make available globally a plant collection begun almost 2 centuries ago and, at the same time, train a new generation of taxonomists. Although the effort has won high marks for its scientific merit, its progress is threatened by the country's economic crisis. Cost overruns in obtaining the necessary cabinets and supplies to refurbish and house the collection have forced officials to suspend plans to develop a computer database that would be accessible via the Internet. They have also shelved efforts to create and disseminate a host of products—such as documentation kits and field guides—to help would-be collectors.

The Indonesian effort illustrates what Vellinga and others call the experimental nature of GEF projects, which includes a willingness to take risks. "In retrospect, I believe the World Bank might have limited the scope of the project more and eliminated some items that were not so urgent," says Kathy MacKinnon, senior biodiversity specialist with the bank's global environment division. Still, MacKinnon applauds the Indonesian government for proposing "such an exciting and ambitious project as a national priority."

The importance of developing countries in shaping GEF's agenda is highlighted by the recent selection of Madhav Gadgil, a human ecologist at the Indian Institute of Science in Bangalore, to succeed Vellinga as chair of the scientific committee. India is the second largest recipient of GEF funds, and his appointment "is long overdue," says microbiologist Mostafa Kamal Tolba, the former executive director of UNEP.

Although the success or failure of individual projects is important, environmental scientists from both North and South say that GEF's biggest challenge will be to incorporate sustainable development into the actions of every participating nation. "GEF is a unique international experiment of learning by doing," says biologist Thomas Lovejoy, chief biodiversity adviser to the Smithsonian Institution and to the World Bank. "Living within natural ecosystems must become the accepted way for people to live on Earth."

–Pallava Bagla

With additional reporting by Jeffrey Mervis.

AUTONOMOUS OCEANOGRAPHY

Mixed Results From the Labrador Sea

It was the most ambitious venture yet in robotic oceanography: Launch two automated submarines in the stormy Labrador Sea in midwinter and then go home, leaving them behind to explore how frigid surface waters sink to the ocean floor. Bottom-water formation, as this sinking is called, feeds currents that snake through the abyss around most of the globe, but it takes place only in remote, icy seas. The designers of the experiment hoped to study the process from the comfort of their home laboratories, as the autonomous underwater vehicles (AUVs) probed the sinking water to depths of 2000 meters or more and relayed data back to them.

It didn't quite work out that way for the team, from the Massachusetts Institute of Technology (MIT), the Woods Hole Oceanographic Institution (WHOI), and the University of Washington. The ambitious experiment, which ran for 2 weeks in early February, did give investigators a detailed view of how kilometers-wide parcels of water cool and sink. But a mechanical glitch prevented the AUVs from "parking" automatically at a docking station moored deep underwater, so they could not be left unattended for long-term study. "A number of factors conspired against us," explains WHOI research engineer Mark Johnson, a principal investigator on the cruise. "Almost all the engineering was novel—every component on the edge of what you dare take to sea."

The concept behind the experiment, autonomous ocean sampling, promises a cheaper, less arduous way to study the ocean. It also offers the potential for making fine-scale observations not easily captured by ships. AUVs can patiently wait for episodic, short-lived events, and they can freely roam the ocean, changing course to concentrate on the most interesting areas as the experiment unfolds. They are ideal for studying deep-water formation, says Martin Visbeck, an oceanographer at Lamont-Doherty Earth Observatory in Palisades, New York, who was not on the cruise. "AUVs can move very fast [10 knots] horizontally and measure vertical sinking to see whether it occurs over a distance of 1 kilometer, 5 kilometers, or more."

But these 2-meter-long, $100,000 vehicles need tending: Every few hours, they have to recharge their batteries, dump their data, and receive new instructions. To meet these needs, a team from WHOI designed a docking station that can be moored 500 meters down, where it serves as a high-tech "garage" for the subs. The docking station, in turn, communicates by cable with a surface buoy that can relay signals directly to the ship and, via satellite, to shore. James Bellingham of MIT, the chief scientist, and his colleagues hoped that automated docking—never before attempted in the deep ocean—would enable them to release the AUVs in the Labrador Sea for about 3 months of data collecting.


J. BELLINGHAM/MIT

Helping hand. Glitches prevented prolonged autonomous operations.

Once they had deployed the equipment at a site roughly 350 kilometers east of the Labrador coast, the team quickly scored several firsts. After a couple of days of tinkering, the AUVs homed in on an acoustic beacon on the dock. They also sent some data via acoustic signals to the dock, which relayed the data via the surface buoy to the ship and satellite system. Says WHOI senior engineer Keith von der Heydt, "This was the first time data were automatically sent from AUV to dock to desktop."

But the fatal glitch soon became apparent. A "carriage" piece designed to secure the AUVs to the dock was jammed, which meant that a vehicle could not "park," recharge its batteries, or download and upload data. After trying to fix the carriage by driving an AUV into it—"ramming it with a $100,000 hammer," says Bellingham—the researchers had to launch and recover the AUVs from the side of their ship, the *Knorr*, limiting them to 2 weeks of data collecting.

This snafu and other difficulties, including problems charging the AUVs' batteries, cut deeply into the project's scientific yield, team members say. The AUVs could not monitor bottom-water formation during its peak later in February and March. Still, radio signals from the 70 subsurface floats set adrift during the cruise are allowing the oceanographers to track the movements of parcels of especially salty, dense water that may be destined to sink. And the AUVs did make measurements that would not have been possible from the ship, such as tracing sharp variations in the depth of the boundary layer between the warmer surface water and cooler water below. This uneven boundary, says Bellingham, may hold clues about how bottom water begins to form.

Visbeck thinks it may take 5 years or longer before oceanographic experiments can be left to run themselves, but it will be worth the wait. AUVs and other autonomous ocean sampling devices, he says, "will enable us to do things we can't do now or can only do in inconvenient ways."

–Steve Nadis

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