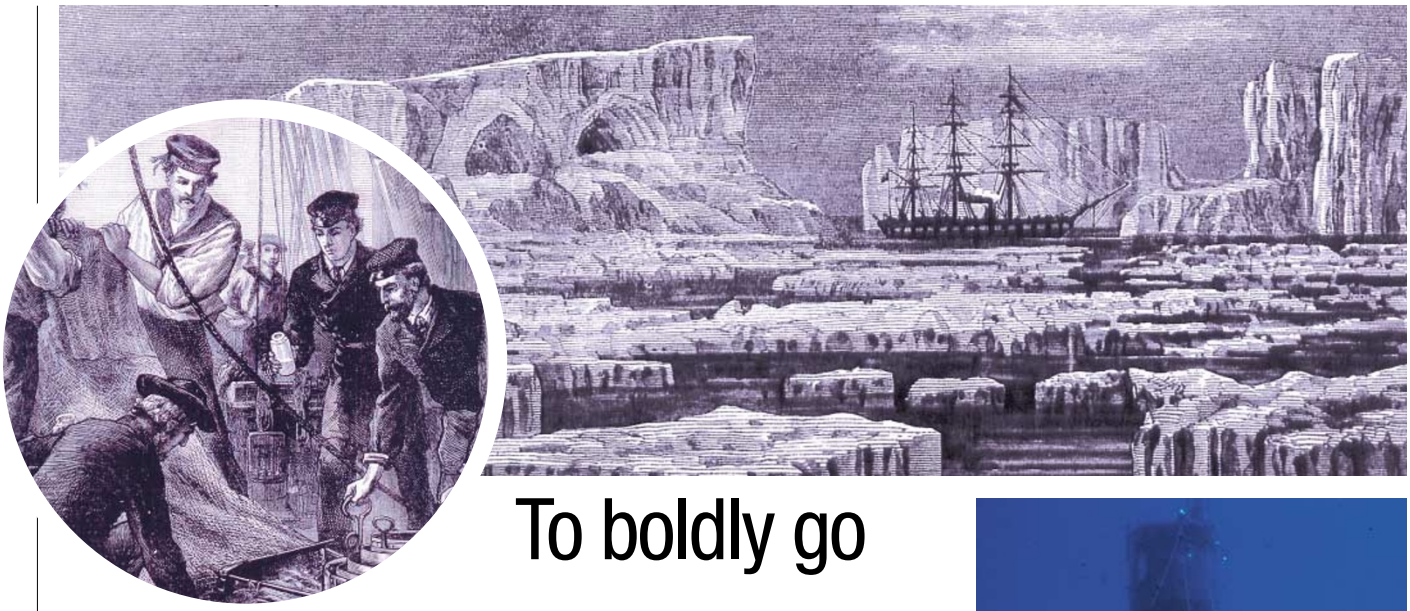

MARY EVANS

To boldly go

The nineteenth century scientists who studied the oceans were explorers, not hypothesis testers. Mark Schrope finds that modern-day oceanographers want to revive this pioneering spirit.

OAR/NURP/WOODS HOLE

Into the blue: the submersible Alvin (above) will be used on new missions aimed at reviving the exploratory spirit of *Challenger* (top).

The scientists on board *HMS Challenger* had little idea what they would find when they sailed from Portsmouth in December 1872. The voyage, the first thorough survey of the world's oceans, is now recognized as the start of modern oceanography. But because so little was known about the oceans at the time, the journey was one of exploration. The scientists simply set out to see what they could find.

In the decades that followed, oceanography left some of this sense of adventure behind. Like a lot of science, it is now built on the careful testing of preformed ideas. But for some, this switch has been premature. A fresh exploratory drive is needed, say researchers, because vast stretches of ocean remain unstudied. "Without exploration, we would continue on a familiar path, with familiar subjects, enjoying an occasional surprise. But with exploration, our purpose is to discover these surprises," says Craig McLean, director of the Office of Ocean Exploration (OOE) at the US National Oceanic and Atmospheric Administration (NOAA) in Silver Spring, Maryland.

Luckily for oceanographers, plans for exploratory missions have caught the imagination of US politicians. Funding has been made available, and the first of a new series of missions is scheduled for September. Add in recent advances in the technology needed to support these missions, and the future looks bright for ocean science. "We are at a turning point," says Sylvia Earle, former chief scientist at NOAA. "Look at what was done for aviation and aerospace during the twentieth century. We're poised right now to parallel that in the present century for the oceans."

Political interest took shape last October, when a panel set up by former President Bill Clinton delivered its plans for ocean exploration. Its report called for US funding agencies, including NOAA and the National Science Foundation (NSF), to support new exploration projects. These calls were answered last year when Congress awarded NOAA $4 million for 2001 to set up the OOE. Congress is currently considering a funding increase to $14 million for the programme in 2002. Ultimately, researchers hope that support will reach the annual level of $75 million recommended in the panel's report.

All at sea

Researchers have traditionally found it difficult to persuade funding bodies to support exploratory missions. "How can you write a proposal to the NSF to do something when you don't know what it is you're going to find?" says Robert Ballard, leader of the team that discovered the wreck of the *Titanic*, and founder of the Institute for Exploration, a deep-water archaeology research centre in Mystic, Connecticut. The NSF does have a small budget for exploratory research, but grants cannot exceed $100,000 and are typically much smaller.

The OOE aims to support explorers — defined in the panel's report as people who have "not narrowly designed the observing strategy to test a specific hypothesis". Researchers on OOE missions will naturally have ideas about what they may find and hypotheses they hope to test, but these will not be the driving forces behind the expeditions. Instead, the voyages will be open-ended. The OOE will also fund the development of technologies to advance exploration, such as underwater-imaging technology and crewed or robotic submersibles.

By using interdisciplinary teams of scientists, the new missions should be prepared for surprises. The hope is to make discoveries as exciting as the first glimpses, in 1977, of hydrothermal vents and the astonishing array of life that surrounds them, but to avoid the problems that arose from that mission's nar-

row focus. The expedition consisted solely of geologists who were unprepared for biological work and so ended up preserving samples in "vodka and good bourbon", says Ballard, who was co-chief scientist on the mission.

Marine biotechnology is one of the disciplines that stands to gain from the new programme. Biologists have been mining the ocean floor, much as they do the rainforests, looking for compounds that could be useful — some of which have already been used to develop new cancer treatments. But for the field to fulfil its potential, researchers need samples from the huge areas of ocean that have never been surveyed.

Studies of biodiversity should also benefit, says David Guggenheim of the Center for Marine Conservation in Washington. Data on the oceans are patchy, so it is hard to assess the impact of human activities on marine life. Deep-water corals are a good example. Because oceanographers have only recently realized how extensive these corals are, they were not aware of the damage being done by fishing vessels trawling the ocean floor for cod and haddock. "Exploration is absolutely critical," says Guggenheim, "because unless scientists can get a handle on what is in the oceans, they certainly can't develop practices to protect them, and potentially significant problems could go unnoticed."

Making a splash

Several existing projects have already been incorporated into the OOE programme, including the Sustainable Seas Expeditions. This project — funded by NOAA in partnership with the National Geographic Survey and the Richard and Rhoda Goldman Fund, a charitable organization based in San Francisco — was planned as a series of exploratory missions to marine sanctuaries. It was expanded this year to examine sites of interest in the Caribbean and the waters off South Carolina.

The OOE has also organized a new mission, dubbed Deep East, in near-record time. Set to begin in September, it will focus on three areas off the northeast US coast. Scientists on each of the legs will be drawn from a variety of disciplines and will use the research submersible Alvin to explore specific areas.

The first leg will focus on a region, about 165–300 kilometres off the coast of New England, known as Georges Bank. The team will study the deep-sea corals that grow there as well as the movement of animals between different areas of the bank. Researchers on the second leg will study the biodiversity of the Hudson Canyon off New Jersey.

The final stage will probe the Blake Ridge, about 165 kilometres east of Charleston, South Carolina. There the main interest will be a large tongue of the seabed in about 2,000 metres of water. In 1995, researchers with the Ocean Drilling Program, an international project to investigate what lies beneath the sea-floor, discovered substantial quantities of methane hydrates in the ridge.

Sea view: exploration should give scientists a better idea of deep-sea life such as this giant squid.

Methane hydrates are deposits of methane trapped in ice crystals. Researchers estimate that worldwide these deposits contain three times more fossil fuel than the world's oil resources. But because the hydrates are generally spread out over large areas in deep waters, they have not yet been exploited. Deep East will test ideas about how to estimate the extent of hydrate deposits using acoustic surface measurements. The team will also study the site's geology and palaeontology, as well as the plant and animal life supported by the methane that seeps out.

Next year, as long as its funding gets congressional approval, the OOE will support an expanded programme that will include expeditions to other areas off the US coasts, as well as either Antarctica or the Arctic — regions that are particularly underexplored.

Back to bed

The OOE will also help to fund an emerging form of exploration, using a series of long-term, unmanned observatories. Last year, a US National Academy of Sciences report outlined a plan for a series of seabed observatories to provide data on areas that are not feasible for ships to visit for long periods (see *Nature* **406,** 449; 2000).

The academy report envisaged a network of stations continuously monitoring the biology and chemistry of the surrounding ocean, but it also called for a dynamic element to the project. A series of rapidly deployable ocean buoys could be used to monitor events such as algal blooms and volcanic eruptions. The OOE plans to support existing projects to develop the necessary technology, says McLean.

If the new exploratory programme does get the full funding recommended by the exploration panel, it could have big consequences for oceanography. Marcia McNutt, president of the Monterey Bay Aquarium Research Institute in California, is confident that some well-established hypotheses will lose their footing when tested in places that no one has ever been. And Andrew Shepard of the National Undersea Research Center at the University of North Carolina at Wilmington expects a host of questions to arise from the research. "It's the first step in the scientific process," he says, "see what's there."

Despite this confidence, the nature of exploration dictates that the benefits of any one mission are unpredictable. There is always a chance that a trip will fail to turn up anything especially interesting.

But those involved believe the missions will quickly show their worth. For these researchers, the voyages are an attempt to contrive those moments of luck that lead to leaps in understanding. "Anytime you go to a new place with new technology you are bound to find something," says McNutt, "It doesn't matter what you find, ultimately it will be put to very good use. History has shown that." ■

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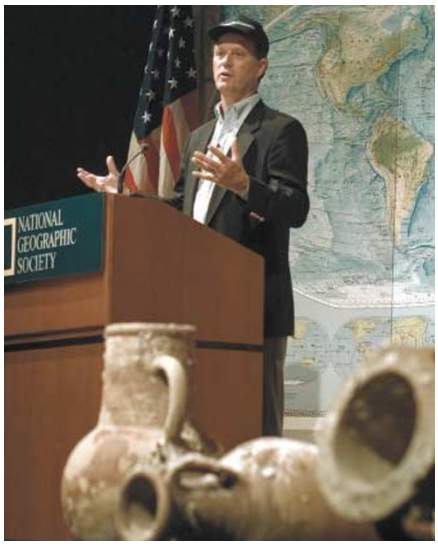
http://oceanexplorer.noaa.gov



AP

Expect the unexpected: Robert Ballard is searching for surprises in the deep.