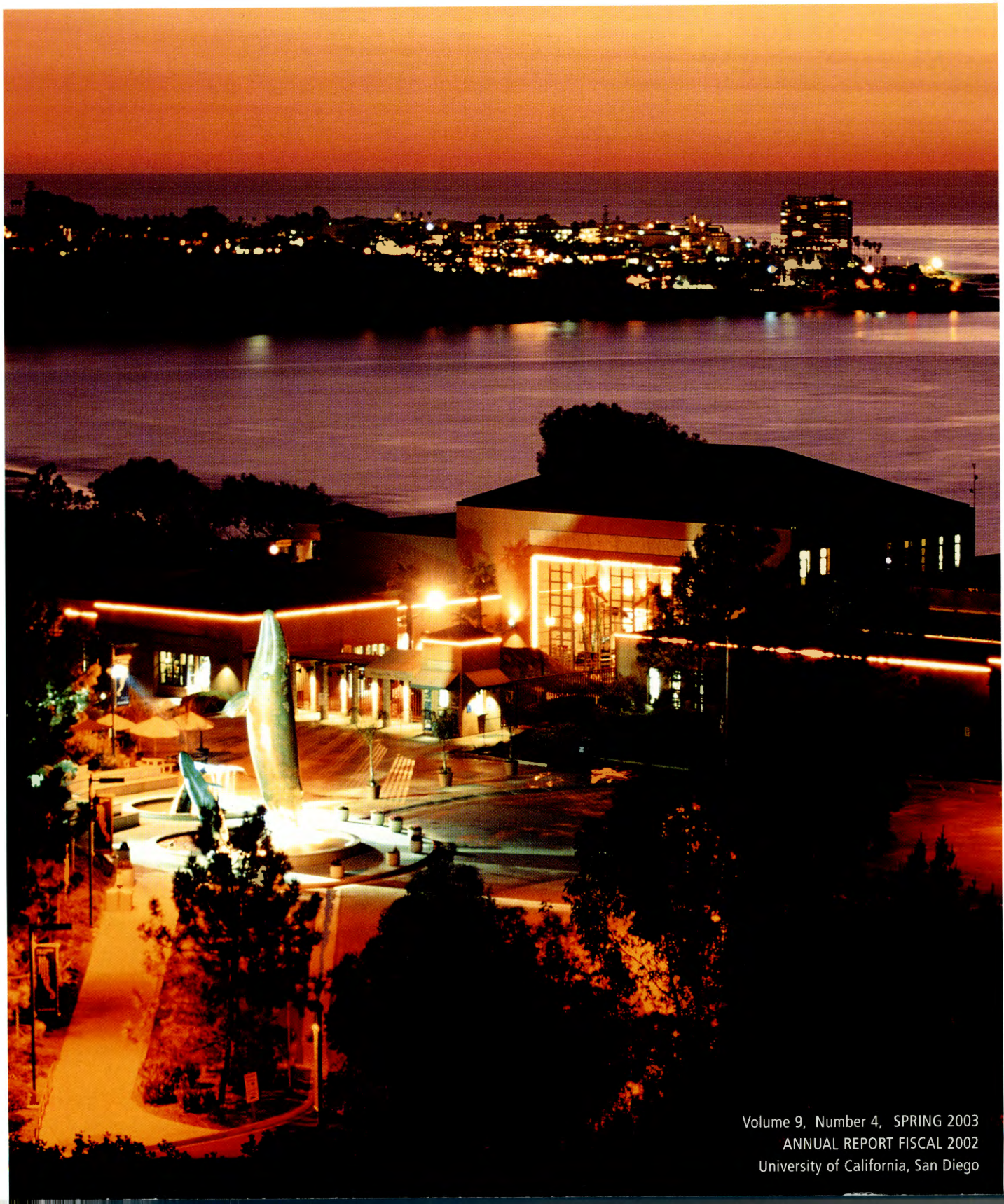
SCRIPPS INSTITUTION OF OCEANOGRAPHY

EXPLORATIONS

Global Discoveries for Tomorrow's World



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Scripps Institution of Oceanography

global discoveries
for tomorrow's world

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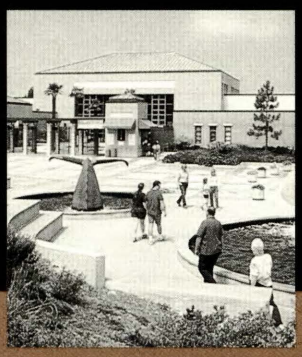

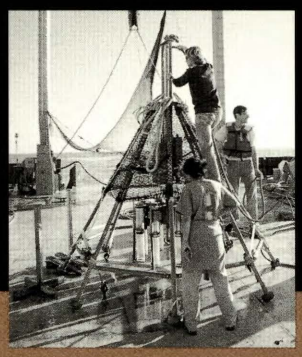

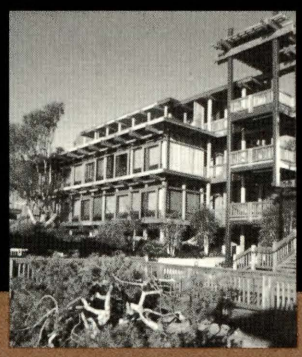

Throughout the twentieth century,

Scripps Institution of Oceanography played

a key role in defining the new science

of oceanography in the United States.

In 2003, Scripps will celebrate 100 years

of oceanography in San Diego.

100 YEARS

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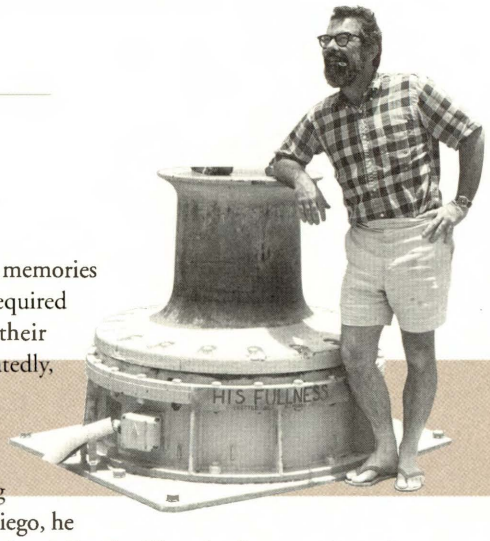
John A. McGowan

BY DORA DALTON



Exploring the waters of Lake Winnebago as a boy in Oshkosh, Wisconsin, sparked John A. McGowan's interest in marine life. Much of his time since has been devoted to studying life in the world's oceans, including half a century spent at Scripps Institution of Oceanography, first as a student, then as a researcher and professor.

He has contributed some of Scripps's most important research in biological oceanography, particularly on ocean circulation, distribution of plankton species, and pelagic community structure. McGowan has also interacted with many of the most familiar names in the history of Scripps oceanography. His first course in physical oceanography was cotaught by geophysicist Roger Revelle, who had just become director of Scripps. He took diving officer Conrad Limbaugh's first course in scuba diving, using a French Aqua Lung, resulting in McGowan writing the first peer-reviewed paper about using scuba as a research tool, published in the journal *California Fish and Game* in 1954.

Working as a teaching assistant at a summer marine station in Oregon, McGowan heard about Scripps and wrote a letter to Martin Johnson to learn more. Johnson, who was an invertebrate zoologist at Scripps for decades, encouraged McGowan to join his team of five marine biology students and participate in the newly established California Cooperative Oceanic Fisheries Investigations (CalCOFI).

"The reason I came to Scripps was CalCOFI," McGowan said.

CalCOFI, a partnership of Scripps, the California Department of Fish and Game, and the National Oceanic and Atmospheric Administration's Fisheries Service, has taken hundreds of thousands of ocean measurements and net tows during 50 years of cruises from San Francisco to Baja California. The California Current is the best ecologically understood pelagic region in the world, a direct result of the CalCOFI program.

"CalCOFI measurements were taken over a particular point in time and space which can never be replicated, so the data cannot be replaced," he said. "It established baselines used by oceanographers everywhere. It is the only way we can quantitatively define change."

He has many fond and frightening memories of CalCOFI cruises, which sometimes required researchers, hanging on tightly, to dip their low-tech instruments in the ocean repeatedly, day and night, with the ship cruising.

McGowan's first chance for adventure—and work—at sea came when, at age 17, he joined the U.S. Navy during World War II. After boot camp in San Diego, he boarded an ammunition ship sent to the South Pacific. There he first experienced skin diving, exploring coral reefs wearing machinist goggles transformed into diving goggles by sealing their edges with beeswax. Later McGowan joined the crew of a cruiser that was part of the first battle fleet to reach the coastal waters of Japan.

After four years in the Navy, he returned to the United States and attended Oregon State University on the G.I. Bill, receiving his bachelor and master degrees.

"I didn't know you could make a living as a biologist, and I didn't care," McGowan said. He decided to pursue the disciplines that he was passionate about: oceanography and general ecology.

He has shared that passion with the students he has taught over the years.

"I'm very proud of my twenty-one students and their accomplishments," McGowan said, noting that many have gone on to research and professorships.

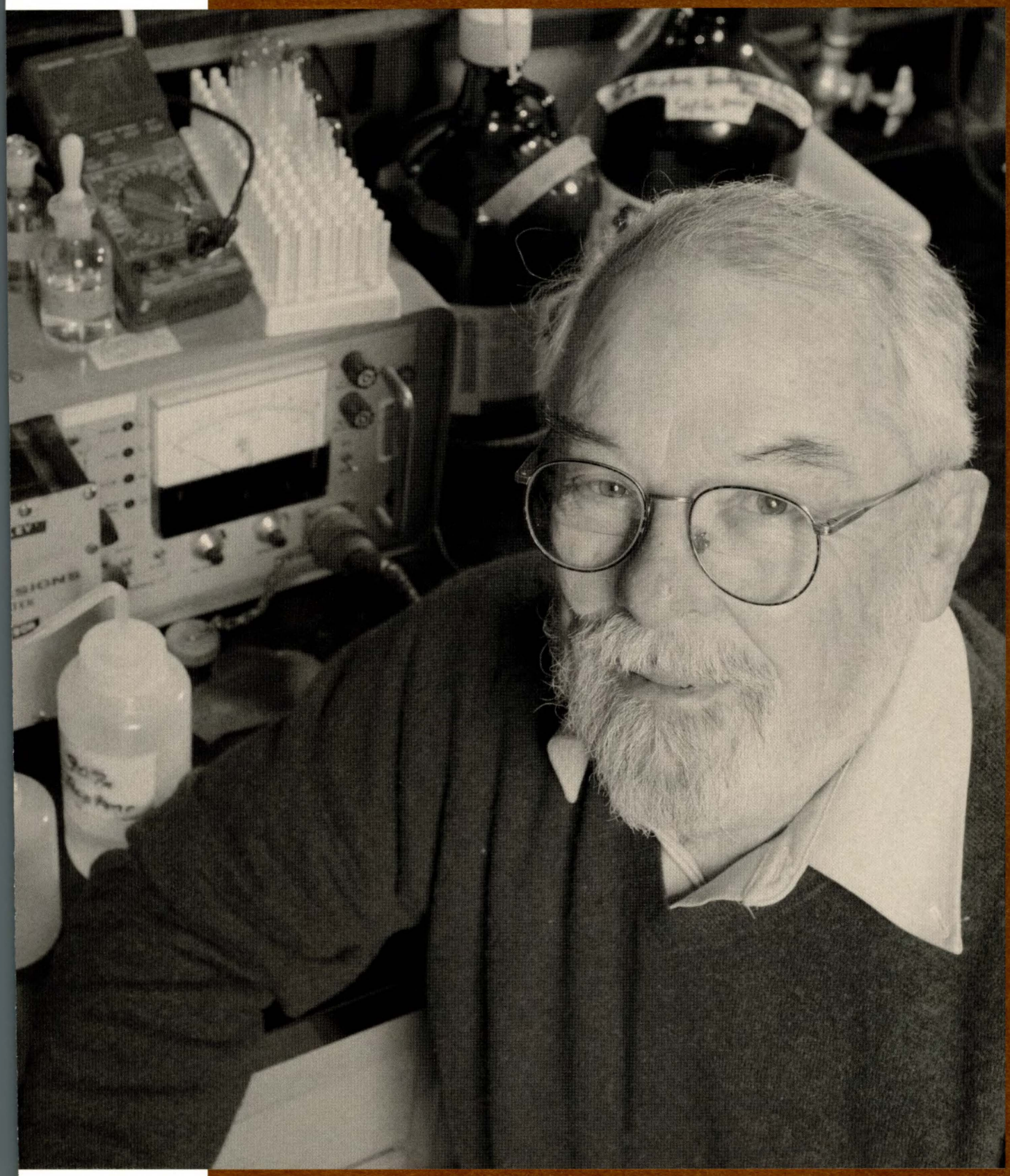
Scripps even led McGowan to his wife of nearly 40 years, Vernie, whom he met when she was working as a researcher for longtime Scripps marine biologist Carl Hubbs. McGowan and Vernie have two daughters, Teresa and Kathleen. The couple has a second home on the Oregon coast where they spend several months each year. They enjoy traveling to exotic places, including a trip to Outer Mongolia and three trips to the Amazon Rain Forest.

McGowan's lifelong love of living things also extends to land animals. He is an award-winning equestrian in hunter-jumper trials, though he humbly says that his 21-year-old horse, Spyder Dancer, is a much finer athlete than he is.

His career has also included stints teaching at the University of the Pacific and in marine biology research for the U.S. Department of the Interior. McGowan established a monitoring program in the Palau Islands of the west Pacific, where he trained locals in scuba diving and sampling marine life. He is coinventor, with Scripps researcher Daniel M. Brown, of the bongo net, which has become a standard sampling tool for researchers all over the world.

Today McGowan's research is focused on monitoring the biological response to the global climate changes he has witnessed and studied throughout his career, a period in which our understanding of the ocean has changed as well.

"We've learned that the ocean is not just a big biological goulash, but a series of very large-scale ecosystems, with distinct patterns, boundaries, and interrelated units," he said. "We're only just beginning to understand it."



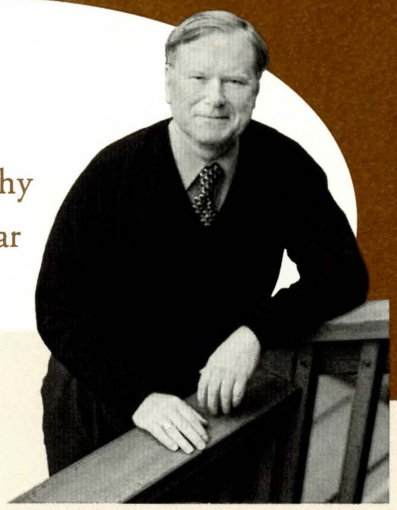
Opposite page, In 1972, John A. McGowan on the Cato Expedition in the North Pacific central gyre.
Above, Today in a biological laboratory at Scripps.

While the shadow of the budget cut looms, a larger view of the past year reveals the continuing vigor of Scripps and its scientific

endeavors.

Charles F. Kennel
SCRIPPS DIRECTOR

DIRECTOR'S Report



On September 26, 2002, Scripps Institution of Oceanography celebrated its 99th birthday and kicked off its centennial year at the Hotel del Coronado—where Scripps began.

After a century of achievement, Scripps now faces serious financial challenges, as many of you have heard. The California budget crisis affects all University of California research programs and adds to multimillion-dollar cuts to Scripps's state-funded research budget over the past decade.

Several core programs of long-standing value to the state of California are at risk, but Scripps is working hard to give those programs adequate time to restructure and seek alternate sources of funding.

Over the coming decade, we plan to increase our private fund-raising efforts and seek additional long-term government and foundation grants. To enhance growth and open up new funding opportunities, we will be moving toward expanded undergraduate education programs, ultimately to create a full-service educational enterprise at Scripps: undergraduate, graduate, postgraduate, and advanced educational offerings.

We are relying on our staff and academic personnel to work even more creatively and productively, and have enlisted their help in confronting this crisis, in both the near and long term. Our international and local groups of advisers, the SIO Council and the SIO Director's Cabinet, have offered support and counsel.

While the shadow of the budget cuts looms, a larger view of the past year reveals the continuing vigor of Scripps and its scientific endeavors.

Our student body is thriving. We welcomed 44 new students in fall 2002, and our student population is now at an all-time high of 203. And today, one-quarter of our students are international (from Asia, Africa, Europe, and the Americas), and women make up nearly half of the student population (compared with just 24 percent 20 years ago).

In April 2002, *Nature* magazine reported that Scripps would soon be creating "the world's first centre devoted to marine bioinformatics." Now, one year later, Terry Gaasterland is joining Scripps as director of this new center, expanding Scripps's efforts in the genetic analysis and understanding of marine ecosystems and the health of the oceans. With her arrival, you can expect to hear much more about Scripps's work in this exciting field in the near future.

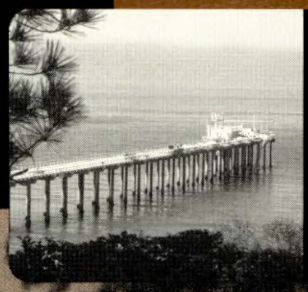
This year we celebrated the tenth anniversary of the Birch Aquarium at Scripps and welcomed Nigella Hillgarth as the aquarium's new executive director. We are pleased to have Dr. Hillgarth on board as our "chief community officer" and look forward to the leadership and ideas she will bring to the aquarium's science and education programs. The interim aquarium director, Jeff Graham, has returned to his scientific research, with our gratitude for his two years of enthusiastic service at the aquarium.

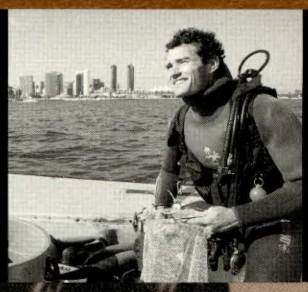
After four years of creative and dedicated service, Bill Hodgkiss stepped down as deputy director of scientific affairs to return to research and teaching. John A. Orcutt, former director of the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics (IGPP) at Scripps, has now undertaken the role of deputy director of Scripps and associate vice chancellor for marine sciences. He will concentrate on education and the enhancement of resources from federal and state agencies, as I concentrate on developing a more aggressive multisource funding model and on finding new federal programs important to the core functions of the institution.

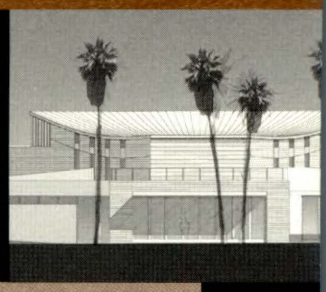
We unveiled a new facility on campus, the Scripps Visualization Center, which features a panoramic screen that scientists can use to transform data into immersive three-dimensional presentations. Directed by researchers at IGPP, the "Viz Center" is a cooperative effort among several academic research groups in San Diego. You can learn more by visiting siovizcenter.ucsd.edu.

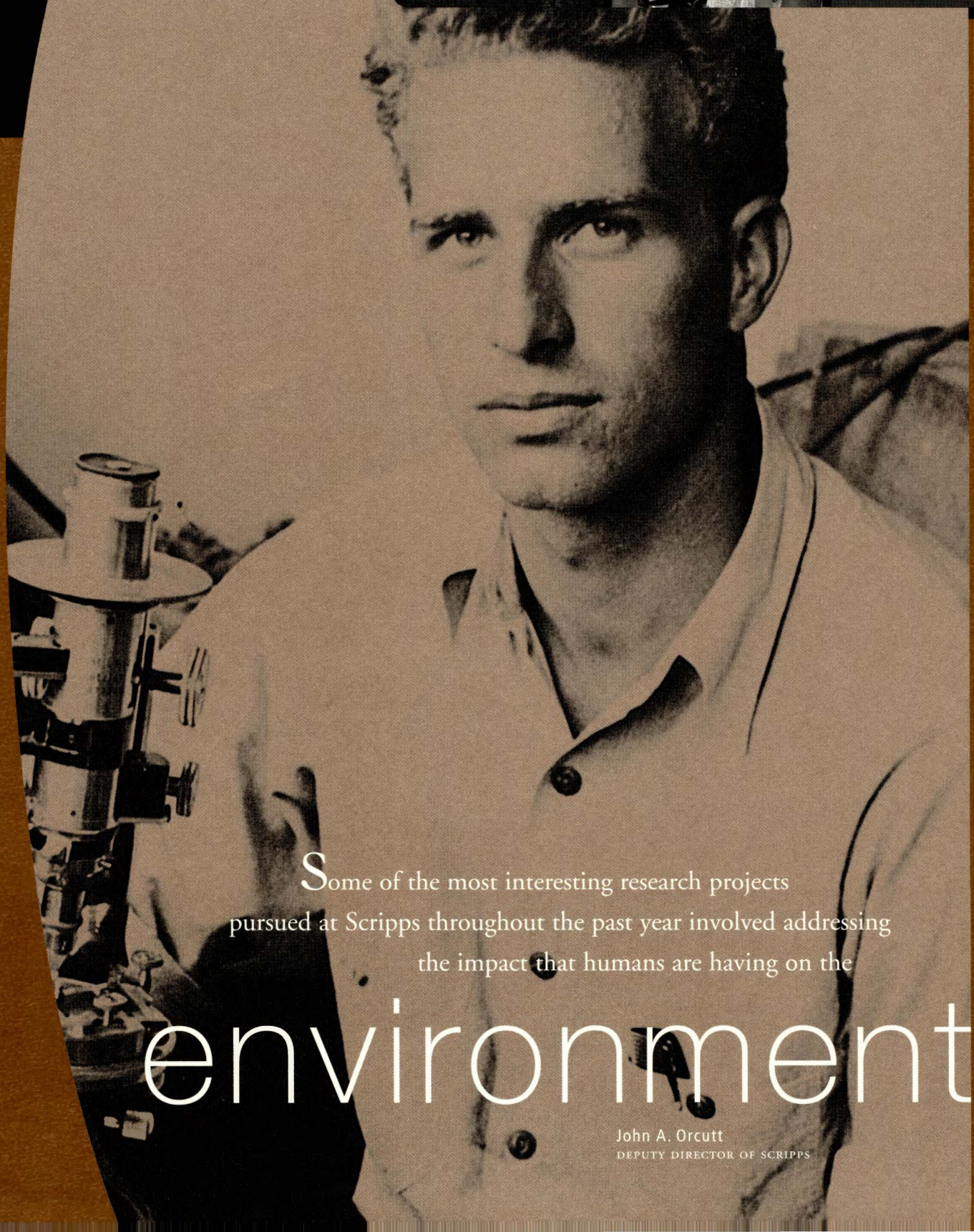
This fall will bring an opportunity for you to visit the Scripps campus by joining our scientists, staff, and students at a very special centennial-year Open House. For more information about this and other centennial events, and to learn more about Scripps's century of discovery, please visit scripps100.ucsd.edu.

Charles F. Kennel
SCRIPPS DIRECTOR





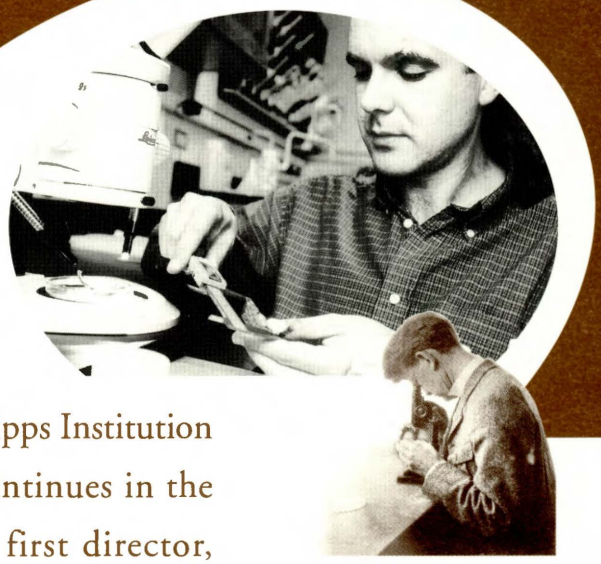




Some of the most interesting research projects pursued at Scripps throughout the past year involved addressing the impact that humans are having on the

environment.

John A. Orcutt
DEPUTY DIRECTOR OF SCRIPPS



On the eve of its centennial, Scripps Institution of Oceanography research continues in the tradition begun by the institution's first director, William E. Ritter—to explore the interrelatedness of all life forms and ecosystems while studying particular species or phenomena. I wonder, though, if even he could have imagined the extent to which this concept would be applied to modern oceanography.

From the solid earth and ocean to the atmosphere, the planet's natural resources are being pushed to the brink, and some of the most interesting research projects pursued at Scripps throughout the past year involved addressing the impact that humans are having on the environment, and vice versa.

As a result of a rapidly increasing population and enormous economic growth, a three-kilometer-deep cloud of haze—made up of ash, acids, aerosols, and other pollutants—now blankets South Asia. Scripps atmospheric researchers Veerabhadran Ramanathan and Paul Crutzen participated in a 2002 study of the economic and environmental effects of the haze, now known as the "Atmospheric Brown Cloud." Working with the United Nations Environment Programme, and relying on extensive data collected during the Indian Ocean Experiment, Ramanathan, Crutzen, and other leading scientists from around the world found that this pollution cloud affects Asia's climate and rainfall, triggering droughts in the region, and could be linked to hundreds of thousands of premature deaths as a result of increased levels of respiratory diseases.

As a next step, the scientists aim to determine how the effects of pollution are related to global climate change and then advise policy makers on reducing pollution levels while sustaining economic growth in South Asia.

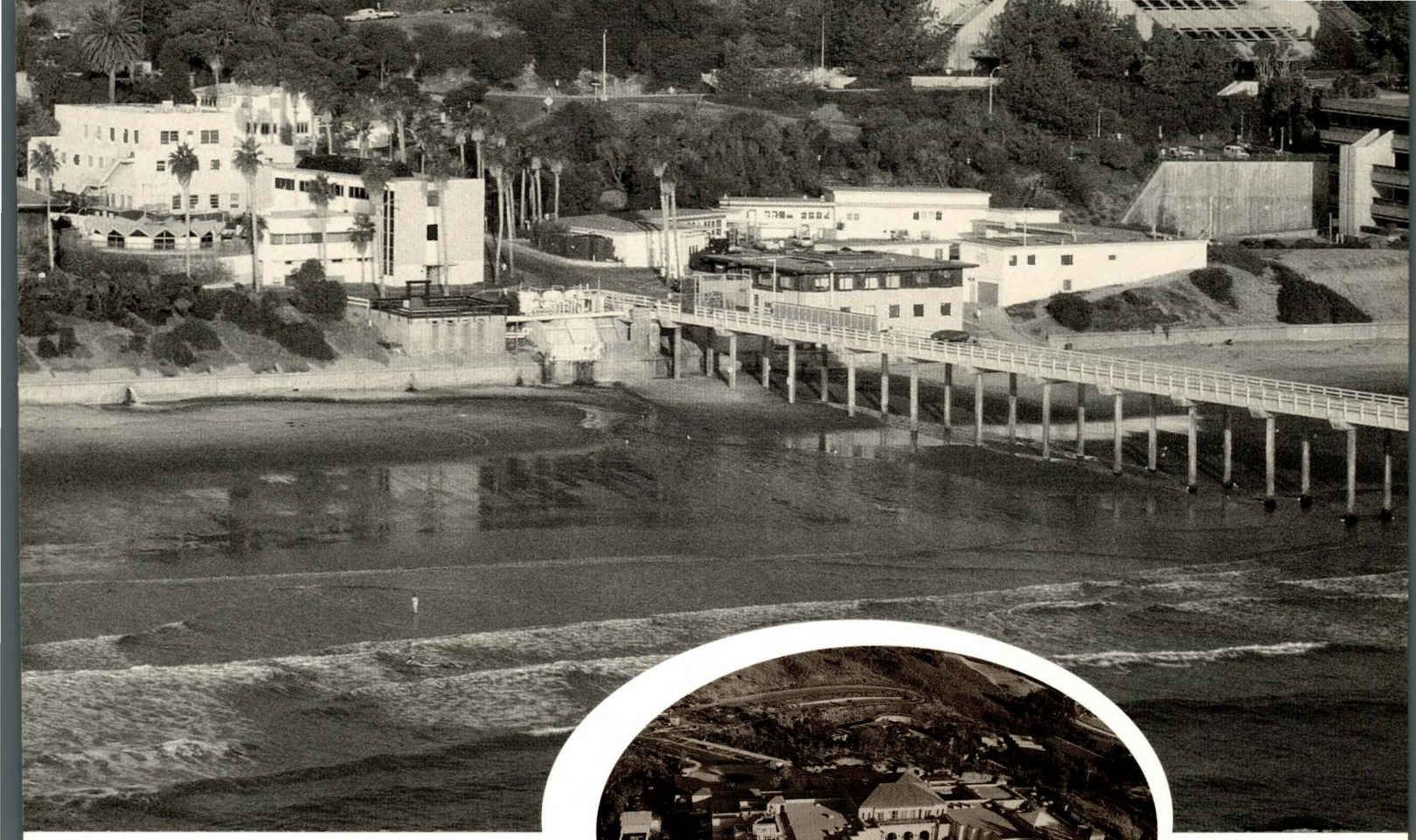
In other areas of climate research, Scripps researchers Richard Somerville and Sam Iacobellis offered new understanding of the role clouds play in Earth's climate system. Working with new, advanced theories on the microphysical aspects of cloud ice crystals as well as high-quality measurements of real cloud behavior, the researchers were able to improve computer simulations of climate, which could lead to more accurate understanding and prediction of climate change in the future.

In addition to the wide range of research activities, there were significant advances in engineering, instrumentation, and technology at Scripps that will help scientists and students in their quest for answers.

The Visualization Center at Scripps, located at the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics (IGPP), opened in early 2002. The center's state-of-the-art system allows scientists to take enormous data sets, such as earthquake activity east of San Diego, the morphology of the global seafloor, or the topography of Mars, and illustrate them on a large screen in three dimensions. It's the first system of its kind that is networked to another visualization facility—one at San Diego State University. One new project taking advantage of the Visualization Center's data management capabilities is termed ROADNet (Real-Time Observatories, Applications, and Data-Management Network). ROADNet's sensors, located throughout the world and on Scripps's largest ship, R/V *Roger Revelle,* deliver real-time data to the center for nearly instantaneous review by scientists on campus.

Biophysicist Jules Jaffe and biological oceanographer Peter Franks developed a new technology to view microscopic dinoflagelletes that amass by the millions to produce an effect in the ocean known as a "red tide." To study these algae in their environment without displacing surrounding waters, a laser instrument is lowered into the sea where it induces the algae to emit a red glow visible to an attached camera. This device will further advance the study of this naturally occurring phenomenon that has been observed by humankind since biblical times. This is an exciting example of how technological innovations help advance scientific understanding of the oceans.

Scripps scientists are also involved in the study of human-induced phenomena in oceans, bays, and wetlands. As part of a multifaceted study, Scripps researchers John Largier, Moninya Roughan, and Melissa Carter of the Integrative Oceanography Division tracked water movement in San Diego's Mission Bay to help determine pollution and bacteria sources.



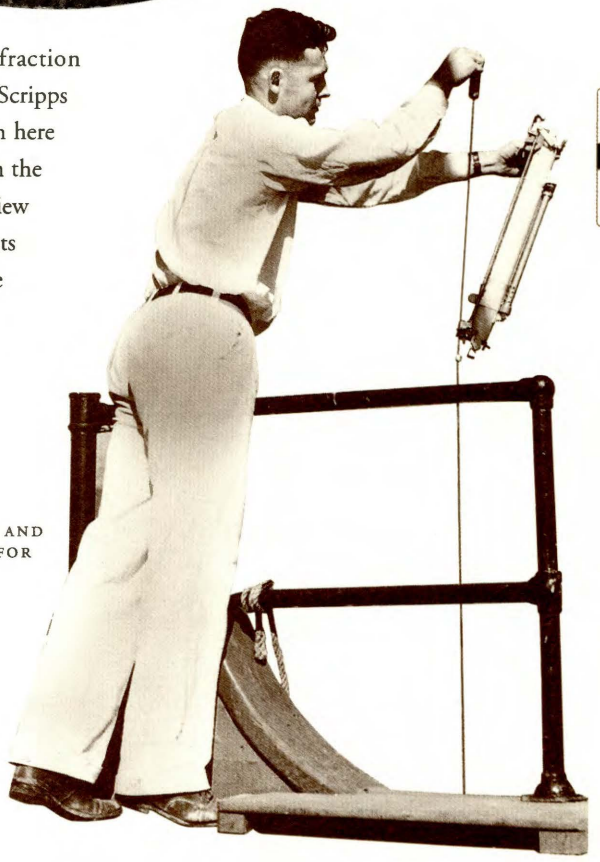
Using nontoxic red and green dyes, the researchers observed water flow throughout the bay. Although the results of this study are not yet complete, Largier and his team will be able to identify where pollution is being released into the bay, helping the city improve the water quality of one of its most popular recreational spots.

High-tech instrumentation also contributed to greater knowledge of the processes of breaking waves. Ken Melville, Peter Matusov, and Eric Terrill of the Marine Physical Laboratory at Scripps used remote-imaging techniques to monitor these processes, some of which transfer heat and gas between the air and ocean, which may have an effect on weather and climate. A future project will investigate characteristics of hurricanes and their influence on air–sea interactions. Increased knowledge of hurricane behavior will improve numerical predictions of hurricanes.

I offer here only a tiny fraction of the complex research that Scripps scientists were involved in both here at the institution and abroad in the field. For a more in-depth review of the work of Scripps scientists in 2002, take a look at the pages that follow this report. You might just catch yourself thinking, "I didn't know they did that."

John A. Orcutt

DEPUTY DIRECTOR OF SCRIPPS AND ASSOCIATE VICE CHANCELLOR FOR MARINE SCIENCES




Research on the Antarctic peninsula.

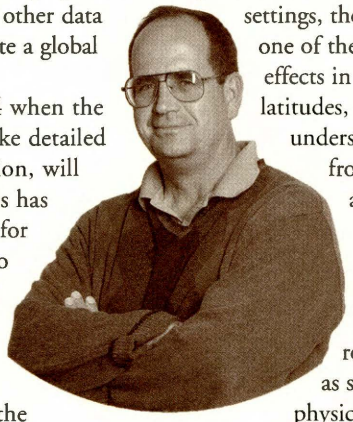
The California Space Institute (CalSpace), a multicampus research unit of the University of California, supports space and earth sciences, education and technology. CalSpace scientists conduct pure and applied research in various interdisciplinary space-related fields. Many CalSpace researchers emphasize the atmosphere and atmosphere-ocean interactions. Some scientists study space plasma physics and planetary science, while others investigate Earth's environment using remote sensing from satellites.

Several continental-scale water cycle experiments taking place around the world are in the midst of an unprecedented synchronization of data collection that could yield answers about aspects of the hydrological cycle that are currently not well understood.

John Roads, director of the Experimental Climate Prediction Center at Scripps, heads up one of six working groups in the Coordinated Enhanced Observing Period (CEOP), being led by the World Climate Research Program, to understand the path of water in nature through phenomena ranging from droughts to monsoons. Observations, satellite measurements, and other data focused on 41 reference sites around the world will be used to create a global perspective of the water cycle.

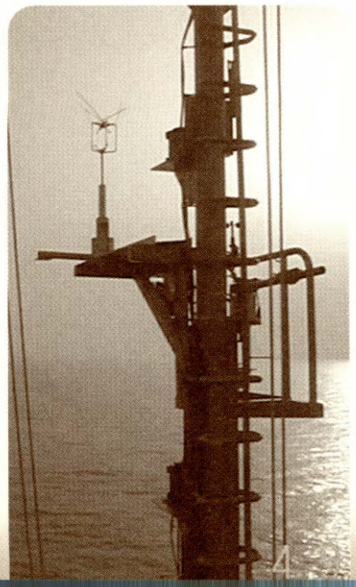
CEOP takes place from July 2001 through December 2004 when the maximum number of operating ground-based studies, which make detailed measurements of phenomena like precipitation and solar radiation, will coincide with the launch of several observational satellites. Roads has participated in water cycle research in the Mississippi River Basin for the past seven years. The challenge posed by CEOP, he said, is to develop the research needed to keep up with the vast amounts of data that the next generation of satellites and weather prediction models will generate.

"It's an exciting period," Roads said. "In the next 10 years, there will be a lot of research devoted to better understanding the global water cycle, and CEOP is the premier pilot study to understand how to best do this."


John Roads

Dust carried in the atmosphere from regions around the world often contains pollutants specific to those regions, according to Scripps researchers participating in the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia).

In 2001, the International Global Atmospheric Chemistry Program launched ACE-Asia to increase understanding of how atmospheric aerosol particles affect Earth's climate system. Scripps research groups led by Piotr J. Flatau and Francisco Valero participated in the multinational effort.


Hazy skies over the Sea of Japan.

Air pollution changes dust aerosols in many ways, adding black carbon, toxic materials, and acidic gases to mineral particles. Additionally, there are dramatic regional differences in the chemical and optical properties of aerosols. ACE-Asia researchers determined that the dust transported from East Asia to the Pacific does not absorb as much light as the dark aerosols from South Asia or dust from the Sahara Desert. Flatau said that the radiative effects of aerosols vary according to the environmental conditions of their particular region, such as relative humidity changes between land and ocean.

Unlike previous aerosol experiments performed in relatively simple meteorological settings, the ACE-Asia experiment was one of the first studies of radiative effects in complex flows in the mid-latitudes, which will add to scientists' understanding of how aerosols from regions around the world affect global climate.

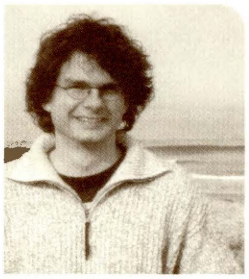
The hole in the ozone over Antarctica apparently has not affected life at the base of the region's food chain as much as scientists once feared, said physicist Dan Lubin, who helped create a simulation of the physiological response of phytoplankton to ultraviolet radiation.

Lubin and colleagues examined a 1992 event in which the protective ozone layer was particularly depleted and compared it with 1979 ozone levels. Previous research estimated that the quantity of phytoplankton in the western Antarctic peninsula could have diminished by as much as 10 percent because of the photoinhibition of ultraviolet rays.

But in the simulated comparison, which used NASA satellite data covering the entire Southern Ocean around Antarctica, the loss of phytoplankton was less than one-quarter of one percent in the period of extreme depletion. Lubin attributes the resilience of phytoplankton to several factors, among them the fact that maximum ozone loss occurs in early spring while maximum phytoplankton abundance takes place in early summer.

CALSPACE.UCSD.EDU

Researchers at the Center for Atmospheric Sciences (CAS) focus on fundamental investigations of the atmosphere related to large-scale climate change. To interpret and predict these changes, CAS scientists design and conduct field experiments, map out new satellite missions and use regional and global atmospheric models. Their analyses include integration of the models with satellite and in-situ observations.

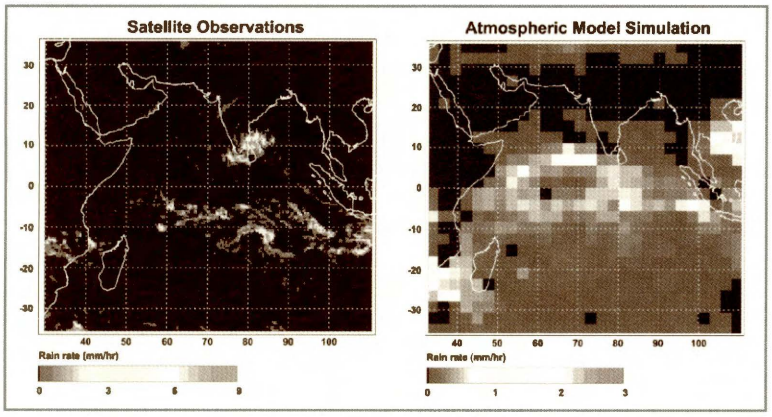


Roland von Glasow

In computer models, monsoon-season rain falls over southern India and the Indian Ocean in a uniform, steady drizzle.

In reality, though, rain falls over some parts of the region in intense storms and not at all in other parts. Computer models of this type of activity are tools researchers use to make predictions that can influence public policy. Getting them to more closely match with what actually takes place over the subcontinent has been the goal of postdoctoral researcher Eric Wilcox.

Wilcox has improved techniques for testing computer models by comparing their results to human observations.



How rain really fell in the Indian Ocean (left) and how it was simulated.

In side-by-side comparisons, Wilcox found that computer models frequently miss nuances of precipitation and that the results could skew estimates of other atmospheric events.

For instance, rain is the main mechanism by which dust is washed out of the atmosphere. Wilcox's results suggest that current modeling techniques appear to significantly overestimate how much dust and other aerosols travel out of the south Asian region to other parts of the world.

Resolving the uncertainties in the role that aerosols play in the planet's climate has become a topic of renewed interest in recent years. While many studies have focused on the important cooling effects aerosols have at short (solar) wavelengths, meteorologist Andy Vogelmann has found that they can also cause significant warming effects at thermal infrared wavelengths.

In one of the few experimental studies to consider aerosol effects at infrared wavelengths, Vogelmann used data taken from NOAA research vessel *Ronald H. Brown* as it traveled from Hawaii to the Sea of Japan. Taking this route, the vessel encountered the haze of airborne particles transported from Northeastern Asia.

Vogelmann found that aerosols, such as dust, could significantly increase the emission of infrared energy directed at Earth's surface, from two to nine watts per square meter. These surface increases are significant compared with the one to two watts per square meter resulting from increases in greenhouse gases throughout the twentieth century. The new information will help researchers understand the energy balance that is at the center of global climate change studies.

"If you're interested in long-term climate, you need to understand what's going on with all of the radiatively important constituents, and this is one of the items that has been largely overlooked," Vogelmann said.

With 70 percent of Earth's surface covered by oceans, the release of gases and sea spray droplets from the oceans' surface into the atmosphere is important to climate studies on a global scale.

Atmospheric researchers Roland von Glasow and Paul Crutzen are studying the chemical reactions that take place when halogens and other components of sea salt aerosol interact with atmospheric gases. Currently they are investigating how much halogens influence destruction of dimethyl sulfide, a precursor gas for the formation of new aerosol particles on which droplets grow to create clouds. Their work suggests that halogens might ultimately affect the brightness of clouds through their influence on the size and number of sulfate particles and the resulting reflection of sunlight off the clouds.

The work could also help researchers to better understand photochemistry over the oceans because ozone gas is effectively destroyed by halogen radicals.

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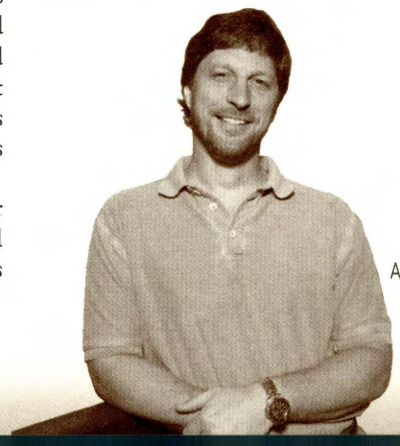
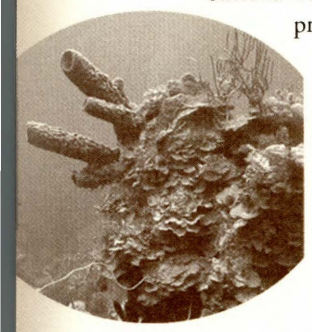


Andy Vogelmann

The Center for Marine Biotechnology and Biomedicine (CMBB), housed at Scripps, is a UCSD campuswide center dedicated to the exploration of potential biotechnological and biomedical resources found in the world's oceans. CMBB researchers conduct a broad range of investigations, from the special properties of deep-sea marine microbes to the genetic engineering of commercially important marine animals.



The antifungual alga *Lobophora.*

Since the breakthrough discovery in 2001 of an ocean-dwelling group of bacteria with remarkable capacities to produce antibiotics and anticancer agents, researchers led by microbiologist Paul Jensen have identified at least four additional taxonomic groups within the bacterial order actinomycetes that reside exclusively in the marine environment.

Jensen, whose surveys of marine sediments a decade ago set the stage for the initial discovery of the genus *Salinospora,* said scientists are just beginning to tap into a previously unappreciated bacteria community with vast genetic variety. One newly identified group, *"Marinomyces,"* has even greater phylogenetic diversity than *Salinospora,* which thus far has been found to produce at least five different classes of compounds, four of which show potent anticancer activity.

This is good news for a pharmaceutical industry trying to stay one step ahead of increasingly drug-resistant forms of cancer and infectious bacteria. Jensen said that the National Cancer Institute has tested a number of the compounds discovered from these unique bacteria for efficacy against several types of tumor cells, and some have advanced to testing on animals.

Jensen is also interested in the role these microbes play within their own habitat. Subsisting on organic matter like the chitin in some marine creatures' shells, the bacteria could be the missing link that scientists have been searching for in the ocean's carbon cycle.

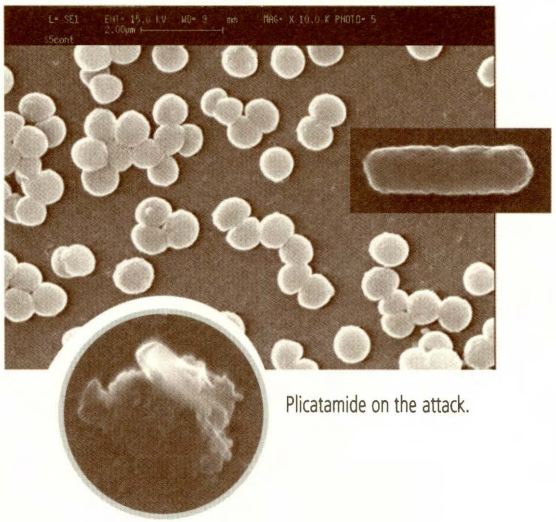
Marine creatures are surrounded by deadly pathogens in seawater that provide the perfect medium for infection. Yet, most marine life has a basic imperviousness to them. It is only in its dying hours that a marine plant or invertebrate succumbs to disease, efficiently decomposing within hours.

To understand how plants and animals without immune systems ward off disease, William Fenical and colleagues are identifying the chemicals they use to stay alive. The answers could protect the health of wild and farmed fish—and ultimately humans.

"It's fundamentally clear that we don't understand marine diseases well," Fenical said.

Fenical's research group announced this year that it has identified naturally occurring protective antibiotics employed by marine algae and seagrasses, including a compound found on the surface of one species of seagrass that prevents passage of marine microorganisms into its internal structure.

The understanding of how marine invertebrates fight disease is the basis of fourth-year student Andy Tincu's research on sea squirts. These marine invertebrates, which generally live on undersea rocks, stave off infection using antimicrobial peptides, organic compounds that provide a chemical defense.



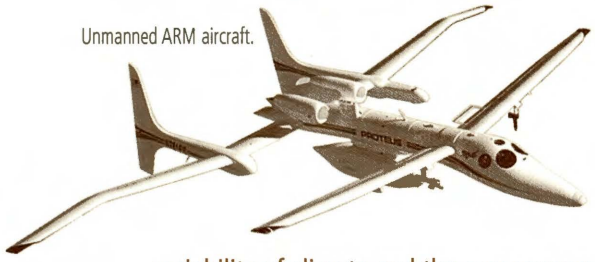
Plicatamide on the attack.

Tincu has isolated several sea squirt peptides and found that one in particular, plicatamide from the ascidian *Styela plicata,* is able to kill bacteria ranging from *E. coli* to *Staphylococcus,* two strains that can also fatally infect people. Now he is creating synthetic derivatives of sea squirt peptides to create antimicrobials to be used on infected people.

Tincu said the peptide derivatives may prove to be better tolerated and more effective as human antibiotics than other developing therapies because of their simple structure, which makes them easy to mass produce. His results were published in the *Journal of Biological Chemistry.*

CMBB.UCSD.EDU

Paul Jensen


Unmanned ARM aircraft.

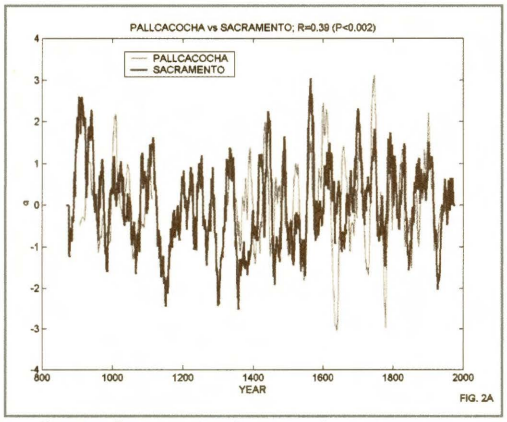
CLIMATE RESEARCH DIVISION

In the Climate Research Division, scientists study phenomena spanning time scales from weeks to decades. They identify and predict the natural variability of climate and the consequences of anthropogenic increases in the greenhouse effect. CRD researchers use the principles of meteorology, oceanography, hydrology, and other disciplines to understand the complex interactions among the atmosphere, the seas, the land, and the world of living things.

Sam Iacobellis and Richard Somerville have spent more than a decade creating computer models of clouds to better predict the future of Earth's climate. Since 1990, as part of the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Program, the two have created a series of increasingly complex "single-column" climate models that take detailed physical processes into account. These models simulate atmospheric phenomena, such as cloud cover and precipitation, at a single geographic location.

By including new observations and highly accurate theories of how tiny ice particles in clouds interact with sunlight and heat from Earth, the scientists' latest models are more realistic than any currently in use. Such improvements in climate modeling will help create more accurate global warming scenarios.

Models now vary widely in their forecasts, predicting that global average temperature increases throughout the next century will range anywhere from one to five degrees centigrade.



A millennium of corresponding climate signals.

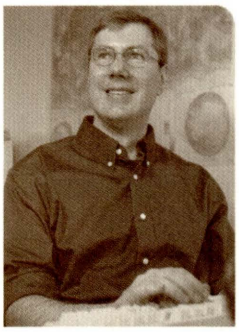
"The models all show global warming but it's too wide a range of warming for policy makers," Iacobellis said. "We think we can help reduce that uncertainty."

Most climate data gathered by researchers date back no more than a century—not enough time to accurately track cycles that last from 50 to 100 years.

Nick Graham has turned to paleorecords such as tree ring data, ice cores, and sediment records from places such as the Sacramento River Basin and the Andes to look for matching signs of climatic signals over the past millennium. Synthesizing his own findings with the field research of others, he has found that records from a variety of locations in the Western Hemisphere correspond with each other on the scale of decades or longer.

Detection of clear connections between reconstructions of precipitation and drought in the western United States is of particular interest to Graham. These connections suggest that variations in tropical Pacific sea-surface temperatures have been an important factor in modulating precipitation changes in the West at time scales from decades to centuries.

Low-frequency swings between wet periods and drought periods characterize climate in this region, and as water is a critical resource in the West, these findings may assist in developing environmental policies that are currently based on inadequate, short-term records.


David Pierce

David Pierce hopes that climate patterns of the North Pacific can become the basis of long-range weather forecasts and better explain phenomena from El Niño to varied fish catches.

Ocean temperatures in the North Pacific fluctuate in a distinctive pattern. A finger of warm water extends east from Japan surrounded by colder water in some years, vice versa in others. The variation is linked to winter temperatures and precipitation in North America.

The traits of this cycle and information about common atmospheric patterns in the region already help scientists predict phenomena like ocean temperatures off Japan years in advance. Pierce is combining such data in detailed computer models to determine if similar long-term predictions can also be made in other areas. His computer modeling has thus far suggested that ocean temperatures in the North Pacific might have less to do with El Niño than previously thought and that cold water traveling from the Southern Hemisphere to the equator could be a stronger influence.

In related research, Pierce is attempting to understand whether fluctuations in fish populations are more strongly influenced by these temperature variations or corresponding current changes.

METEORA.UCSD.EDU

Scientists within the Geosciences Research Division (GRD) address a wide range of topics in the earth, ocean, and atmospheric sciences, including studies of physical, chemical, and geobiological processes of Earth's mantle, crust, ocean, and atmosphere. They carry out detailed investigations in marine geology, petrology, paleomagnetism, tectonics, geophysics, isotope geology, geochemistry, mantle and crustal evolution, and paleontology.

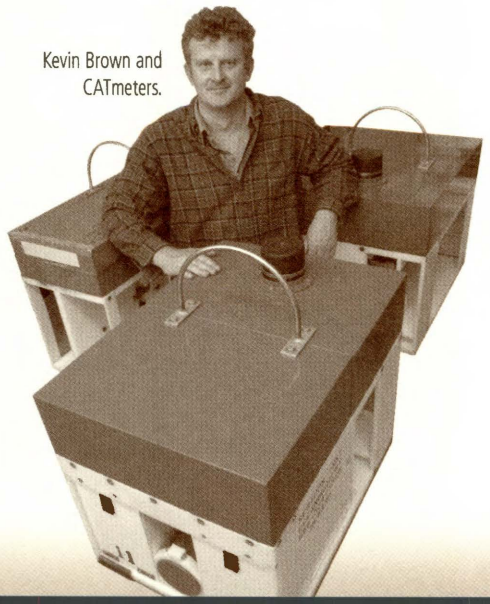
Richard Norris (right) and associates examine black shale.

Charles David Keeling and his research group are conducting an integrated program of concurrent measurements on land, at sea, and in the atmosphere to determine where carbon dioxide produced by fossil fuels is distributed.

They have been accumulating rare time-series measurements of carbon dioxide concentrations at ocean stations near Hawaii and Bermuda for more than 10 years to study the flow of nutrients from deep waters that indirectly affects CO_2 levels. After creating a model depicting the seasonal cycle at each station, they found that carbon dioxide from fossil fuel combustion is shifting the balance of the water chemistry at both locations.

At the same time, atmospheric measurements by the Keeling group are showing links between ocean tidal cycles and carbon dioxide levels at lengthy time scales. Using data collected for decades, the group has tracked correlations between carbon dioxide and El Niño and longer term temperature variations. They are working to tie such cyclical correlations to the tidal cycles that have made temperatures cooler when tides are strongest.

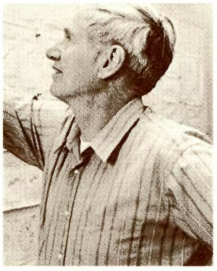
In addition, research group member Stephen Piper is leading a study that has helped validate models of global-scale carbon dioxide intake and emission by land plants. The atmospheric model that he and colleagues created can be used to deduce such exchanges from the observed concentration gradient of CO_2 from polar to tropical latitudes. The largest CO_2 sinks appear to occur in temperate regions. Results of the model are similar to those that extrapolate to large scales the plant CO_2 uptake and release measured at small-scale individual vegetated sites on land.



Kevin Brown and CATmeters.

The Demerara Rise near the Caribbean Sea contains seafloor sediments that are as old as 80 million years. Richard Norris is drilling there for samples from the Cretaceous period and early Eocene epoch to find evidence of the super-greenhouse climates that existed on Earth long ago.

Norris and colleagues have argued that CO_2 concentrations in the atmosphere have been more than four times what they are now at various points in history. Norris said that they hope to recover well-preserved microfossils in the soft sediments that will help determine why the planet underwent warm periods with high levels of CO_2. The fossils will help generate longer and more complete paleotemperature records of surface temperature than those available now.



Charles David Keeling

Norris also hopes to recover sediments that could provide clues to one of the largest global warming events in history, one that took place 55 million years ago during the Paleocene/Eocene boundary. At that time, the large-scale melting of gas hydrates and the resulting release of greenhouse gases into the atmosphere are believed to have triggered the event.

Considering the tremendous power of earthquakes, one might deduce that seismic events would involve the shearing of very strong materials at plate boundaries in the earth. In fact, says Kevin Brown, the materials at such interfaces are paradoxically weak clays.

Brown hopes to characterize the properties of this material, the low permeability of which traps water and creates slips akin to the hydroplaning of tires on wet roads. He wants to find out what makes the material become seismogenic and what chemical and physical conditions are present at the plate boundary interface. Along with researchers from academic centers around the world, he will conduct several geological research projects as part of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) taking place off Japan's southeastern coast throughout the next decade.

The program will also involve deep-ocean drilling and the installation of long-term monitoring equipment in boreholes drilled to depths of five to seven kilometers (3.1 to 4.3 miles). Researchers will collect material samples and geophysical measurements in the seismogenic portion of the subduction plate boundary interface.

Brown will also deploy CATmeters—specialized instruments he designed that measure fluid flow out of the seabed in the deep ocean—at this and several other subduction zones. He has found potential correlations between water flow out of underground streams and the onset of seismic activity in some environments and the release of gas and methane hydrates in others.

It is possible, Brown said, that flow variability in seabed streams is intimately coupled with a variety of widespread natural processes. He is particularly interested in the potential associations of hydrologic events with earthquakes and aseismic creep events in subduction environments.

GRD.UCSD.EDU

Cathy Constable at Spitsbergen archipelago.

The Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics (IGPP) at Scripps is a branch of the University of California IGPP and hosts the systemwide office. Researchers at IGPP operate a global network of seismic stations, including a permanent space geodesy network in California; an acoustic thermometry network in the North Pacific; and an X-band antenna for satellite communications. IGPP also maintains an active seagoing program, including projects to study gravity and absolute gravity on the seafloor, nonlinear processes, acoustic thermometry, and seafloor electromagnetics.

Birth of an iceberg.

Helen Amanda Fricker and graduate student Jeremy Bassis are hoping to learn whether tides, physical stresses within ice, or other forces are the primary causes of the rifts that create icebergs.

Using a variety of instruments, they are witnessing the calving of an iceberg from the Amery Ice Shelf in eastern Antarctica. There, a nascent iceberg known as the "loose tooth" is forming at the edge of the shelf and is expected to grow to 30 square kilometers (18.6 square miles) before it breaks off the shelf completely.

In 2002, Bassis spent four months in Antarctica with Australian colleagues conducting seismological fieldwork at Amery. He helped deploy global positioning equipment and seismic instruments that will make in situ measurements. Additional data will eventually come from the Ice, Cloud, and land Elevation Satellite, known as ICESat, which was launched in January 2003 and carries a laser altimeter capable of making precise measurements of Antarctic ice sheet elevations.

Though ice shelf collapses elsewhere in Antarctica have raised public concern over an apparent manifestation of anthropogenic global climate change, calvings are part of a natural cycle of mass release and do not necessarily result from changes brought on by humans.

"If we find out there are huge changes in Antarctica, how much of that change is man-made? Who knows?" Fricker said. "Antarctica's been changing considerably over geological time, and we are contributing to a community-wide effort to understand these changes."

Earth's magnetic field reverses itself every few hundred thousand years; the magnetic north pole was most recently in the Southern Hemisphere some 780,000 years ago.

Cathy Constable looks at magnetic field changes known as paleosecular variations that take place between such major reversals. She has studied these changes by charting the direction and strength of the fields recorded in lava flows that date back several million years. She and colleagues have been mapping the average magnetic field and its variability over that period of time, most recently studying flows on the Spitsbergen archipelago in the Arctic Circle.

Data from high latitudes have been underrepresented in paleomagnetic field maps, but Constable said historical data suggest such information is crucial to understanding the dynamics of Earth's core.

To understand the composition of Earth's mantle, Peter Shearer models seismic waves as discrete "particles" of seismic energy. This approach is similar to the way in which light waves are sometimes modeled as individual photons.

Scientists know that the energy of an earthquake or other seismic event will scatter in waves through the shallow part of earth's crust. By tracking the trajectories of seismic "photons," Shearer hopes to create the first global-scale simulations of scattering in the deep earth. The goal, he said, is to understand how the energy of a seismic wave field travels.

"What we're trying to understand is whether there's scattering deep inside the earth that would tell us something about the degree to which mantle convection smoothes out small-scale differences in mantle chemistry," Shearer said.

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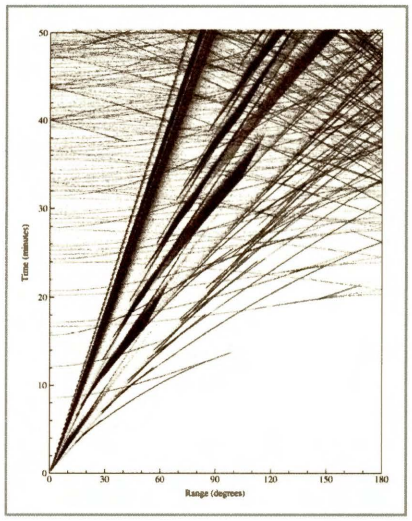
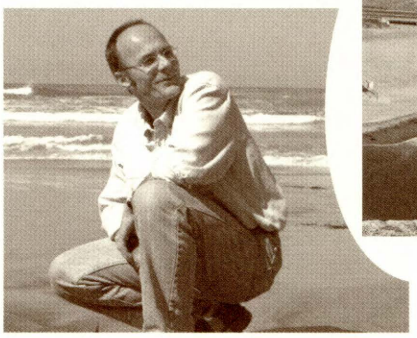
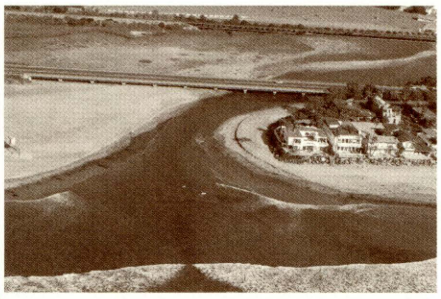


The path of energy in a deep seismic event.

To formalize existing collaborations between coastal physicists and biologists and to strengthen interdisciplinary capabilities in nearshore and offshore systems, the Center for Coastal Studies and the Marine Life Research Group merged to form the Integrative Oceanography Division. In addition to collaborative research benefits, this new division is intended to be a base from which to develop a more interdisciplinary graduate student curriculum.



John Largier



San Dieguito Lagoon shortly after reopening.

In October several Scripps scientists participated in a study of the reopening of the San Dieguito Lagoon as part of a larger look at the role wetlands play in influencing fecal pollution levels along the coast. As the lagoon mouth was opened, coastal oceanographer Clint Winant released 30 drifters in the lagoon to monitor the exchange of water between the lagoon and the ocean.

Among the biological questions to be answered by the research is whether vegetated wetlands act as filters that clean out water on its way to the ocean or as incubators of bacteria. From the time of the opening, Lisa Levin and colleagues have tracked changes in lagoon water temperature, salinity, and oxygenation, and even some rapid changes of biology as animals from outside the lagoon settled.

In ongoing research, Levin is exploring the influences of wetland variables—such as the type and amount of vegetation they contain—on how fecal bacteria is processed before release to the ocean.

Freda Reid, who is a member of the Del Mar San Dieguito Lagoon Committee, also took part in the October study. Reid helped to coordinate volunteer efforts on the day the previously closed river mouth was artificially reopened to the ocean.

Scientists were interested in the difference between bacteria levels in the lagoon and in the surf zone before and after the opening. Reid and volunteers, including IOD codirector Elizabeth Venrick, were stationed at several locations and collected water samples, most of which needed to be transported to the University of California, Irvine (the lead institution in the study) for analysis within six hours of collection.

"It was a valiant effort," Reid said. "You don't get an opportunity like this very often."

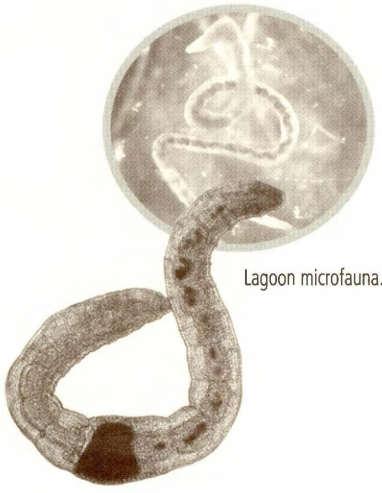
To provide the understanding necessary to interpret and act on routine monitoring of fecal bacteria levels in Mission Bay, John Largier and collaborators have been tracking the flow of land runoff and ocean waters through the bay.

The team of researchers deployed current meters, water-level recorders, GPS drogues, temperature and salinity recorders, and dye fluorometers to track this movement and mixing of waters, as well as to explain the driving forces. Bay circulation is also being represented in a computer model. Dye and salinity are used as tracers to follow specific parcels of water, following paths similar to those that pollutant bacteria could take through the bay.

Largier said that when polluted water is found at a given location, the results of the study will help public officials know the spatial extent of the pollution and its likely persistence, as well as its possible origin.

The ultimate aim, said Largier, is to stop pollution at its source, rather than treating it at the so-called "end-of-the-pipe," where it moves through bays and estuaries. This study, like the San Dieguito Lagoon study, will provide public officials with information to better protect the public when contamination does occur.

IOD.UCSD.EDU



Lagoon microfauna.

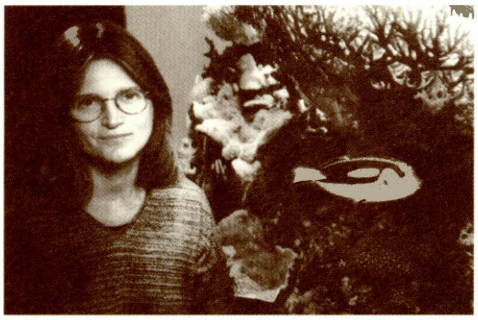
Scientists in the Marine Biology Research Division (MBRD) investigate the fundamental processes affecting life and energy flow in marine ecosystems. They examine biodiversity at multiple levels, from geographical and ecological to physiological and molecular. MBRD investigators explore a variety of habitats, including coral reefs, the deep sea, Antarctica, and coastal California.

The reproductive success of coral falls off dramatically in areas where deteriorating conditions diminish its ability to spawn, according to Nancy Knowlton.

In a multi-institutional study described in a 2002 paper, Knowlton and colleagues examined the reproductive success of three coral species that breed in the same areas within hours of each other. The annual spawning events take place during full moons between August and October.

The research, conducted in the Bahamas and Panama, revealed the importance of that synchrony and the possible damage when coral colonies are not healthy enough to devote energy to spawning.

"What we've found is that you get very low fertilization rates unless lots of coral are breeding at the same time," Knowlton said. "This suggests that these corals are often unsuccessful, and as disturbances to the environment increase, they could face a real threat in terms of their ability to propagate."



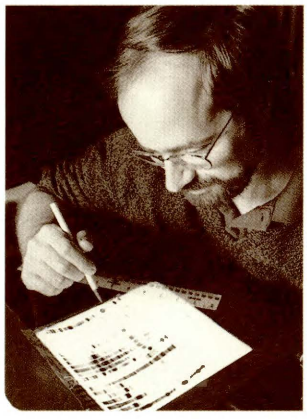
Nancy Knowlton

After completing a map of the genome of the phytoplankton *Synechococcus,* Brian Palenik is discovering that species from the open ocean are far more stripped down genetically than their freshwater relatives.

Palenik and colleagues used comparative genomics to study different types of cyanobacteria, key players at the base of marine food webs. He said the oceanic species' relative sparsity of rapid adaptive abilities shows how much more slowly their environment changes than that of freshwater *Synechococcus.*

In addition, the genome study has shown how the phytoplankton's genetic material is influenced by outside forces.

"You see this organism get attacked by lots of things, like viruses," Palenik said. "If it survives, it sometimes ends up with bits of DNA from these other organisms and sometimes those bits give it new capabilities."



Brian Palenik

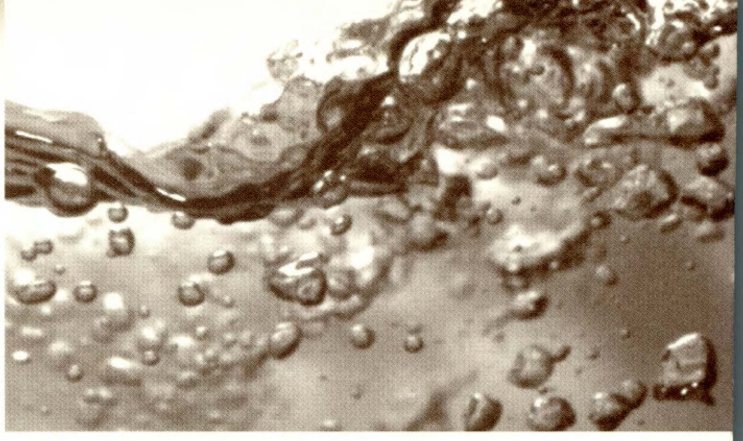
The fast and powerful mako shark.

Researchers Robert Shadwick and Jeffrey Graham, along with graduate students Jeanine Donley and Chugey Sepulveda, studied the swimming biomechanics of the mako shark and have shown that, in some respects, it has more in common with tuna than with other sharks.

As part of an ongoing study of the evolutionary convergence of tuna and sharks of the family Lamnidae, the team measured the comparative muscle activation patterns, strains, and kinetics of a mako and a leopard shark of the family Triakidae. They found that when a mako swims, its muscle activity produces a lateral bending motion in its posterior akin to the thrust-producing motions of tuna.

The researchers are currently taking a closer look at shark muscle performance, including examining the effects of temperature on power output. Both lamnids and tuna are partly warm blooded.

MBRD.UCSD.EDU



"BubbleCam" view of bubbles in a wave.

Scientists in the Marine Physical Laboratory (MPL) use knowledge of the ocean and its boundaries to perform basic research and to solve problems in ocean acoustics, ocean optics, marine physics, marine geophysics, signal processing, and ocean technology. MPL scientists develop advanced ocean technology for in situ and remote environmental measurement programs and for testing of new engineering concepts.

In an effort to improve the effectiveness of radar, Scripps engineer Peter Gerstoft is studying the effects of the marine layer on electromagnetic waves and the subsequent effects on radar response.

When atmospheric marine layers form, they trap temperature and humidity, creating a ceiling above which electromagnetic waves cannot travel. That vertical limit, however, allows waves to propagate in the marine layer over long distances without losing much energy. Gerstoft and colleagues are among the first researchers estimating the refractivity structure of the atmosphere and how it influences radar and cellular telephone transmissions.

The research, conducted in conjunction with the U.S. Navy's Space and Naval Warfare Systems Command (SPAWAR), could lead to improved radar performance prediction.

Grant Deane and Dale Stokes received widespread attention in 2002 when they gained a new glimpse into the world of breaking-wave bubbles.

Bubble formation is crucial to air–sea exchange of gases like carbon dioxide, as well as heat and moisture. In addition, sound is scattered through the bursting of the bubbles, resulting in the crashing sound of waves. Using a high-speed video camera dubbed "BubbleCam," Dean and Stokes were able to monitor the size and quantity of bubbles formed as waves crash. They discovered that the process follows very basic principles of physics, despite the apparently random, complicated nature of waves.

In the wake of their findings being published in the journal *Nature,* the two are adding another observational component in the form of bioluminescent plankton. The glow of the creatures, triggered by the shear stress of waves, is a complementary measure of turbulence within waves.

In an ecological research area that traditionally relies on visual surveys, Scripps geophysist John Hildebrand has spent the past decade recording the sounds of marine mammals to assess population sizes. In 2002, he documented a plethora of activity that could lead to new understanding of whale abundance and behavior.

Hildebrand deployed an array of seven acoustic recording instruments that picked up more than 300,000 blue whale calls in a region near the Antarctic peninsula—an area in which only one blue whale has been spotted in the past decade. The challenge is to ascertain how many blue whales produced these calls.

"Clearly there are many more blue whales than the lone animal that has been seen, and it is much more efficient to study this area with acoustic techniques," Hildebrand said.

In addition, he is working with other scientists to create a model assessing the physiological effects on cetaceans of human-made underwater sound emissions. The model is meant to simulate how sound propagates into the bodies of marine mammals and to determine what physical effects may be taking place.

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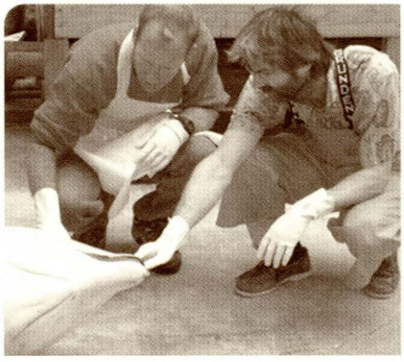
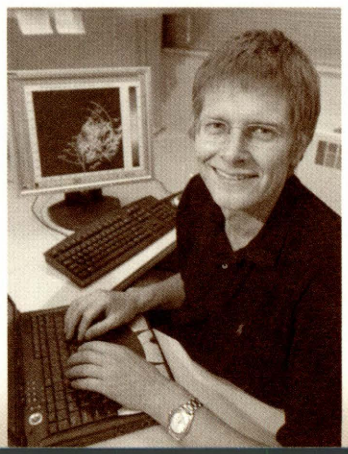
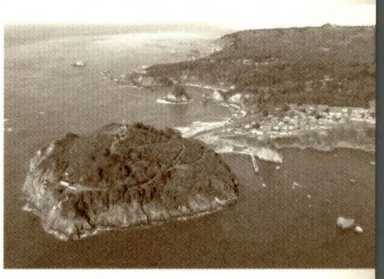


John Hildebrand (right)



Peter Gerstoft

Scientists in the Marine Research Division (MRD) encompass the disciplines of marine chemistry and biological oceanography. MRD research includes studies of the variations of atmospheric oxygen over time and their relationship to the global carbon cycle and climate change, marine pollution and environmental issues, interstitial water chemistry of deep-sea cores, the geochemistry of nearshore sediments, marine natural products chemistry, as well as extraterrestrial geochemistry and chemistry related to the origin of life.



Climate station at Trinidad Head.

Biological oceanographer Greg Mitchell deploys optical sensors during research cruises to gather data about the physiology, ecology, and production of phytoplankton, microscopic plant life whose abundance, type, and physiological status govern the color of the ocean.

Using such data, Mitchell develops mathematical relationships relating surface phytoplankton chlorophyll and primary production to ocean color signals imaged by satellites. In September 2002, along with colleague Mati Kahru, he reported that low nutrients in the unusually warm waters during the 1997–98 El Niño off California resulted in dramatic declines in primary production of phytoplankton.

Greg Mitchell

In recent years Mitchell's group has collaborated with the Southwest Fisheries Science Center to improve satellite estimates of phytoplankton in the Antarctic's Southern Ocean. In 2004 he will lead a multi-institutional, interdisciplinary team of oceanographers on a cruise to Antarctica to study how iron distributions control phytoplankton biomass, physiology, and primary production.

The study site in the southern Drake Passage was selected based on satellite data that revealed a predictable transition from low to high phytoplankton biomass that will allow the group to efficiently explore the plankton community response to physical–chemical influences across the gradient.

The wind that blows along the California coast churns deeper waters up to the surface, setting in motion an exchange of gases like oxygen and nitrous oxide.

For the first time, researchers Tim Lueker and Ralph Keeling are able to continually monitor this gas exchange during upwelling events using a suite of instruments installed at a station in the northern California coastal town of Trinidad. The measurements, collected every eight minutes via computer, have been a great improvement over in-the-field air samplings that were only taken a few times a month.

The researchers have compared their data with satellite observations of sea-surface color, which reflects the concentration of chlorophyll, and with sea-surface temperature readings. The combined data will help scientists track changes in the rate of upwelling from year to year and to make predictions about likely concentrations of gases exchanged during the events and primary production in the ocean.

Osmund Holm-Hansen's research focuses on physiological responses of phytoplankton to changes in the chemical and optical conditions in the upper water column. He is active in three major projects, two of which are concerned primarily with polar regions.

One study considers with the biological impact of increased solar ultraviolet radiation resulting from atmospheric ozone depletion. Among the aspects being studied are the mechanisms of cellular damage by ultraviolet radiation and the degree to which the damage is reversible, as well as the overall ecological impact on seasonal rates of primary production in the Southern Ocean.

Another project, also taking place in the Antarctic, is a long-term, multidisciplinary study to better understand the factors responsible for the seasonal and yearly variability in phytoplankton distribution and biomass and the importance of such variability in regard to the food resources available to grazing zooplankton, particularly krill. One facet of this study involves the importance of ocean-mixing processes in the transport of dissolved iron from coastal waters to the euphotic zones—the upper layer of ocean where photosynthesis takes place—of pelagic, open ocean waters.

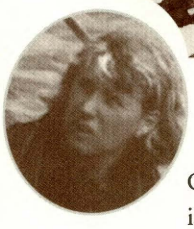
Holm-Hansen's third research project involves the ecological impact of high concentrations of copper and zinc on the bacterial and phytoplankton assemblages in San Diego Bay. This study considers seasonal field studies and laboratory experiments designed to better understand the importance of naturally occurring compounds in reducing potential toxicity of these metals.

Osmund Holm-Hansen

WWW.MRD.UCSD.EDU

Scientists in the Physical Oceanography Research Division (PORD) study a range of observational and theoretical topics related to the physics of the ocean. Some researchers study the large-scale circulation of the world's oceans or the specifics of smaller environments such as the continental shelf, estuaries, or the shoreline. Others examine the interaction between the ocean and atmosphere. PORD scientists also develop new technologies, such as autonomous drifters, specialized sensors, and new versions of current profilers.

R/V *Gould* at Palmer Station.



Janet Sprintall

The Antarctic Circumpolar Current in the Southern Ocean is by volume the world's largest ocean current system, but it is poorly characterized because of lack of sampling in this remote region.

Satellites have measured ocean surface temperature variability of the current that travels around the entire Antarctic continent, but subsurface measurements are lacking. The most intense variability has been observed in Drake Passage—a chokepoint or constriction of the current—between the tip of South America and the Antarctic Peninsula.

In September 1999, Teresa Chereskin began a long-term sampling program of ocean currents across the Drake Passage from a shipboard acoustic Doppler current profiler installed on the National Science Foundation research vessel *Laurence M. Gould.* The vessel traverses Drake Passage several times per month, from Punta Arenas, Chile to Palmer Station, Antarctica. After four years of data gathering, representing about 70 cross sections of the current, Chereskin and graduate student Yueng-Djern Lenn are beginning to characterize the mean structure of the jets that make up the Antarctic Circumpolar Current.

Eddies are the ocean's version of weather systems and play a critical role in circulation and heat distribution. Using data from the long-running climate observation satellite TOPEX/Poseidon, Detlef Stammer has found that some ocean regions show a wide range of variability in eddy activity.

In areas like the eastern Indian Ocean, Stammer has observed an increase of variability in excess of 30 percent over the past decade. In contrast, the North Atlantic and the western tropical and south Pacific Ocean have had a steady decrease in eddy variability.

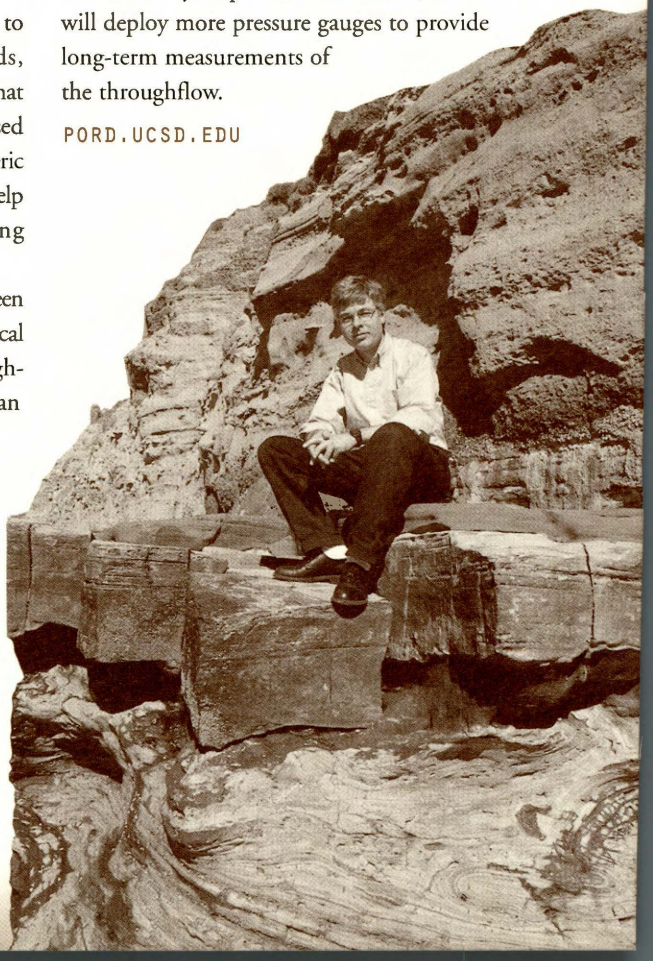
Such changes are likely related to how the ocean responds to winds, Stammer said. The finding suggests that TOPEX/Poseidon data could be used to extrapolate the effects of atmospheric circulation on ocean circulation and help researchers understand the mixing properties of this interaction.

The only connection point between the Pacific and Indian oceans at tropical latitudes is at the Indonesian throughflow, an area of importance to ocean circulation on a global scale. Using pressure gauges, Janet Sprintall and colleagues have gathered sea-level variation data since 1995. They have found that the throughflow varies in response to seasons and to monsoonal winds from the Indian Ocean and tradewinds from the Pacific Ocean.

To overcome data gaps that have hampered analysis to date, Sprintall is one of several scientists who have joined an international effort to measure the throughflow's velocity, temperature, and salinity simultaneously. The project, INSTANT (International *Nusantara* Stratification and Transport), includes researchers from Australia, the United States, the Netherlands, France, and Indonesia. *Nusantara* is the Indonesian word for archipelago.

Starting in December 2003, INSTANT researchers will deploy moorings at major inflow and outflow points in the throughflow over a three-year period. In addition, researchers will deploy more pressure gauges to provide long-term measurements of the throughflow.

PORD.UCSD.EDU



Detlef Stammer

ON THE EVE OF ITS CENTENNIAL, SCRIPPS INSTITUTION OF OCEANOGRAPHY RESEARCH CONTINUES IN THE TRADITION BEGUN BY THE INSTITUTION'S FIRST DIRECTOR, WILLIAM E. RITTER—TO EXPLORE THE INTERRELATEDNESS OF ALL LIFE FORMS AND ECOSYSTEMS WHILE STUDYING PARTICULAR SPECIES OR PHENOMENA.

John A. Orcutt

AQUARIUM.UCSD.EDU

SCRIPPS OCEANOGRAPHIC SOCIETY
7,090 memberships

VOLUNTEER HOURS
22,400

STAFF MEMBERS
49 career, 1 casual, 27 by agreement, 5 students

EARNED INCOME
$2,637,131

DONOR-DESIGNATED GIFTS AND GRANTS
$581,522

IN-KIND DONATIONS
$124,638

OPERATING EXPENSES
$2,778,815

ON-SITE VISITORS
328,997 (including 39,489 schoolchildren on educational field trips)

PUBLIC EDUCATION ACTIVITIES
105 on-site and field programs
193 naturalist-led whale-watching cruises
68 birthday party programs
Total participants: 31,343

SUMMER LEARNING ADVENTURES
70 sessions with 1,018 participants

OUTREACH PROGRAM PARTICIPANTS
207 programs for 7,094 students K-12
27 charity programs for 298 participants
19 community fairs reaching 350,000 people
253 total programs reaching a total of 357,592 people

The Education Department at Birch Aquarium continues to offer informative, yet fun, classes for both children and adults, providing the public an opportunity to take an in-depth, interactive approach to studying marine life at the aquarium and in the wild.

Nigella Hillgarth
EXECUTIVE DIRECTOR BIRCH AQUARIUM

The Birch Aquarium at Scripps enjoyed a successful fiscal year 2002, despite the downturn experienced in America's tourism industry and the worsening economic climate. Aquarium attendance, excluding education groups, was down only three percent from last year. This resilience can be attributed to new exhibits, exceptional field and classroom offerings, and a marketing program that increased public awareness of the Birch Aquarium.

As part of the aquarium's mission to promote ocean conservation, new exhibits opened last year that highlight environmental and conservation issues.

In May, Secrets of the Seahorse opened to the public with great fanfare and an enthusiastic reception from visitors. Sea horses have fascinated humans since ancient times. Unfortunately, though, at least 20 million sea horses are being taken from the ocean each year, according to recent estimates. The exhibit, which features tanks with 10 species of sea horses raised at the aquarium as well as spectacular sea dragons, teaches visitors about these intriguing creatures and current efforts to protect them.

Kelp forest ecology has been an important part of Scripps science for decades and thus is an integral part of the aquarium's educational mission. To complement the 70,000-gallon kelp forest tank at Birch Aquarium, *Ghost Forest,* a multimedia presentation, opened last year. *Ghost Forest* documents evidence of the decline of marine life in these habitats and the devastating impacts humankind has had on them.

To add some thrills to the educational atmosphere, the Morphis Movie Ride was installed. In this 20-seat motion-simulating theater, visitors can ride inside a raindrop through the water column, swim with dolphins in the open ocean, or visit the habitat of African mountain gorillas.

Birch Aquarium visitors have also responded positively to the 13,000-gallon Lynne and Howard Robbins Shark Tank, which features five species of Indo-Pacific Reef Sharks. The aquarium's annual Shark Days weekend was more spectacular than ever with the addition of the new tank.

The Education Department at Birch Aquarium continues to offer informative, yet fun, classes for both children and adults, providing the public an opportunity to take an in-depth, interactive approach to studying marine life at the aquarium and in the wild. An education highlight in fiscal year 2002 was securing additional funding for the School Partnership Program, which provides science education for 600 economically disadvantaged middle-school students. Exciting new science and arts programs—such as field biology camp, a remotely-operated-vehicles class, and ocean arts camp—were added to the Summer Learning Adventures curriculum.

In June, more than 200 guests attended an elegant fund-raising event: Neptune's World. The third annual Birch Aquarium gala raised $121,310, with net proceeds supporting science education programs at Birch Aquarium. Journalist Walter Cronkite attended, and the next day he received Scripps's Nierenberg Prize for Science in the Public Interest.

Once again, the Birch Aquarium was transformed into the Haunted Aquarium for two days in October. This Halloween event delighted children and adults alike with spooky science exhibits featuring creatures that glow in the dark, creeps from the deep, and a "ghost forest."

More than 150 evening events contributed to the aquarium's bottom line and visibility in the community. Events clients came from all over the world, including guests from the government of Singapore, and domestic dignitaries such as state governors, university presidents, and CEOs from major corporations.

Last year for the first time, the aquarium was featured in two outdoor media campaigns resulting in higher attendance at the gate. For the fall campaign an advertising agency supplied its services pro bono, and focused on billboard and bus shelter ads.

Growing accolades for the Birch Aquarium at Scripps point to greater recognition of its unique offerings and exhibits. *San Diego Magazine* listed the Birch Aquarium as one of 15 "Best Places to Take Your Kids." And for the second year in a row, Birch Aquarium was the most visited museum in the annual Museum Month discount admission program.

None of this would be possible without the exceptional support the aquarium received from a community of generous donors, members of the Scripps Oceanographic Society, and the more than 300 volunteers who helped make all the events and programs happen last year.

For more information about programs and exhibits at the aquarium, call 858/534-FISH or visit aquarium.ucsd.edu.

Jeffrey B. Graham
BIRCH AQUARIUM DIRECTOR (THROUGH JULY 2002)

Nigella Hillgarth
EXECUTIVE DIRECTOR BIRCH AQUARIUM

SCRIPPS.UCSD.EDU/GRAD_DEPT

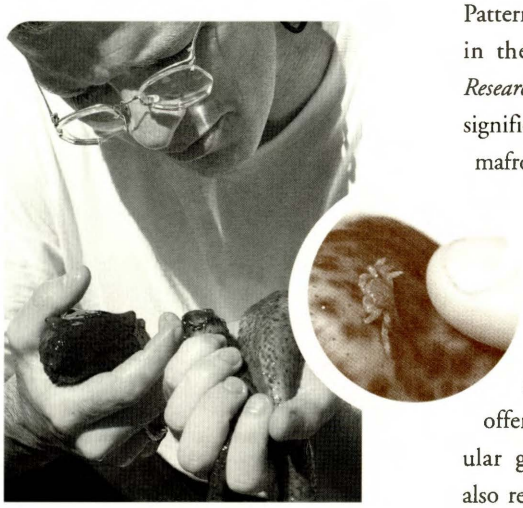
As we celebrate our centennial, we look forward to yet another year in which we attract an outstanding class of graduate students and continue to train world-class scientists in the tradition of William E. Ritter and his

successors.

Myrl C. Hendershott
SCRIPPS GRADUATE DEPARTMENT CHAIR

A century ago, a handful of zoology students helped William E. Ritter collect marine specimens. Today, more than 200 graduate students continue to participate in vital research at Scripps Institution of Oceanography.

In addition to playing an integral role in research activities, students receive exceptional graduate instruction at one of the world's oldest and largest global science research centers.



During the past year, 24 students completed their Ph.D. studies in the fields of oceanography, marine biology, and earth sciences. The research interests of these individuals—ranging from the study of seismic deformation to the effects of bioactive secondary metabolites on marine sponges—reflect the breadth of the research activities at Scripps.

Last summer, the Scripps Graduate Department awarded Mark Kessler the Edward E. Frieman Director's Prize for Excellence in Graduate Student Research for his outstanding research paper, "A Model for Sorted Circles as Self-Organized Patterns," which was published in the *Journal of Geophysical Research* and was recognized as a significant contribution to permafrost and periglacial studies.

As part of a continuing effort, the Graduate Department and faculty devoted considerable effort to reviewing and revising the core courses offered by a number of curricular groups. The department also recruited three new faculty members, and along with the seven recruited in the preceding year, they have significantly contributed to the strength and talents of the existing faculty.

On an administrative note, a new staff position was created last year to help establish a much needed alumni database. Until now, our alumni outreach has been neglected, but we are making great strides in locating alumni and soliciting their interest to mentor current students. For more information on alumni relations, contact the Graduate Department.

As we celebrate our centennial, we look forward to yet another year in which we attract an outstanding class of graduate students and continue to train world-class scientists in the tradition of William E. Ritter and his successors.

Myrl C. Hendershott
SCRIPPS GRADUATE DEPARTMENT CHAIR

CURRICULAR Groups

The Graduate Department of Scripps Institution of Oceanography offers instruction leading to Ph.D. degrees in oceanography, marine biology, and earth sciences. Because of the interdisciplinary nature of the ocean sciences, the department provides a choice of eight curricular groups through which the student may pursue a Ph.D. degree. Each group has prerequisites for admission in addition to the departmental requirements.

Applied Ocean Science (AOS)

This interdepartmental program serves as a bridge between the classical disciplines of biological, geological, and physical oceanography and the UCSD engineering departments. The aim of the AOS program is to develop scientists capable of designing and operating novel instrumentation in support of ocean research, as well as analyzing and interpreting the data.

Biological Oceanography

In the biological oceanography curriculum, the interactions of marine organisms with the physical–chemical environment and with each other are studied. Research and instruction in this curriculum range from food-web dynamics and community structure to systematics, behavior, biogeography, and physical–biological interactions.

Climate Sciences

The climate sciences curriculum concerns the study of the climate system of the earth with emphasis on the physical, dynamical, and chemical interactions of the atmosphere, ocean, land, ice, and the terrestrial and marine biospheres. The program includes investigations of changes on seasonal to interannual time scales, changes induced by human activities, and paleoclimatic changes on time scales from centuries to millions of years.

Geological Sciences

This curriculum applies observational, experimental, and theoretical methods to the understanding of the solid earth and the solar system and how they relate to the ocean and the atmosphere. Principal subprograms are marine geology and geophysics, tectonics, sedimentology, micropaleontology and paleoceanography, petrology and geochemistry, and isotope geology. Expedition work at sea and field work on land are emphasized as essential complements to laboratory and theoretical studies.

Geophysics

This curriculum educates the student about the physics of the solid earth, including the earth's magnetic field, the mechanics of tectonic processes, earthquakes and the waves they produce, the physics of the earth's interior, and mathematical methods for analyzing data and interpreting them in terms of models of the earth. Physical and mathematical approaches to geophysical research are emphasized.

Marine Biology

The marine biology curriculum emphasizes course work, seminars, and research on all aspects of the biology of marine organisms. Teaching and research focusing on both prokaryotes and eukaryotes encompass the disciplines of cell and molecular biology, biochemistry, developmental biology, physiology, biomechanics, genetics, ecology, and evolutionary biology.

Marine Chemistry and Geochemistry

The marine chemistry and geochemistry curriculum emphasizes the chemical and geochemical processes operating in the oceans, atmosphere, and other environments, and includes the subdiscipline of marine natural product chemistry. Education and research in this curriculum combine field observations with laboratory or modeling projects. Studies of natural systems are often multidisciplinary and integrate chemical concepts and techniques with information about physical, geological, or biological processes, including the effects of human activity.

Physical Oceanography

The physical oceanography curriculum deals with mechanisms of energy transfer through the sea and across its boundaries and with the physical interactions of the sea with its surroundings, especially its influence on climate. Research activities are both observational and theoretical. These include study of the general circulation of the oceans; mechanisms of transport of energy, momentum, and physical substances within the sea and across its boundaries; properties of wind waves, internal waves, tsunami waves, and planetary waves; the thermodynamic description of the sea as a system not in equilibrium; optical and acoustical properties of the sea; and the influence of the surf on nearshore currents and the transport of sediments.

Student Enrollment

In the fall of 2001, 60 new students were admitted to graduate study. Of these, 5 were admitted to applied ocean science, 7 in biological oceanography, 5 in climate science, 8 in geophysics, 6 in geological science, 10 in marine biology, 12 in marine chemistry and geochemistry, and 7 in physical oceanography. From December 2001 to December 2002, UCSD awarded 27 doctor of philosophy degrees and 2 master of science degrees to the students listed in this section.

Doctor of Philosophy Degrees Awarded, with Titles of Dissertations

Earth Sciences

Barry Eakins
"Structure and Development of Oceanic Rifted Margins"

Mark Kessler
"Sorted Patterned Ground: Numerical Models Exhibiting Self-Organization"

Suzanne Lyons
"Investigations of Fault Creep in southern California Using Interferometric Synthetic Aperture Radar and GPS"

Christina Massell
"Large-Scale Structural Variation of Trench Outer Slopes and Rises"

Rosanne Nikolaidis
"Observation of Geodetic and Seismic Deformation with the Global Positioning System"

Vera Schulte-Pelkum
"Mantle Structure and Anisotropy from the Particle Motion and Slowness of Compressional Body Waves"

Renato Solidum, Jr.
"Geochemistry of Volcanic Arc Lavas in Central and Southern Phillipines: Contributions from the Subducted Slab"

Marine Biology

Yolanda Arias
"Natural Attenuation of Cr(VI) by Bacteria in Harbor Sediments"

Eric Allen
"Piezophysiology of Membrane-Based Adaptations in the Deep-Sea Bacterium Photobacterium Profudum Strain SS9"

Diego Bernal
"Physiological and Morphological Specializations for High-Performance Swimming in the Mako Shark, Isurus Oxyrinch"

Melinda Duplessis
"Gill Endosymbiont Respiration and Nutritional Strategies in the Chemosymbiotic Bivalave Family Lucinidae"

Laura Fandino
"Molecular Ecology of Bacteria Associated with Marine Phytoplankton Blooms"

Luana Galver
"The Molecular Ecology of Spinner Dolphins, Stenella Longirostris: Genetic Diversity and Population Structure"

Kathryn Mengerink
"Sea Urchin Sperm Membrane Glycoproteins"

Michael Tryon
"The Development and Application of a New Benthic Aqueous Flux Meter for Very Low to Moderate Discharge Rates"

Oceanography

Kim Cobb
"Coral Records of the El Niño—Southern Oscillation and Tropical Pacific Climate over the Last Millennium"

Christopher Halle
"Observations of Internal Waves and Eddies in the Beaufort Sea During the Winter of 1993/94"

Akkharawit Kanjana-Opas
"New Antifungal Compounds from Marine Fungi"

Seongil Kim
"Ocean Time Reversal Acoustics and Application to Reverberation Reduction"

Linden Clarke
"Surfzones 'Megaripples"

Katherine McArthur
"Geoacoustic Inversions in a Very Shallow Water Environment"

Thomas Noyes
"Field Observations of Shear Waves"

Baijun Tian
"Tropical Cloud Radiative Forcing and the Hadley/Walker Circulation"

MartinVollmer
"Studies of Deep-Water Renewal in Lakes Malawi/Nyasa and Issyk-Kul Using Sulfur Hexafluoride and Chlorofluorocarbons as Time-Dependent Tracers"

Eric Wilcox
"Spatial and Temporal Scales of Precipitating Tropical Cloud Systems"

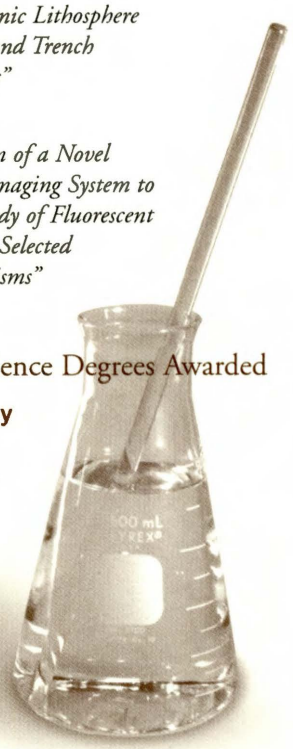
Kimberly Williams
"Rifting of Oceanic Lithosphere at Transforms and Trench Slop Seamounts"

David Zawada
"The Application of a Novel Multispectral Imaging System to the In Vivo Study of Fluorescent Compounds in Selected Marine Organisms"

Master of Science Degrees Awarded

Oceanography

Jason Jordan
Genevieve Lada



For application procedures or more information, please write to:

University of California, San Diego
Scripps Institution of Oceanography
Graduate Department
9500 Gilman Drive, Dept. 0208
La Jolla, CA 92093-0208
siograddept.ucsd.edu

This centennial year is a time to reflect on how much UCSD, San Diego, and the world owe to Scripps Institution of Oceanography. Scripps leaders helped found this great research university, and they laid the foundation for a high-tech and biotech hub in San Diego that grew into a regional economic powerhouse. Scripps scientists have shaped ocean and evironmental sciences through studies that have had a profound global impact. I salute Scripps's accomplishments and the vital future role it will play in protecting our beloved

planet.

Robert C. Dynes
UCSD CHANCELLOR

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John Gilson, PORD, Physical Oceanography

Ralf Goericke, IOD, Biological Oceanography

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CMBB/MBRD, Marine Biology/Physiology

Nicholas E. Graham, CRD/MPL, Meteorology

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MPL/GRD, Applied Physics

Mark Hildebrand, MBRD, Biochemistry

★ **David R. Hilton,** GRD, Isotope Geochemistry

✖ **Noritaka Hirohashi,** MBRD, Life Sciences

★ **William S. Hodgkiss, Jr.,**
MPL, Signal Processing

Linda Z. Holland, MBRD, Molecular Biology

★ **Nicholas D. Holland,** MBRD, Marine Biology

Rainer Hollerbach, IGPP, Earth Sciences

Osmund Holm-Hansen,
MRD, Marine Biology

✖ **Ibrahim Hoteit,** PORD, Applied Mathematics

● **John R. Hunter,** D-SIO, Ichthyology

Sam F. Iacobellis,
CRD, Physical Oceanography

★ **Glenn R. Ierley,**
IGPP/PORD, Physical Oceanography

Anand K. Inamdar, CAS,
Radiative Transfer/Numerical Computation

❖ **Douglas L. Inman,**
IOD, Physical Oceanography

✚★ **Jeremy B. C. Jackson,** GRD/MBRD, Geology

Jules S. Jaffe, MPL, Biophysics

Bernd Jahne, PORD, Atmospheric Chemistry

Paul R. Jensen, MRD, Microbiology

✢ **Edward R. Johnson,**
IGPP, Applied Mathematics

★ **Catherine Johnson,** IGPP, Geophysics

Kenneth G. Johnson, GRD, Geology

Mati Kahru, MRD, Biological Oceanography

Adrianus J. Kalmijn, PORD, Biology/Physics

Masao Kanamitsu, CRD, Meteorology

★ **Miriam Kastner,** GRD, Geology

■ **Ronald S. Kaufmann,** MBRD, Marine Biology

★ **Charles D. Keeling,** GRD, Marine Chemistry

★ **Ralph F. Keeling,**
MRD, Atmospheric Chemistry

◗ **Michael P. Kennedy,** GRD, Geology

★ **Charles F. Kennel,** Director, Astrophysics

Graham M. Kent, IGPP, Geophysics

✖ **Deborah L. Kilb,** IGPP, Seismology

✖■ **Michael Kirby,** GRD, Geology

Jochen Klinke, PORD, Physics

◗ **John A. Knauss,** PORD, Oceanography

✖ **Andrea Knower,** CMBB, Marine Biology

✖ **Noah Knowles,** CRD, Oceanography

★ **Nancy Knowlton,** MBRD, Zoology

Robert A. Knox,
PORD/SOMTS/DO, Oceanography

✖ **Armin Koehl,** PORD, Physical Oceanography

✖■ **Achim Kopf,** GRD, Geology

Antonius Koppers,
IGPP, Isotope Geochronology

❖ **Gerald L. Kooyman,** CMBB, Physiology

✖ **Monika Korte,** IGPP, Geophysics

✖ **Chundakkadu Krishna,** MRD, Biotechnology

★ **William A. Kuperman,**
MPL, Marine Acoustics

Ngai C. Lai, CMBB, Marine Biology

✖ **Claudia Lainscsek,** MPL, Physics

★ **Devendra Lal,** GRD, Nuclear Geophysics

Carina B. Lange, GRD, Marine Diatoms

John L. Largier,
IOD, Coastal and Estuarine Hydrodynamics

M. Gabrielle Laske, IGPP, Geophysics

Michael Latz, MBRD/CMBB,
Marine Biology

■ **Dong Kyu Lee,** PORD, Oceanography

✖ **Olwijn Leeuwenburgh,**
PORD, Geodesy/Oceanography

★ **James J. Leichter,** IOD, Biological Sciences

✖ **Paul Lepper,** MPL, Underwater Acoustics

✢ **Alan R. Levander,** IGPP, Geophysics

★ **Lisa A. Levin,** IOD,
Marine Population and Community Ecology

❖ **Ralph A. Lewin,** MBRD/CMBB, Marine Biology

✖ **Fang Li,** CRD, Mechanical Engineering

◆ **Leonard N. Liebermann,** Physics/MPL, Physics

Thomas C. Lippmann,
IOD, Nearshore Oceanography

✖ **Richard Long,** MBRD, Marine Biology

★ **Peter F. Lonsdale,** MPL, Geology

✖ **Katja B. Lorbacher,**
PORD, Physical Oceanography

◆ **Ralph Lovberg,** PHYS, Physics

Carl D. Lowenstein, MPL, Marine Physics

Youyu Lu, PORD, Physical Oceanography

Dan Lubin, CAS/CSI, Atmospheric Physics

Timothy J. Lueker, MRD, Oceanography

Gunter W. Lugmair, GRD, Geochemistry

■ **Mary Ann Lynch,** GRD, Oceanography

★ **J. Douglas Macdougall,** GRD, Marine Geology

◆ **Jacqueline Mammerickx,** GRD, Geology

✖ **Aldo J. Manfroi,** PORD, Oceanography

■ **Maura Manganelli,** MBRD, Marine Biology

✖ **Elizabeth Mann,**
MBRD, Biological Oceanography

Arnold Mantyla, IOD, Oceanography

✖ **Rama Manum,** MRD, Chemistry

✖ **David Marsden,** CAS, Physics

Simon J. Mason, CRD/MPL, Geography

★ **T. Guy Masters,** IGPP, Geophysics

❖ **John A. McGowan,**
IOD, Biological Oceanography

★ **W. Kendall Melville,**
MPL/PORD, Fluid Mechanics

■ **Frances B. Michaelis,** MBRD, Marine Biology

❖ **John W. Miles,** AMES/IGPP,
Geophysics/Fluid Dynamics

Arthur J. Miller,
CRD/CSI, Physical Oceanography

✖ **Benjamin R. Miller,** GRD, Earth Sciences

Stephen P. Miller, GRD, Geophysics

★ **Jean-Bernard H. Minster,** IGPP, Geophysics

B. Gregory Mitchell,
MRD, Phytoplankton Biology

Michael Molitor,
CRD, Public International Law

Russell Moll, SGP, Biology

◗ **H. Geoffrey Moser,** MBRD, Fisheries Biology

✖■ **Rosa Mourino,** MBRD, Marine Ecology

✖ **Mohamed Moustaoui,**
CAS, Atmospheric Dynamics

❖ **Walter H. Munk,** IGPP, Geophysics

✖ **David Mustra,** MRD, Pharmacology

✖ **Venkata R. Muvva,**
CAS, Atmospheric Sciences

✖ **Boris Nemzer,** MPL, Thermodynamics

Cynthia Nevison, GRD, Atmospheric Sciences

★ **William A. Newman,**
MBRD/DO, Biological Oceanography

■ **Catherine Nigrini,** GRD, Geology

★ **P. Peter Niiler,** IOD/PORD, Applied Mechanics

■ **Walter Nordhausen,** MBRD, Marine Biology

★ **Joel Norris,** IGPP, Atmospheric Sciences

✪ **R. Glenn Northcutt,** Neurosciences, Zoology

Anna Obraztsova, MBRD, Microbiology

★ **Mark D. Ohman,**
IOD/STS, Biological Oceanography

Michele S. Okihiro, IGPP, Oceanography

★ **John A. Orcutt,** IGPP, Geophysics

★ **Brian Palenik,** MBRD, Oceanography

◗ **Dorothy L. Parker,** MBRD, Molecular Biology

★ **Robert L. Parker,** IGPP/PORD, Geophysics

✖ **Paul Parnell,** IOD, Oceanography

Cheryl L. Peach, BAS, Geology

● **William F. Perrin,** D-SIO, Zoology

✖ **Emily Pidgeon,**
IOD, Civil & Environmental Engineering

★ **Robert Pinkel,** PORD/MPL, Internal Waves

Stephen C. Piper, GRD, Modeling

Jacek Piskozub, MPL, Oceanography

■ **Fabio Bettini Pitombo,** MBRD, Marine Biology

✖ **Lawrence Plug,** IGPP, Geology

Igor A. Podgorny,
CAS, Physical & Mathematical Science

Paul J. Ponganis, CMBB, Biology

Shelly K. Pope, CAS, Planetary Sciences

■ **Michael Porter,** MPL, Ocean Acoustics

✖ **Linette Prawiridirdjo,** IGPP, Earth Sciences

✖ **Melany Puglisi,** MRD, Pharmacognosy

◗ **Zhengxu Qian,** PORD, Physics

▲★ **Veerabhadran Ramanathan,**
CSI/CRD/CAS, Planetary Atmospheres

◗ **Anthony E. Rathburn,** IOD, Geology

◗ **Freda M. Reid,** IOD, Taxonomy

❖ **Joseph L. Reid,** IOD, Physical Oceanography

■ **Genelle W. Renz-Killmar,** GRD, Geology

❖ **William R. Riedel,** STS, Marine Geology

■ **Kim B. Ritchie,** MBRD, Marine Biology

John O. Roads, CRD/CSI, Meteorology

★ **Paul E. Robbins,** PORD, Oceanography

✖ **Gregory C. Roberts,**
CAS, Atmospheric Sciences

★ **Dean H. Roemmich,**
PORD/IOD, Oceanography

★ **Richard H. Rosenblatt,** STS, Marine Zoology

◗ **Arnold Ross,** MBRD, Marine Biology

★ **Daniel L. Rudnick,**
PORD, Physical Oceanography

★ **Enric Sala,** IOD, Ecology

★ **Richard L. Salmon,** PORD, Oceanography

★ **David T. Sandwell,** IGPP, Marine Geophysics

Annika B. Sanfilippo, GRD/STS, Paleontology

Glenn S. Sasagawa, IGPP, Earth Sciences

Allan W. Sauter,
MPL/GRD, Ocean Bottom Seismology

Nicklas Schneider, CRD, Oceanography

✖ **Vera Schulte-Pelkum,** IGPP, Geophysics

★ **John G. Sclater,** GRD, Geophysics

★ **Jeffrey P. Severinghaus,**
GRD, Geological Sciences

Richard J. Seymour, IOD, Oceanography

★ **Robert E. Shadwick,** MBRD/CMBB,
Biophysics

ErChang Shang, MPL, Underwater Acoustics

Raj Kumar Sharma, PORD, Physics

★ **Peter M. Shearer,** IGPP, Seismology

Jeffrey T. Sherman,
PORD, Applied Ocean Sciences

✢ **Steven Shkoller,** IGPP, Mechanics

❖ **George G. Shor, Jr.,**
SOMTS/MPL, Marine Geophysics

Alexander Shukolyukov,
GRD, Radiochemistry

James J. Simpson,
IOD, Physical Oceanography

✢ **Deborah K. Smith,** IGPP, Earth Sciences

Jerome A. Smith,
PORD/MPL, Physical Oceanography

Kenneth L. Smith, Jr.,
MBRD, Ecological Energetics

● **Paul E. Smith,** D-SIO, Pelagic Ecology

★ **Raymond C. Smith,** MRD, Physics

★ **Richard C. J. Somerville,**
CRD/CAS, Meteorology

Hee Chun Song, MPL, Ocean Engineering

❖ **Fred N. Spiess,** MPL, Marine Physics

Janet Sprintall, PORD, Physical Oceanography

★ **Detlef Stammer,**
PORD, Physical Oceanography

Hubert H. Staudigel, IGPP, Geology

◗ **Jeffrey L. Stein,** MBRD/CMBB, Marine Biology

✖ **Iris T. Stewart,** CRD, Hydrogeology

Malcom D. Stokes,
MPL, Biological Oceanography

Malgorzata Stramska, MRD, Oceanography

★ **Dariusz Stramski,** MPL, Oceanography

★ **George Sugihara,**
PORD, Mathematical Biology

✖ **Philip Sura,** PORD, Physical Oceanography

James H. Swift,
PORD/IOD/STS, Physical Oceanography

William Sydeman, IOD, Ecology

★ **Lynne D. Talley,** PORD, Oceanography

✖ **Lik T. Tan,** MRD, Pharmacy

✖ **Toste Tanhua,** GRD, Marine Chemistry

★ **Lisa Tauxe,** GRD, Geophysics

Steven W. Taylor, CMBB/MBRD, Chemistry

Bradley M. Tebo,
MBRD/CMBB, Marine Biology

✖ **Jane Teranes,** GRD, Earth Sciences

Eric Terrill, MPL, Oceanography

■ **Jurgen Theiss,** PORD, Oceanography

✖ **Virginie Thierry,** PORD, Physical Oceanography

Aaron Thode, MPL, Oceanography

William H. Thomas, MRD, Microbiology

Mizuki Tsuchiya, MRD, Physical Oceanography

Frederick I. Tsuji, MBRD/CMBB, Biochemistry

◆ **Victor Vacquier,** MPL, Geophysics

★ **Victor D. Vacquier,** MBRD/CMBB, Developmental Biology

■ **David Valentine,** MBRD, Marine Biology

Francisco Valero, CAS/CSI, Atmospheric Physics

✖ **Robert P. Van Dam,** CMBB, Biology

◆ **William G. Van Dorn,** PORD, Physical Oceanography

Elizabeth L. Venrick, IOD, Oceanography

Maria Vernet, MRD, Oceanography

Frank L. Vernon, IGPP, Seismology

Andrew M. Vogelman, CAS/CSI, Meteorology

✖ **Roland E.A. Von Glasow,** CAS, Atmospheric Physics (Meteorology)

■ **Laura Waggoner,** MBRD, Marine Biology

★ **Martin Wahlen,** GRD/CAS, Physics

✖■ **John P. Walsh II,** GRD, Oceanography

❖ **Kenneth M. Watson,** MPL, Physical Oceanography

Spahr C. Webb, MPL/PORD, Oceanography

◗ **Gerold Wefer,** GRD, Geology

Wuchang Wei, GRD, Micropaleontology/Paleoceanography

■ **Michael Wells,** GRD, Geology

✢ **Erhard Wielandt,** IGPP, Geophysics

★ **Ray F. Weiss,** GRD, Geochemistry

★ **Bradley Werner,** IGPP, Geomorphology

✖ **Lyndon West,** MRD, Organic Chemistry

✖ **Anthony Westerling,** CRD, Economics & International Affairs

◆ **Fred N. White,** Medicine/CMBB, Comparative Physiology

Warren B. White, PORD/CRD, Oceanography

✢ **Rudolf Widmer-Schnidrig,** IGPP, Earth Sciences

✖ **Duncan Williams,** MPL, Theoretical Mechanics

✖ **Christopher S. Willett,** MBRD, Genetics

★ **Clinton D. Winant,** IOD, Oceanography

Amos Winter, GRD, Geology

❖ **Edward L. Winterer,** GRD, Geology

Peter F. Worcester, IGPP/MPL/PORD, Oceanography

■ **Alexandra Worden,** MBRD, Marine Biology

✖ **Linda L. Woods,** MRD, Chemistry

■ **Slawomir Wozniak,** MPL, Earth Sciences

★ **A. Aristides Yayanos,** MBRD/CMBB, Physiology

★ **William R. Young,** PORD/IGPP, Physical Oceanography

✖ **Elena V. Yulaeva,** CRD, Atmospheric Sciences

Guang J. Zhang, CAS/CSI, Atmospheric Physics

Xin Zhang, PORD, Physical Oceanography

■ **Wiebke Ziebis,** IOD, Marine Biogeochemistry

◗ **Alberto Zirino,** MRD, Oceanography

Mark A. Zumberge, IGPP, Physics

● Adjunct professor series

✢ Cecil H. & Ida M. Green Scholar

▲ Alderson chair

◆ Emeritus

❖ Emeritus, on campus

★ Faculty, Department of Scripps

✱ John D. Isaacs Chair

✖ Postresearch scientist

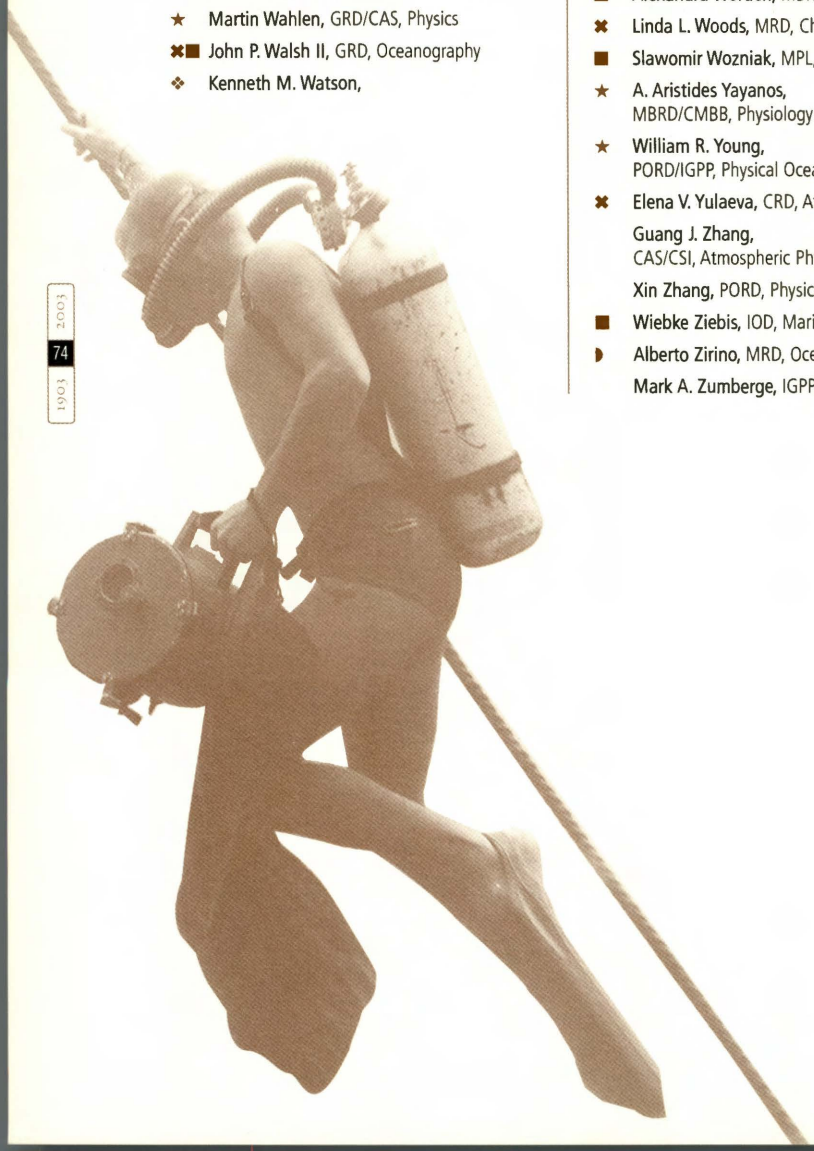
✚ Ritter chair

■ Visiting/postdoctoral scholar

◗ Nonsalaried, affiliated elsewhere

✪ Member of Scripps faculty

AMES	Applied Mechanics and Engineering Sciences Department
CAS	Center for Atmospheric Sciences
CMBB	Center for Marine Biotechnology and Biomedicine
CRD	Climate Research Division
CSI	California Space Institute
IOD	Integrative Oceanography Division
DO	Director's Office
ECE	Electrical and Computer Engineering Department
GRD	Geosciences Research Division
IGPP	Institute of Geophysics and Planetary Physics
INLS	Institute for Nonlinear Science
MBRD	Marine Biology Research Division
MPL	Marine Physical Laboratory
MRD	Marine Research Division
NU	Neurobiology Unit
PHYS	Physics Department
PORD	Physical Oceanography Research Division
SGP	Sea Grant Program
SIO	Scripps Institution of Oceanography Graduate Department
SOMTS	Ship Operations and Marine Technical Support
STS	Shipboard Technical Support



AWARDS AND Honors

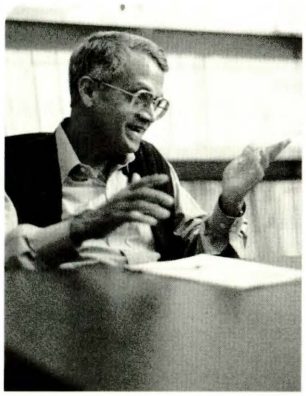
Scott Rapoport

Scripps graduate student Nancy Bowers was awarded the 2002 Chrysalis Scholarship from the Association for Women Geoscientists.

The Bullock/Heiligenberg Pavilion for Behavioral Physiology at the National Institute for Amazonian Research in Manaus, Brazil, was named in honor of Ted Bullock and the late Walter Heiligenberg.

The University of California's Systemwide Toxic Substances Research and Teaching Program Symposium honored two Scripps marine biology graduate students. Aubrey Davis won for best poster and Karen Murray received an honorable mention.

Paul K. Dayton received the Scientific Diving Lifetime Achievement Award from the American Academy of Underwater Sciences. He also received an Award for Merit from the Aquarium of the Pacific in Long Beach, California, for his outstanding scientific research and his work in management and policy.



Veerabhadran Ramanathan

Jeremy Jackson received the Faculty Excellence Award for research in science and engineering from the UCSD Chancellor's Associates.

Charles D. Keeling was selected by President George W. Bush to receive the National Medal of Science, the nation's highest award for lifetime achievement in scientific research.

Scripps graduate student Mark Kessler received the Edward A. Frieman Director's Prize in recognition of excellence in graduate student research.

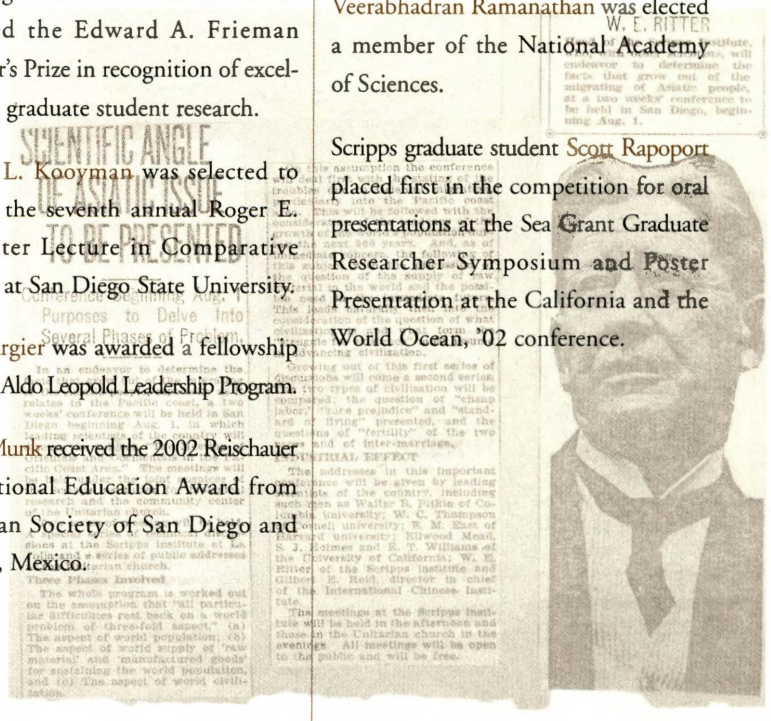
Gerald L. Kooyman was selected to present the seventh annual Roger E. Carpenter Lecture in Comparative Biology at San Diego State University.

John Largier was awarded a fellowship from the Aldo Leopold Leadership Program.

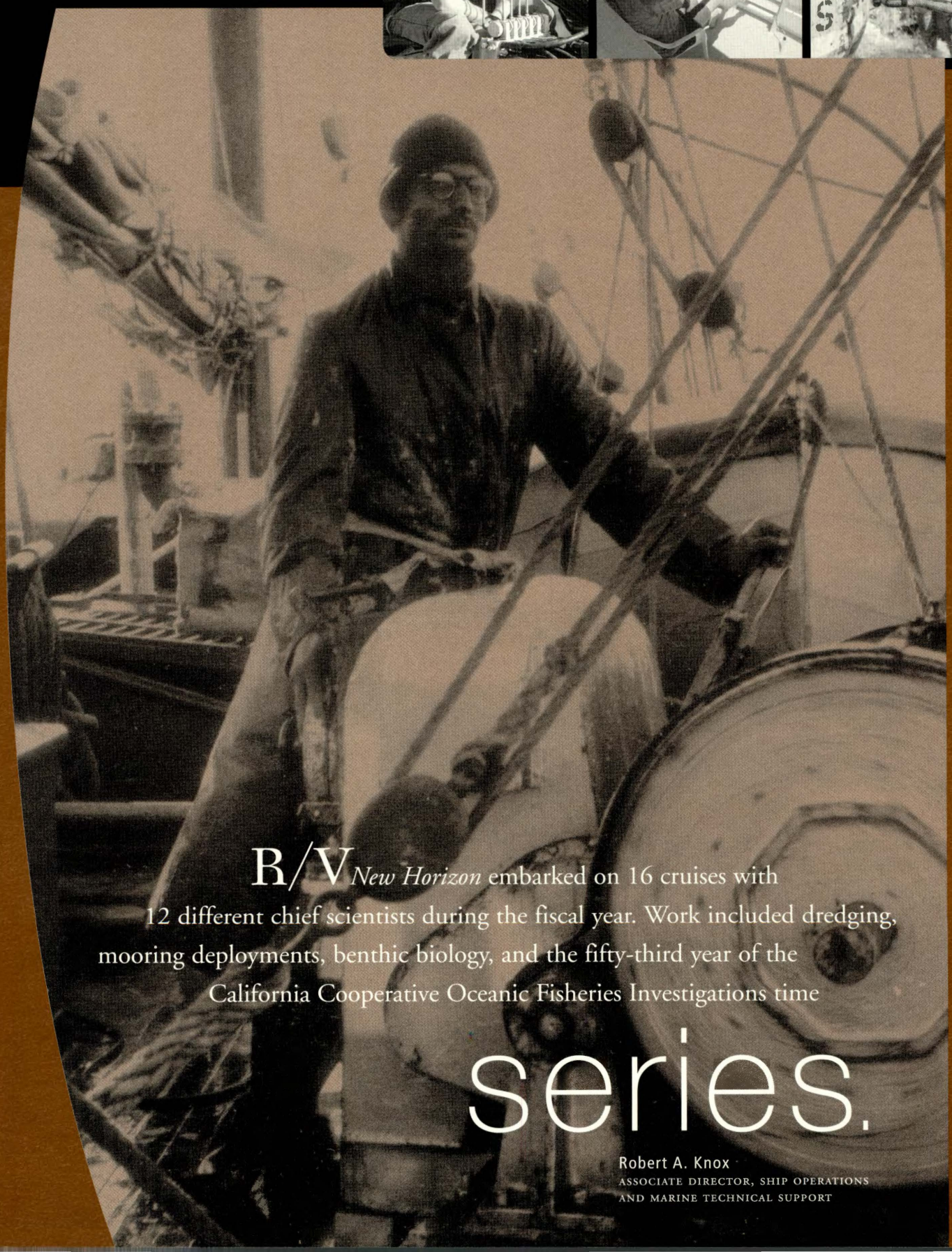
Walter Munk received the 2002 Reischauer International Education Award from the Japan Society of San Diego and Tijuana, Mexico.

John A. Orcutt was named the American Geophysical Union's president-elect and was elected to the American Philosophical Society, Class 1, which includes mathematical and physical sciences. Orcutt was also appointed to the Scientific Advisory Panel of the U.S. Commission on Ocean Policy.

Veerabhadran Ramanathan was elected a member of the National Academy of Sciences.

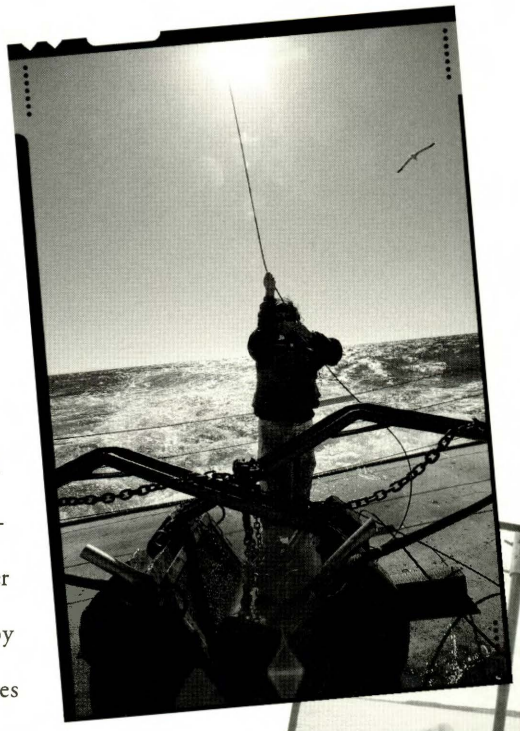


Scripps graduate student Scott Rapoport placed first in the competition for oral presentations at the Sea Grant Graduate Researcher Symposium and Poster Presentation at the California and the World Ocean, '02 conference.



R/V *New Horizon* embarked on 16 cruises with 12 different chief scientists during the fiscal year. Work included dredging, mooring deployments, benthic biology, and the fifty-third year of the California Cooperative Oceanic Fisheries Investigations time series.

Robert A. Knox
ASSOCIATE DIRECTOR, SHIP OPERATIONS
AND MARINE TECHNICAL SUPPORT

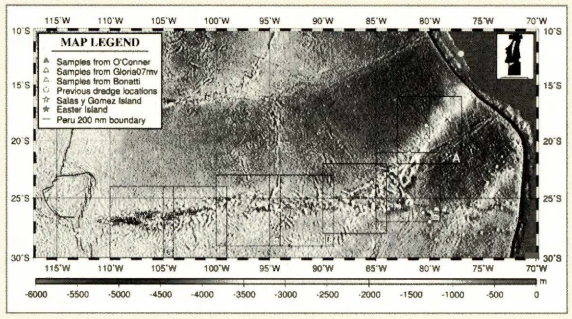


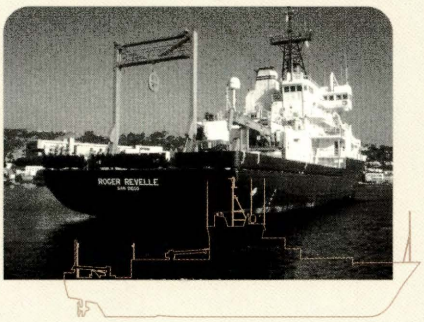
The Scripps fleet completed another year of extraordinarily wide-ranging support of seagoing science. Whether this range is measured geographically, by the spectrum of oceanographic disciplines involved, or by the variety of ship operations and technical support required to accomplish the research, the scope of work was matched by the breadth of capability of the crews and technical support personnel. No element of scientific instrumentation or ship material configuration counted for more than the work carried out at sea by these individuals, with as few setbacks as humanly possible.

Robert A. Knox
ASSOCIATE DIRECTOR, SHIP OPERATIONS AND MARINE TECHNICAL SUPPORT

R/V Roger Revelle

R/V *Roger Revelle* undertook 18 expedition legs under 13 chief scientists. Activities included study of the dynamics of the North Equatorial Countercurrent using the towed, undulating vehicle SeaSoar; investigation of mantle geochemistry and submarine volcanic structure of the Galapagos Archipelago; continuation of long-term seafloor strain measurements at the Nazca-South America Plate Convergence Zone, a mapping and sampling survey of the longest volcanic chain on the Nazca Plate; a two-ship operation with R/V *Melville* for the Southern Ocean Iron Experiment (SOFeX); participation in the Hawaii Ocean-Mixing Experiment (HOME); continued measurements of seafloor deformation near the volcanically active zone on the island of Hawaii; and marine geophysical studies at the Juan de Fuca Ridge. In addition to Scripps scientists, other institutions and organizations conducting research aboard R/V *Roger Revelle* during fiscal year 2002 included the University of South Florida, Moss Landing Marine Laboratories, Woods Hole Oceanographic Institution, the University of Miami's Rosenstiel School of Marine and Atmospheric Science, U.S. Naval Oceanographic Office, and Nova Southeastern University. Captain: Thomas Dejardins. Relief captains: Christopher Curl, Wesley Hill, and David Murline.

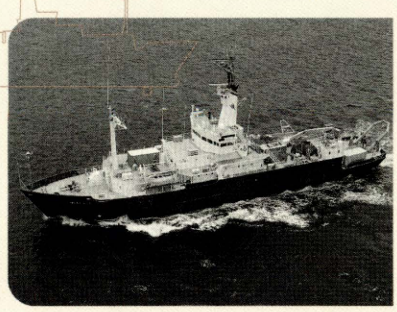




Type	Oceanographic research
Year built	1996
Year acquired by Scripps	1996
Owner	U.S. Navy
Length	273 feet
Beam	52 feet 5 inches
Draft, full	17 feet
Displacement, full	3,512 long tons
Cruising speed	12 knots
Range	13,000 nautical miles at 10 knots
Crew	22
Scientific party	37
Total distance traveled	46,788 nautical miles
Operating days	342 days

R/V Melville

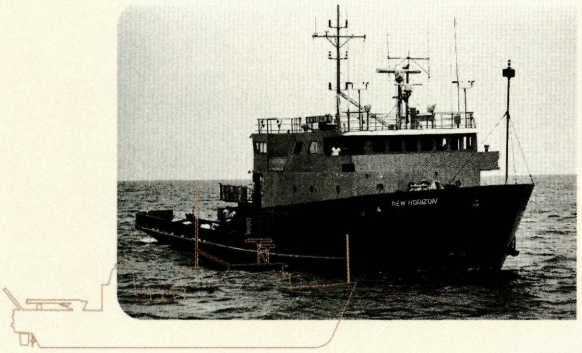
R/V *Melville* supported 16 expedition legs directed by 11 chief scientists. Work included imaging and geological sampling of drowned coral platforms off Papua New Guinea; microbiological studies in the Tonga Trench; geophysical surveying of volcanic ridges and gravity lineations in the deep Pacific; and mooring recoveries as part of the Navy's East China Sea ASIAEX (Asian Seas International Acoustics Experiment). *Melville* also participated in the Navy's multiship Littoral Warfare Advanced Development Sea Test Program. The ship rendezvoused with R/V *Roger Revelle* for the 2002 SOFeX and supported a study of the influence of atmospheric dust deposition on trace element distributions in the surface ocean. Finally, the ship supported an investigation of phytoplankton dynamics in the North Pacific involving open-ocean scuba diving. Other institutions and organizations conducting research aboard *Melville* during fiscal year 2002 included the University of Rhode Island, University of California, Santa Cruz, Brown University, Moss Landing Laboratories, University of Texas, Woods Hole Oceanographic Institution, University of Hawaii, the New Zealand government, and the Naval Air Warfare Center. Captain: Eric Buck Relief captains: Christopher Curl, Murray Stein, and David Murline.



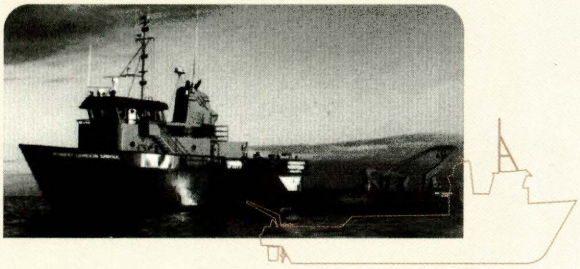
Type	Oceanographic research
Year built	1969 (refitted, 1992)
Year acquired by Scripps	1969
Owner	U.S. Navy
Length	279 feet
Beam	46 feet
Draft, full	16 feet 6 inches
Displacement, full	2,944 long tons
Cruising speed	11.7 knots
Range	10,061 nautical miles at 11.7 knots
Crew	23
Scientific party	38
Total distance traveled	44,214 nautical miles
Operating days	350 days

R/V New Horizon

R/V *New Horizon* embarked on 16 cruises with 12 different chief scientists during the fiscal year. Work included dredging, mooring deployments, benthic biology, and the fifty-third year of the California Cooperative Oceanic Fisheries Investigations time series. *New Horizon* ventured to the equator in a two-ship operation with the National Oceanic and Atmospheric Administration's ship *Ron Brown,* conducting surveys along 95°W using SeaSoar. *New Horizon* acted as the second ship in support of dives by the submersible Alvin to carry out biological studies of hydrothermal vent animals on the East Pacific Rise. Other institutions leading these projects were the Lawrence Berkeley National Laboratory, University of Southern California, University of California, Santa Barbara, and National Marine Fisheries Service. Captain: John Manion. Relief captains: Wesley Hill, Murray Stein, and Christopher Curl.



Type	Oceanographic research
Year built	1978 (refitted, 1995-96)
Year acquired by Scripps	1978
Owner	University of California
Length	170 feet
Beam	36 feet
Draft, full	12 feet
Displacement, full	1,007 long tons
Cruising speed	10 knots
Range	9,600 nautical miles
Crew	12
Scientific party	19
Total distance traveled	16,560 nautical miles
Operating days	298 days



R/V Robert Gordon Sproul

R/V *Robert G. Sproul* hosted 35 separate cruises led by 15 chief scientists during the 2002 fiscal year with all of the activity occurring in local waters, except for work off Baja California. Research and testing included physical oceanography, biological oceanography, biochemical sampling, mooring deployments, acoustic and visual monitoring for marine mammals, biocomplexity research, and student cruises. Other institutions involved in these studies were University of San Diego, Woods Hole Oceanographic Institution, U.S. Geological Survey, Naval Research Laboratory, and University of Hawaii. Captain: Louis Zimm. Relief captains: Thomas Desjardins and Roger Price.

Type	Oceanographic research
Year built	1981
Year acquired by Scripps	1984
Owner	University of California
Length	125 feet
Beam	32 feet
Draft, full	9 feet 6 inches
Displacement, full	696 long tons
Cruising speed	9 knots
Range	4,300 nautical miles
Crew	5
Scientific party	12
Total distance traveled	9,829.5 nautical miles
Operating days	99 days

R/P FLIP

R/P FLIP supported two research cruises off the southern California coast during fiscal year 2002 and was towed to Hawaii for support of a third research cruise. Two of these expeditions were led by Scripps scientists: Robert Pinkel for the HOME II cruise conducted in Hawaiian waters and Gerald D'Spain for the Passive Synthetic Aperture Sonar experiment. The third expedition, sponsored by the Office of Naval Research, was the ARL Penn State Broadland Acoustic Coherence Project. Captain throughout the year: Tom Golfinos.

Type	Floating instrument platform
Year built	1962
Year acquired by Scripps	1962
Owner	U.S. Navy
Length	355 feet
Beam	20 feet
Draft, full	12 feet
Displacement, full	700 long tons
Cruising speed (knots)	varies*
Range (nautical miles)	varies*
Crew	4 in port, 5 under way
Scientific party	11
Total distance towed	5,400 nautical miles
Operating days	100 days

**R/P FLIP is towed to its various destinations.*

In fiscal year 2002, Scripps received $5,568,502 in gifts, pledges, grants, and gifts-in-kind from individuals, corporations, foundations, and other organizations—2,168 gifts in

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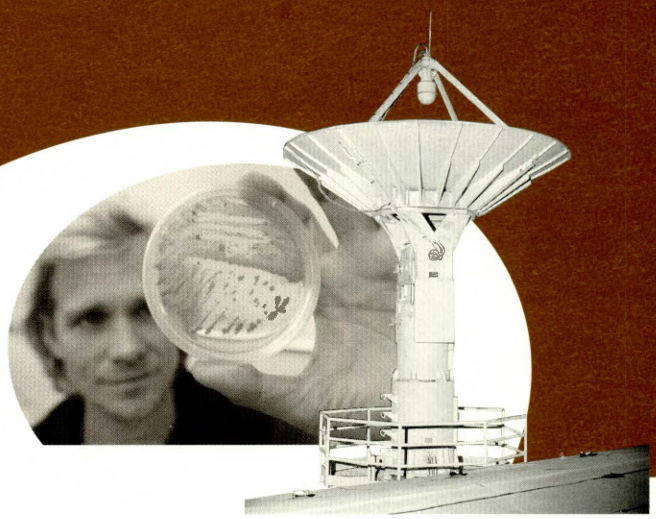
DEVELOPMENT Report



The past year has been eventful as Scripps Institution of Oceanography experienced the exhilaration of great accomplishments and the challenge of revenue reductions precipitated by a dramatically imbalanced California state budget.

Yet, Scripps continues to be a magnet for outstanding graduate students and exceptional faculty and a pathfinder in earth and ocean sciences. That is due in no small part to the meaningful financial support of Scripps's many friends, who are helping the institution fulfill its mission to seek, teach, and communicate scientific understanding of the oceans, atmosphere, Earth, and other planets for the benefit of society and the environment.

In fiscal year 2002, Scripps received $5,568,502 in gifts, pledges, grants, and gifts-in-kind from individuals, corporations, foundations, and other organizations—2,168 gifts in all.

Seek

Scripps received numerous gifts last year to support science.

The G. Unger Vetlesen Foundation contributed $850,000 to continue its support of global change research and $50,000 toward equipment for the Center for Observations, Modeling, and Prediction at Scripps. The Kavli Institute contributed $861,579 to support a project on long-term coastal change, led by physical oceanographer Doug Inman. The IBM Corporation provided $369,024 in matching funds for physical oceanographer Detlef Stammer's collaborative projects with Cal-IT^2. The Alfred P. Sloan Foundation gave $250,000 to support conferences presented by the Center for Marine Biodiversity and Conservation (CMBC). The Moore Family Foundation gave $247,312 toward CMBC Deputy Director Enric Sala's research on fish populations in the Gulf of California.

Richard and Glenda Rosenblatt pledged $100,000 to create the Richard and Glenda Rosenblatt Lecture in Evolutionary Biology, in cooperation with CMBC. The Quest for Truth Foundation gave $150,000 toward a post-doctoral fellowship in coastal studies. The Ralph M. Parsons Foundation contributed $100,000 toward marine ecologist Paul Dayton's research on kelp forest ecosystems. The San Diego Foundation gave $50,000 to support the work of nuclear geophysicist Devendra Lal. And the Green Foundation for Earth Sciences in La Jolla continued its support of the Cecil H. and Ida M. Green Institute for Geophysics and Planetary Physics.

Teach

Gifts to support Scripps's graduate students help the institution educate the scientific leaders of tomorrow.

Last year, the Hanauer Family Foundation, the Pittsburgh Foundation, and the Joan Irvine Smith & Athalie R. Clarke Foundation contributed to the Mia J. Tegner Memorial Fellowship in Coastal Ecology. Bettie P. Cody gave $53,390 for the Robert L. Cody Endowed Memorial Fund. And the Los Angeles and San Diego branches of the ARCS Foundation continued their long-standing support.

Other contributors to fellowships included the Massey Charitable Trust for a first-year fellowship at the Center for Marine Biotechnology and Biomedicine; William S. Price III for the Sea Fellowship; Lanna Cheng and Ralph Lewin for the Cheng An Lun Fellowship; Lauretta W. Cipra for the Shirley Boyd Memorial Fellowship; and Ellis Wyer for the Wyer Family Fellowship.

Communicate

Communicating the results of Scripps science to decision makers in government and industry, as well as to the public, is an important part of Scripps's mission.

The Birch Aquarium at Scripps plays a vital role in communicating Scripps science to more than 350,000 visitors each year. Longtime donor Robert Scripps contributed $50,000 to the aquarium last year.

Secrets of the Seahorse opened at the aquarium in May 2002. Numerous donors supported the exhibit, including the Maurice J. Masserini Charitable Trust, the Wells Fargo Foundation, Audrey Geisel, the La Jolla Beach & Tennis Club, the Rueben H. Fleet Foundation, Creative Nail Design, the McMillan Family/Schoenith Foundation, and Haruko Quirk.

Several gifts were received toward construction of the Robert Paine Scripps Center. Thanks to the recommendation of SIO Council member Shelia Davis, the San Diego Foundation contributed a $250,000 matching grant. Charmaine and Maurice Kaplan pledged an additional $150,000 to the center. Construction of the Scripps Center relies entirely on private support, so fund-raising for this important complex will continue until the full construction costs have been raised.

Particularly in these difficult budgetary times, your gifts truly make a difference. Thank you for your continuing support.

A list of Scripps donors appears on the following pages.

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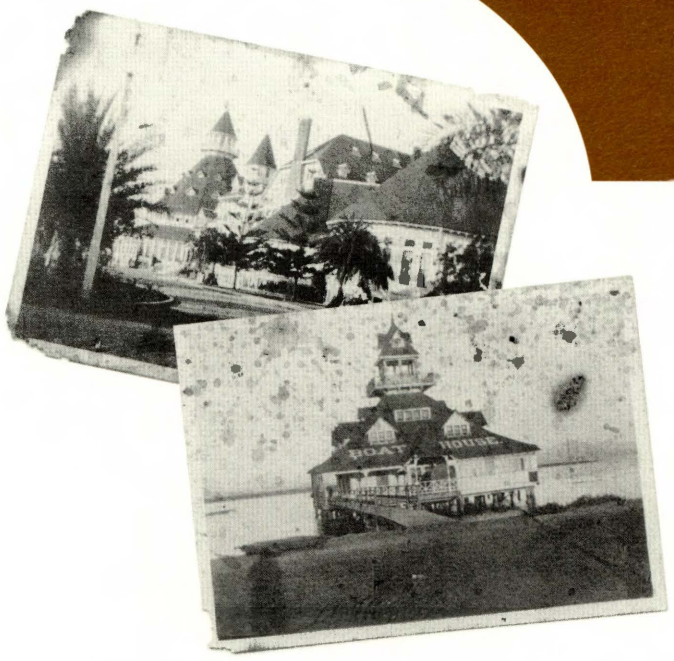

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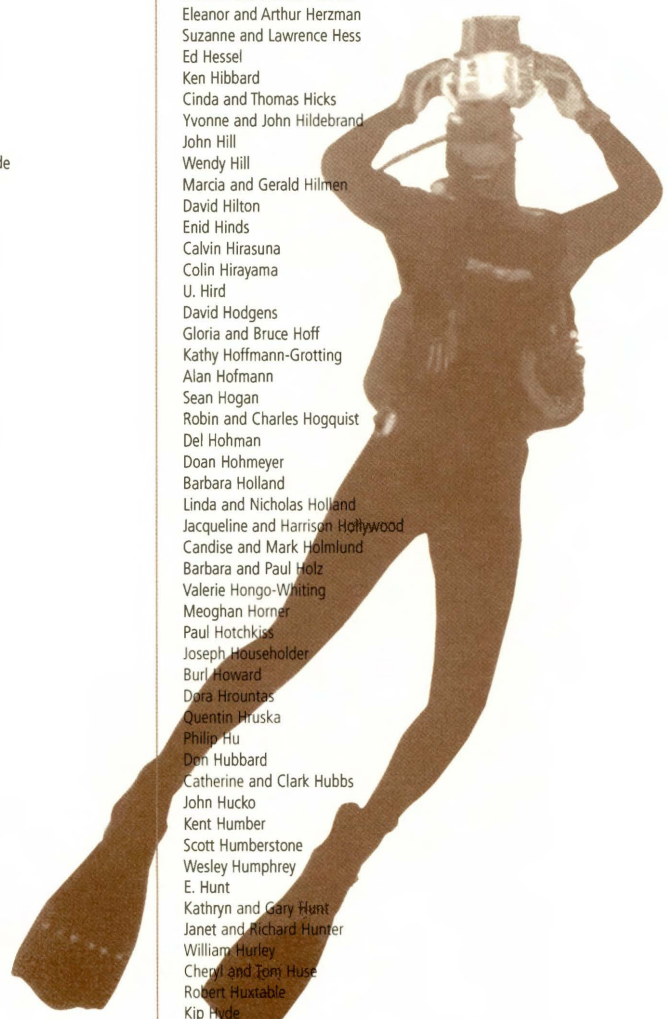

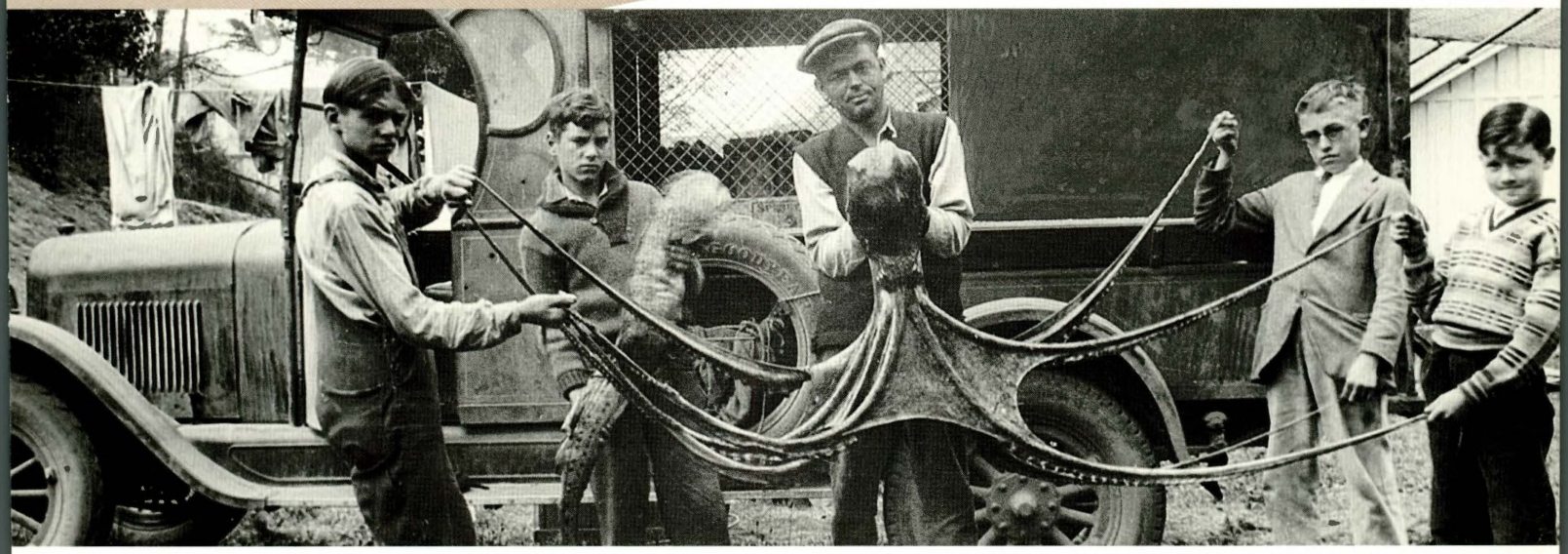

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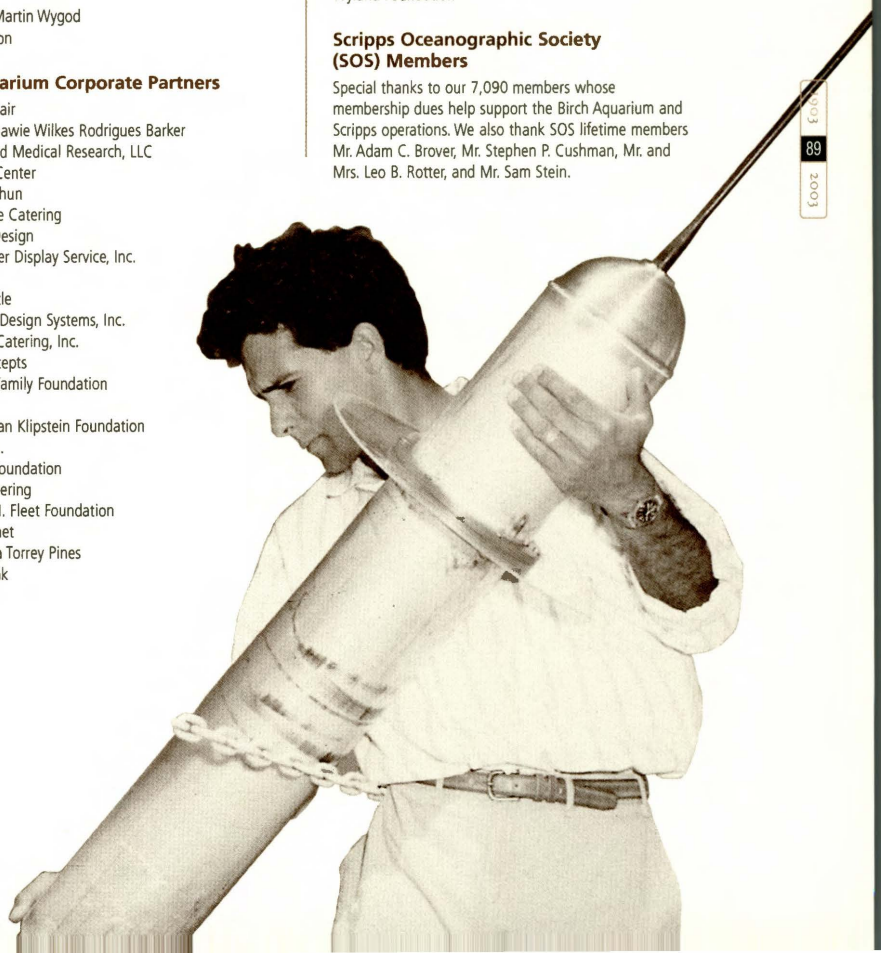

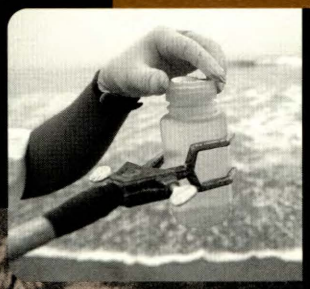

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The work of the California Cooperative Oceanic Fisheries Investigations (CalCOFI), in which Scripps Institution of Oceanography, the California Department of Fish and Game, and the National Marine Fisheries Service cooperate, is published in a variety of formats. Peer-reviewed scientific articles are published annually in the *California Cooperative Oceanic Fisheries Investigations Reports.* Maps of physical, chemical, climatological, and biological factors measured by CalCOFI researchers during the program's 53-year history are published irregularly in the *California Cooperative Oceanic Fisheries Investigations Atlas* series. Data reports, containing the processed data from quarterly cruises carried out under CalCOFI sponsorship, are published regularly in the SIO Reference Series and are available on the CalCOFI website: www.calcofi.org. To obtain copies of any of these CalCOFI publications, write to:

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California Sea Grant College Program
University of California, San Diego
9500 Gilman Drive Dept 0232
La Jolla, California 92093-0232
www-csgc.ucsd.edu

Reference Series

California Sea Grant Program Directory 2002-2003. Report Number R-049. 2002. 40p.

Technical Series

Starr, R. M., J. M. **Cope,** and L. A. **Kerr.** Trends in Fishery Resources: Associated With the Monterey Bay National Marine Sanctuary From 1981-2000. Publication Number T-046. 2002. 15p. ($10)

CD-ROM

Marine Ecological Reserves Research Program: Research Results 1996-2001. 2002. (Free)

Sea Grant Support

Leet, W. S., C. M. **Dewees,** R. **Klingbeil,** and E. J. **Larson,** eds., California's Living Marine Resources and Their Utilization: A Status Report. 2001. 591p. ($25)

CURRENT Funds

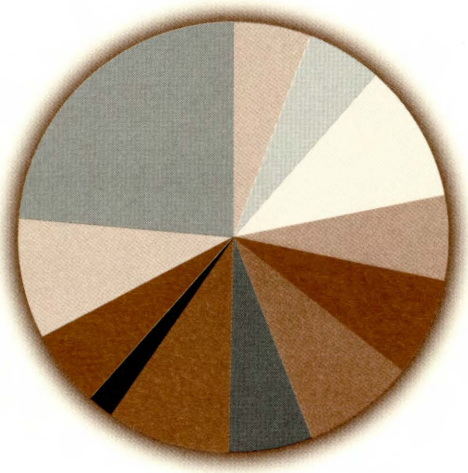
JULY 1, 2001 — JUNE 30, 2002

This statement does not purport to present all annual expenditures associated with operating the institution. Many services provided by UCSD departments outside Scripps are not reflected in Scripps annual expenditures. Examples of campus-provided services include building construction and maintenance, parking lot and road maintenance, utilities, seawater utilities, custodial services, landscaping and grounds maintenance, accounting, payroll, and personnel services.

Tom Collins
DEPUTY DIRECTOR

FEDERAL FUNDS	2001/02	% OF TOTAL
National Science Foundation	$39,309,932.14	26.48
Department of the Navy	$14,158,073.54	9.54
National Oceanic and Atmospheric Administration	$11,587,548.52	7.80
National Aeronautics and Space Administration	$6,982,122.07	4.70
Department of Energy	$2,290,644.60	1.54
Other Department of Defense	$1,342,358.82	0.90
Other federal	$4,539,761.61	3.06
Federal flowthru	$2,569,228.25	1.73
Total FEDERAL	**$82,779,669.55**	**55.76**
OTHER		
State	$2,042,326.84	1.38
General funds	$24,317,873.92	16.38
Private	$6,202,633.75	4.18
Endowments	$1,364,453.09	0.92
University funds	$1,809,976.55	1.22
Other	$29,947,571.45	20.17
Total OTHER	**$65,684,835.60**	**44.24**
Total EXPENDITURES	**$148,464,505.00**	**100.00**

SCRIPPS INSTITUTION OF OCEANOGRAPHY
2002 CENSUS (TOTAL 1,785)



450	VOLUNTEERS AND VISITING SCHOLARS
205	GRADUATE STUDENTS
111	UNDERGRADUATE STUDENT STAFF
36	CENTRAL ADMINISTRATION
148	SCIENTIFIC ADMINISTRATION
95	PROFESSORS
89	RESEARCHERS
179	OTHER ACADEMICS
103	ENGINEERS/TECHNICIANS
115	MARINE SUPPORT
146	SCIENTIFIC SUPPORT
108	COMPUTER/PUBLICATIONS/SPECIALISTS

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

In Memoriam

SPRING 2003

Sally McLellan
December 2001

Sally McLellan was the business officer for UCSD Academic Computing Services. She began her career with the university in 1963, working at the original Computer Center Organized Research Unit at Scripps.

Frances Lawrence Parker
March 2002

Frances Parker was a research paleontologist at Scripps from 1950 until her semi-retirement in 1973, though she continued to work in her Ritter Hall laboratory through the mid-'80s. She was a pioneer in modern micropaleontology and paleoceanography, and was among the world experts on foraminifera. The U.S. Geological Survey christened a bank on the Louisiana shelf "Parker Bank" in her honor and the Frances Parker Program in Public Education in the Earth Sciences at Scripps is named for her.

Yaacov Bentor
October 2002

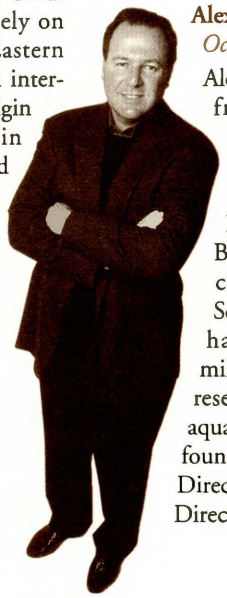
Yaacov Bentor, Scripps research geologist emeritus, was one of the world's experts on the geology of the Middle East. He worked extensively on the petrology and tectonic evolution of the Precambrian crust in the Sinai Peninsula, and published widely on many aspects of Middle Eastern geology. He had a long-term interest in the possible geological origin of many events chronicled in myth and history. Associated with Scripps since 1977, Bentor is survived by his wife, Miriam Kastner, Scripps professor of geology.

Earl D. Bronson
October 2002

Earl D. Bronson managed the construction and initial operations of Scripps's research platform, FLIP, following a distinguished 30-year career in the U.S. Navy. After seeing FLIP through construction and initial trials he became the officer in charge for the first five years of FLIP's operation, during which time he implemented a number of technological improvements. He later oversaw facilities and the ARPA floating platform program for the Scripps Marine Physical Laboratory. Bronson retired from Scripps in 1973.

Sally Spiess
October 2002

Sally Spiess, wife of Scripps Professor of Oceanography, Emeritus Fred N. Spiess for 60 years, was a civic leader in the La Jolla community and a key figure at Scripps since the Spiess family's arrival in 1952. She christened R/P FLIP, cofounded the UCSD women's social group Oceanids, and was instrumental in saving the Old Scripps Building, preparing the documentation necessary for its recognition as a National Historic Landmark in 1977.



Alex Szekely
October 2002

Alex Szekely was a longtime friend of Scripps and cofounder of the E. W. Scripps Associates giving program, along with Rick Gulley and Fred Borrelli. Since the program's creation in 1992, E. W. Scripps Associates members have donated nearly $1 million for student support, research programs, and the aquarium. Szekely also was a founding member of the SIO Director's Circle and the SIO Director's Cabinet.

D. John Faulkner
November 2002

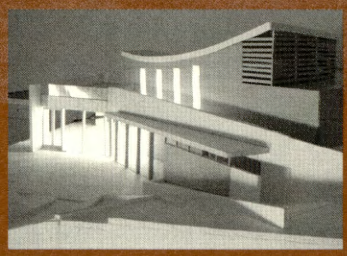
John Faulkner was a professor of marine chemistry at Scripps, and was considered a pioneer in marine natural products chemistry. His contributions include the discovery of new anti-inflammatory agents, new entities for the treatment of cancer, and new antibiotics. A member of the Royal Society of Chemistry and the American Chemical Society, Faulkner had been a member of the Scripps faculty since 1968.

Eugene C. LaFond
December 2002

Eugene LaFond began working at Scripps under its third director, T. Wayland Vaughan. His photographs chronicled Scripps in the 1930s, and he contributed illustrations to the first comprehensive oceanographic textbook, *The Oceans: Their Physics, Chemistry, and General Biology,* published in 1942. He participated in World War II Navy work being conducted at Scripps, and afterward joined the Navy Electronics Laboratory at Pt. Loma. His later work included extensive studies of the Arctic and establishment of the first oceanographic institute on the Asian subcontinent, in India. His wife of 67 years, Katherine, also worked at Scripps, as a chemistry assistant in the '30s.

Wheeler J. North
December 2002

Wheeler North, an leading expert on kelp, grew up in La Jolla and received his Ph.D. from Scripps is 1953. He worked closely with Scripps's first diving officer, Conrad Limbaugh, on early scuba equipment and studies of the physiology of diving. North continued diving throughout his life and received the Scientific Diving Lifetime Achievement Award from the American Academy of Underwater Sciences in 2001. He began teaching at Caltech in 1963 and became professor of environmental science, emeritus, there in 1992.



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EXPLORATIONS, Volume 9, Number 4

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Steve Simpson

Inside front cover: Marc Conlin

Page 1: *left,* Eric Hanauer; *right,* Marc Tule

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Page 11: *sidebar,* courtesy of Janet Mathews/Oregon Sea Grant; *map,* Paul Horn

Page 13: *sidebar,* courtesy of Robert Drever/
University of Washington

Page 14-15: Eric Hanauer

Page 16: *top,* Eric Hanauer

Page 16-17: bottom (left to right), (squarespot rockfish) John Hyde, (halfbanded) John Hyde, (calico) John Hyde, (calico) John Hyde, (treefish) Garry McCarthy, (black-and-yellow) Garry McCarthy, (treefish) Garry McCarthy, (gopher) John Hyde, (bocaccio) John Hyde, (vermilion) Paul Foretic

Page 17: *map,* Paul Horn

Page 18: *left to right,* (chilipepper) John Hyde, (calico) John Hyde, (honeycomb) John Hyde

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