAP), which is also worried about the policy's impact on free markets, plans to take its objections to senators Arlen Specter (R–PA) and Tom Harkin (D–IA), chair and ranking member, respectively, of the Senate appropriations committee for NIH, which will take up the spending bill once it passes the House. "We think there are a lot of questions that should be answered," says Allan Adler, AAP vice president for legal and governmental affairs. However, last week Specter told *The Washington Post* that he does not intend to intervene. **–JOCELYN KAISER**

*grants1.nih.gov/grants/guide/notice-files/NOT-OD-04-064.html

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herbivores, such as crustaceans called copepods; and carnivorous plankton, including arrow worms and voracious crustaceans called amphipods.

Comparing the counts with changes in sea surface temperatures in 20 regions of the northeast Atlantic, Richardson and Schoeman found two patterns. Phytoplankton tended to become more abundant when cooler regions warmed, probably because higher temperatures boost metabolic rates. But they became less common when already warm regions got even warmer, possibly because warm water blocks nutrient-rich deep water from rising to the upper layers, where phytoplankton live. That variable response suggests that climate change will have regional impacts on fisheries, Hays says.

Richardson and Schoeman also demonstrated effects further up the planktonic food chain. When phytoplankton bloomed, both herbivores and carnivores became more abundant. The pattern indicates that the planktonic food web is controlled from the "bottom up," by primary producers, rather than from the "top down," by predators. That means climate effects on primary producers could reach all the way to fisheries. "To date, we are not very good at detecting the consequences of plankton changes for fisheries production or for the rest of the marine ecosystem," says fisheries scientist Keith Brander of the International Council for the Exploration of the Sea in Copenhagen, Denmark.

In the *Nature* paper, Richardson and Edwards charted shifts in the timing of seasonal plankton blooms over the decades. Each species has an annual cycle, and herbivores and carnivores have evolved to exploit the phytoplankton bloom. Since 1987, however, the cycle's peaks have shifted out of synch. In places where waters have warmed, the peak bloom of phytoplankton occurs 3 weeks earlier, but zooplankton grazers peak only 10 days earlier. If the discrepancy causes herbivores to go hungry, they could provide less prey for fish larvae and carnivorous plankton. "These effects at the base of the food web are so dramatic that they're bound to have an effect on the whole North Atlantic ecology," Edwards says.

Measuring that impact will take a lot of work, Greene says, because marine food webs are extremely hard to untangle. Still, he says, ecologists should be concerned, because much more northeast Atlantic warming is predicted. Brander expects further changes in plankton abundance and timing as warming continues. Although some species should adapt, Edwards says, new communities will also likely emerge.

SAHFOS and others will be watching.

–ERIK STOKSTAD

NUCLEAR PROLIFERATION

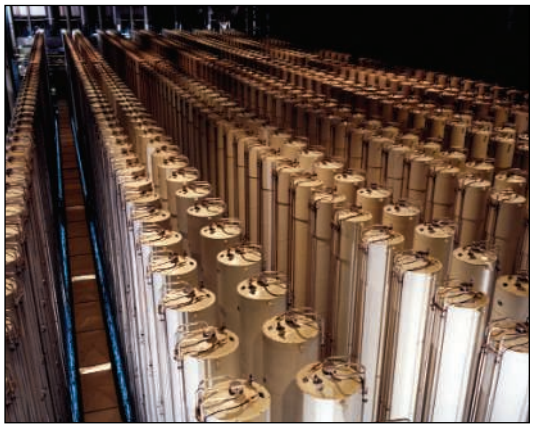
South Korea Admits to Laser Enrichment Program

Another secret nuclear program on the Korean Peninsula is in the news, but this time it's the work of South Koreans that's drawing criticism. The International Atomic Energy Agency (IAEA) announced last week that South Korea had used a covert isotope-separation program to create a few hundred milligrams of highly enriched uranium. The technology, potentially an energy-saving way to separate bomb-worthy uranium-235 from its less dangerous sibling uranium-238, was tried and abandoned in the United States and Russia over the past few decades.

Few details about the nature of the program are available. However, faced with IAEA inspections, the Republic of Korea (ROK) admitted that several years ago its scientists had produced small quantities of near–weapons-quality uranium by using lasers, apparently at a nuclear facility in Taejeon, South Korea. Although the ROK government is claiming that the laser-separation project was run by a handful of rogue scientists, proliferation experts believe that the program must have been sanctioned by higher-ups.

"It's their main nuclear research site," says nuclear proliferation expert David Albright, president of the Institute for Science and International Security in Washington, D.C. "The scientists worked for a government-owned agency, and they had to report to their bosses." Furthermore, nuclear experts say, the technology is too costly and intricate for a small group of rogue scientists to have pursued on its own.

The method in question is known as atomic vapor–laser isotope separation (AVLIS). AVLIS exploits a subtle difference in how uranium-235 and uranium-238 absorb light. Because the two atoms have different masses, they absorb very slightly different colors of light. By shining a laser of precisely the right color on a beam of mixed-isotope uranium vapor, scientists can induce the uranium-235 in the beam to absorb a photon of light and fly in one direction while the uranium-238 in the beam remains unaffected. That's the theory, anyway.



Spin control. Most countries have adopted nonlaser methods for enriching uranium, such as spinning it in gas centrifuges like these.

CREDIT: DOE

In practice, though, AVLIS hasn't proven useful for separating uranium on a large scale. "There are no commercial programs" that use lasers to separate uranium isotopes, says Thomas Cochran of the Natural Resources Defense Council in Washington, D.C. A diplomat who is knowledgeable about nuclear proliferation issues says the countries that have tried it concluded "it was too expensive; you could not produce enough [enriched uranium] quickly." In 1999, the United States killed its own AVLIS program, developed at Lawrence Livermore National Laboratory in California and run by a private firm based in Maryland.

Iraq and Iran also worked on laser-separation technologies, often with help from vendors in other countries. "Laser enrichment is not simple," says Kenneth Luongo, executive director of the Russian-American Nuclear Security Advisory Council in Washington, D.C. "In the Iranian case, they once had a deal with the Russians. In [the South Korean] case, it's not clear where the technology would have come from or whether it was developed indigenously."

Albright says he would be disturbed if the United States had been involved. "But I'd be even more worried if they'd made it themselves," he says, because it would mean that the technology isn't prohibitively difficult to develop. "It shows that, at the laboratory level, you can make nuclear materials."

The few hundred milligrams of enriched uranium are orders of magnitude less than what's needed to build a bomb. But producing even that amount is a serious violation of the nuclear nonproliferation treaty. "It's not so much the quantities but the fact that it wasn't declared," says the knowledgeable diplomat.

–CHARLES SEIFE

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