

# Oceanus<sup>®</sup>

Volume 32, Number 4, Winter 1989/90



*Pacific Century, Dead Ahead!*

*Paul Chesapeake*

# Oceanus®

ISSN 0029-8182

The International Magazine of Marine Science and Policy  
Volume 32, Number 4, Winter 1989/90

Paul R. Ryan, *Editor*

T. M. Hawley, *Assistant Editor*

Sara L. Ellis, *Editorial Assistant*

Robert W. Bragdon, *Advertising Coordinator*

Laura T. Praderio, *Intern*



## *Editorial Advisory Board*

Robert D. Ballard, *Director of the Center for Marine Exploration, WHOI*

James M. Broadus, *Director of the Marine Policy Center, WHOI*

Henry Charnock, *Professor of Physical Oceanography, University of Southampton, England*

Gotthilf Hempel, *Director of the Alfred Wegener Institute for Polar Research, West Germany*

Charles D. Hollister, *Vice-President and Associate Director for External Affairs, WHOI*

John Imbrie, *Henry L. Doherty Professor of Oceanography, Brown University*

John A. Knauss, *U.S. Undersecretary for Oceans and Atmosphere, NOAA*

Arthur E. Maxwell, *Director of the Institute for Geophysics, University of Texas*

Timothy R. Parsons, *Professor, Institute of Oceanography, University of British Columbia, Canada*

Allan R. Robinson, *Gordon McKay Professor of Geophysical Fluid Dynamics, Harvard University*

David A. Ross, *Chairman, Department of Geology and Geophysics, and Sea Grant Coordinator, WHOI*

## *Published by the Woods Hole Oceanographic Institution*

Guy W. Nichols, *Chairman of the Board of Trustees*

John H. Steele, *President of the Corporation*

Charles A. Dana III, *President of the Associates*

Craig E. Dorman, *Director of the Institution*

The views expressed in *Oceanus* are those of the authors and do not necessarily reflect those of the Woods Hole Oceanographic Institution.

Editorial correspondence: *Oceanus* magazine, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543. Telephone: (508) 548-1400, extension 2386.

Subscription correspondence, U.S. and Canada: All orders should be addressed to *Oceanus* Subscriber Service Center, P.O. Box 6419, Syracuse, N.Y. 13217. Individual subscription rate: \$25 a year; Libraries and institutions, \$80. Current copy price, \$6.25; 25 percent discount on current copy orders for five or more; 40 percent discount to bookstores and newsstands. Please make checks payable to the Woods Hole Oceanographic Institution.

Subscribers outside the U.S. and Canada, please write: *Oceanus*, Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, England. Individual subscription rate: £22 a year; Students, £19; Libraries and Institutions, £40. Single copy price, £9. Please make checks payable to Cambridge University Press.

When sending change of address, please include mailing label. Claims for missing numbers from the U.S. and Canada will be honored within 3 months of publication; overseas, 5 months.

Permission to photocopy for internal or personal use or the internal or personal use of specific clients is granted by *Oceanus* magazine to libraries and other users registered with the Copyright Clearance Center (CCC), provided that the base fee of \$2.00 per copy of the article, plus .05 per page is paid directly to CCC, 21 Congress Street, Salem, MA 01970. Special requests should be addressed to *Oceanus* magazine.  
ISSN 0029-8182/83 \$2.00 + .05

# This Holiday Season

Give  
the  
Gift  
of the  
Sea



Or  
come  
aboard  
yourself  
now!

## Oceanus

The International Magazine  
of Marine Science and Policy

Published by Woods Hole  
Oceanographic Institution

### Domestic Subscription Order Form: U.S. & Canada\*

Please make checks payable to Woods Hole Oceanographic Institution.  
Canadian Subscribers add \$3.00 for postage.

Please enter my subscription to OCEANUS for  
Individual

- one year at \$25.00
  - two years at \$45.00
  - three years at \$65.00
  - one year at \$80.00
- Library or Institution:
- payment enclosed.
  - (we request prepayment)
  - bill me

Please send MY Subscription to:

Please send a GIFT Subscription to:

Name (please print)

Name (please print)

Street address

Street address

City State Zip

City State Zip

\*Subscribers other than U.S. & Canada please use form  
inserted at last page.

Donor's Name \_\_\_\_\_

Address \_\_\_\_\_

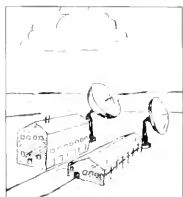
12/89

BOOKS RECEIVED

### 104 Index



Winner



Tracker

COVER: The cover is the work of E. Paul Oberlander, a Cape Cod artist and  
employee of the Woods Hole Oceanographic Institution.

Copyright © 1989 by the Woods Hole Oceanographic Institution. *Oceanus* (ISSN 0029-8182) is  
published in March, June, September, and December by the Woods Hole Oceanographic  
Institution, 9 Maury Lane, Woods Hole, Massachusetts 02543. Second-class postage paid at  
Falmouth, Massachusetts; Windsor, Ontario; and additional mailing points. POSTMASTER:  
Send address changes to *Oceanus* Subscriber Service Center, P.O. Box 6419, Syracuse, NY 13217.

# HAS THE SUBSCRIPTION COUPON BEEN DETACHED?

If someone else has made use of the coupon attached to this card, you can still subscribe. Just send a check—\$25 for one year (four issues), \$45 for two, \$65 for three—to this address:

Please make checks payable to Woods Hole Oceanographic Institution



*Oceanus* magazine  
P.O. Box 6419  
Syracuse, NY 13217-6419



PLACE  
STAMP  
HERE

**Oceanus** magazine  
P.O. Box 6419  
Syracuse, NY 13217-6419



Editorial correspondence: *Oceanus* magazine, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543. Telephone: (508) 548-1400, extension 2386.

Subscription correspondence, U.S. and Canada: All orders should be addressed to *Oceanus* Subscriber Service Center, P.O. Box 6419, Syracuse, N.Y. 13217. Individual subscription rate: \$25 a year; Libraries and institutions, \$80. Current copy price, \$6.25; 25 percent discount on current copy orders for five or more; 40 percent discount to bookstores and newsstands. Please make checks payable to the Woods Hole Oceanographic Institution.

Subscribers outside the U.S. and Canada, please write: *Oceanus*, Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, England. Individual subscription rate: £22 a year; Students, £19; Libraries and Institutions, £40. Single copy price, £9. Please make checks payable to Cambridge University Press.

When sending change of address, please include mailing label. Claims for missing numbers from the U.S. and Canada will be honored within 3 months of publication; overseas, 5 months.

# contents



Explorer



Planner



Worker



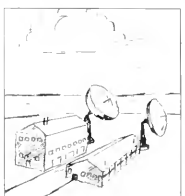
Pirate



Trapper



Winner



Tracker

- 5 **Lookout: 'Pacific Century, Dead Ahead!'**  
*by Paul R. Ryan*
- 13 **The Soviet Far East**
- 19 **North and South Korea**
- 23 **China: Still a Bitter Sea**
- 35 **Japan: The Chrysanthemum Curtain**
- 41 **The Philippines**
- 42 **ASEAN**
- 45 **The Pacific Island States**

- 49 **Notes From Nakhodka**  
*by Joseph R. Morgan and Norton Ginsburg*

- 54 **Caldron in the Sea**  
*by Michael V. Propp and Vitaly G. Tarasov*

- 60 **The Fisheries of the Yellow and East China Seas**  
*by Yang Jinsen*

- 65 **Piracy in Southeast Asia**  
*by Daniel J. Dzurek*

- 71 **Changing Climate and the Pacific**  
*by Frank J. Gable and David G. Aubrey*

## concerns

- 74 **Greenpeace's Pacific Campaign**  
*by Sebba A. Hawkins*

- 83 **Are Dolphins Being Deafened in the Pacific?**  
*by Kathy Glass*

## features

- 86 **Sub Humans Sink to New Heights**  
*by Sylvia A. Earle*

- 93 **The Slocum Mission**  
*by Henry M. Stommel*

- 97 **letters**

- 98 **book reviews/Books Received**

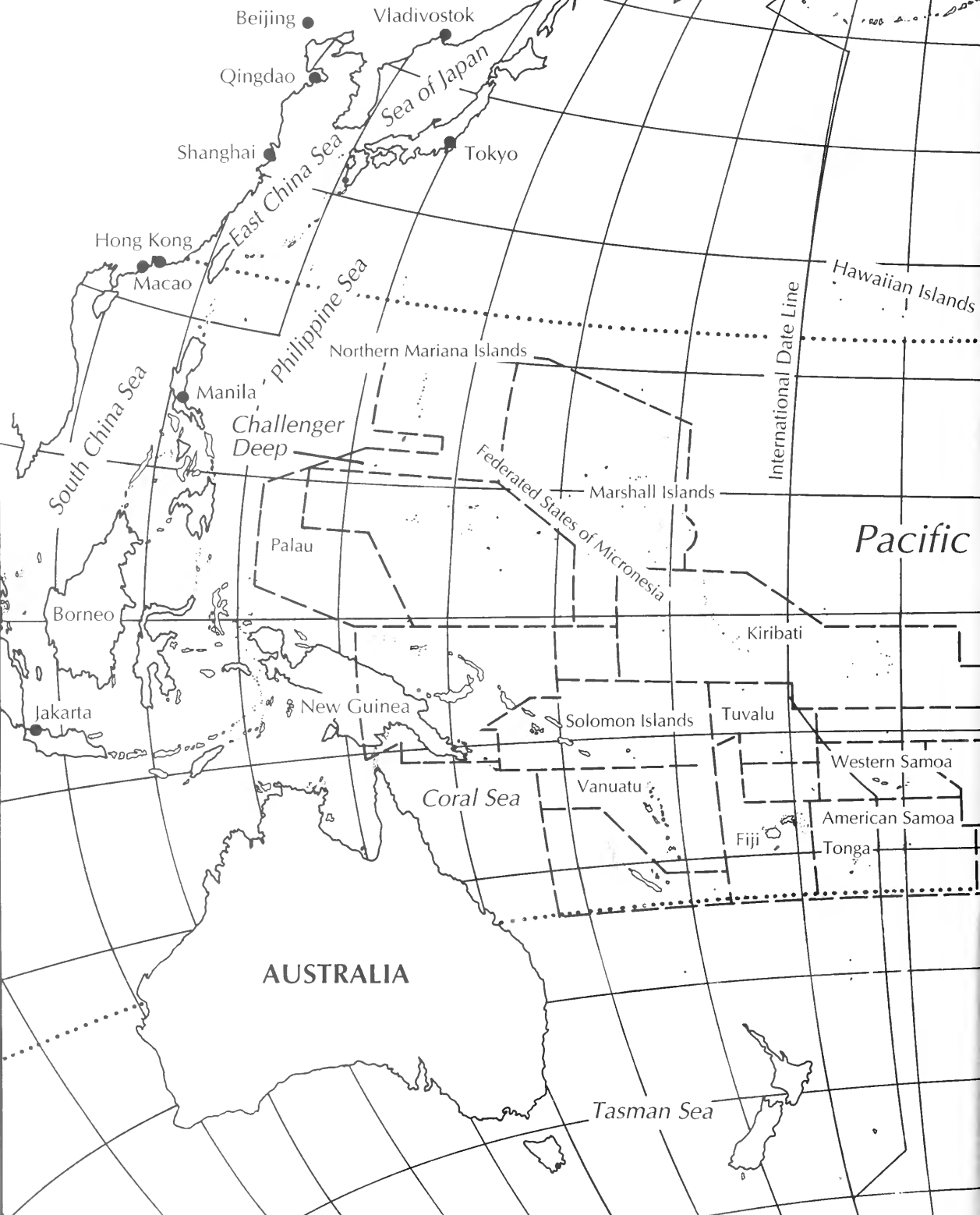
- 104 **Index**

---

**COVER:** The cover is the work of E. Paul Oberlander, a Cape Cod artist and employee of the Woods Hole Oceanographic Institution.

Copyright © 1989 by the Woods Hole Oceanographic Institution. *Oceanus* (ISSN 0029-8182) is published in March, June, September, and December by the Woods Hole Oceanographic Institution, 9 Maury Lane, Woods Hole, Massachusetts 02543. Second-class postage paid at Falmouth, Massachusetts; Windsor, Ontario; and additional mailing points. POSTMASTER: Send address changes to *Oceanus* Subscriber Service Center, P.O. Box 6419, Syracuse, NY 13217.

**ASIA**



Beijing

Vladivostok

Qingdao

Sea of Japan

Shanghai

Tokyo

Hong Kong

Macao

East China Sea

Philippine Sea

Northern Mariana Islands

Challenger Deep

Manila

International Date Line

Hawaiian Islands

South China Sea

Federated States of Micronesia

Marshall Islands

Pacific

Palau

Borneo

Kiribati

Jakarta

New Guinea

Solomon Islands

Tuvalu

Coral Sea

Vanuatu

Western Samoa

**AUSTRALIA**

American Samoa

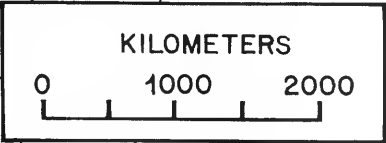
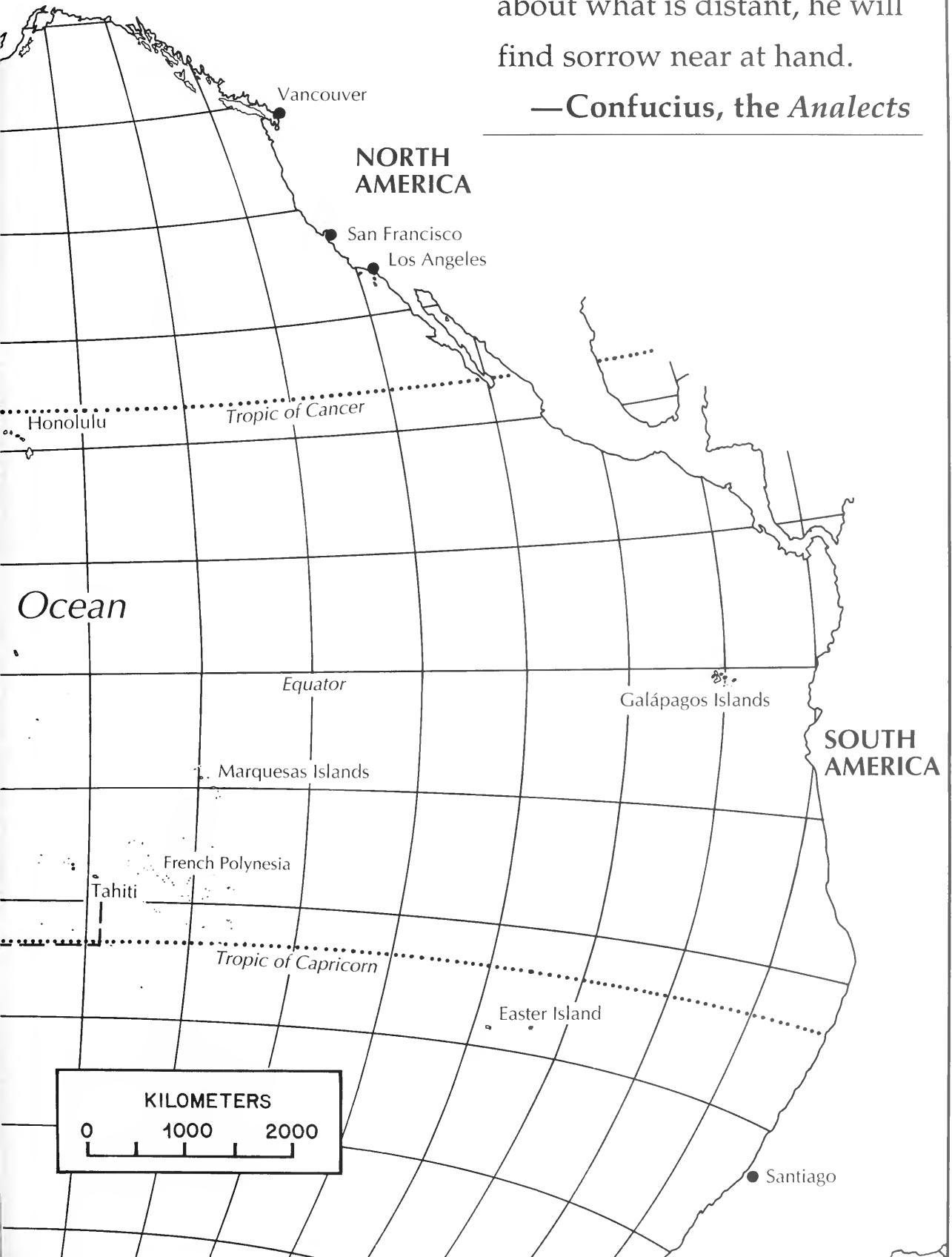
Fiji

Tonga

Tasman Sea

If a man take no thought  
about what is distant, he will  
find sorrow near at hand.

—Confucius, the *Analects*







---

**W**e can delude ourselves no longer in the belief that the Far East is remote, exotic, and dissociated from the concerns that touch us vitally. It has been brought permanently into the world political system. The Far East now is as Europe was 400 years ago. Either a basis for lasting peace must be found for that part of the world now or it must go the way of Europe, chained to a wheel of periodic bloodletting, of chronic warfare, generation on generation, time without end. America will be to the Far East as England has been to the European continent—unwilling to be drawn in, unable to keep out, caught in its fateful pull.

—Nathaniel Peffer, *Basis for Peace in the Far East*, 1942

---

# 'Pacific Century, Dead Ahead!'

by Paul R. Ryan



**T**his issue of *Oceanus* is devoted to the Pacific Region, a vast area of ever-increasing importance to the economic well-being of many billions of people. The Pacific Ocean, a specific concern of this magazine, covers a third of the total area of the globe—an area equal to the land masses of the entire world. What follows is a report on the political, economic, cultural, strategic, scientific, and technological activities in that part of the world from a maritime perspective as we approach the year 2000. The two major concerns are prosperity and security.

This is a time of significant change in the Pacific Region. The Soviet Union, traditionally thought of as a European nation, is now projecting itself as a Pacific power. China, historically a nation of largely coastal interests, exerts considerable influence in the Pacific Region through large settlements of ethnic Chinese. Before the tragic events in Tiananmen Square this last June, it, too, was beginning to seek a wider role in the Pacific Region.

---

*Paul R. Ryan is Editor of Oceanus, published by the Woods Hole Oceanographic Institution.*

The violent events in China appear to have drawn the Soviet Union and the Middle Kingdom closer together—they share many of the same economic problems—while at the same time trade and defense friction between Japan and the United States continues to accelerate and separate. The cornerstone of U.S. interest in the area is defense. The burden of this cost is bringing pressure at home and abroad for a gradual decrease in military commitments to the region, where armed conflict is never more than a bullet away in such countries as Vietnam, Cambodia, and North and South Korea. It is against this background of potential conflict that we offer this report.

I gathered the material for this issue during a Fulbright Fellowship in Japan to study Japanese-U.S. marine interests in the Pacific Region, particularly as they relate to the Soviet Union and China. The study included a month's travel in China in March of 1989, during which I visited Shanghai, Qingdao, Wuhan, and Beijing. My requests to visit the Soviet Far East went unanswered.

The Fulbright Fellowship was given to me as a professional journalist, not as a marine scientist, although my host institution was the Japan Marine Science and Technology Center (JAMSTEC) in Yokosuka. JAMSTEC and the Woods Hole Oceanographic Institution (WHOI), publisher of *Oceanus* magazine, have signed an agreement of cooperation. WHOI also has a cooperation agreement with the Institute of Oceanology in Qingdao, China.

The material presented is the result of interviews; the reading of research reports, books, and newspapers; and personal observations. I was particularly disturbed by two occurrences: in Japan, just prior to the fall of the Takeshita government, the U.S. Embassy was reportedly telling Washington that the Japanese Prime Minister would survive the Recruit bribery-for-favors scandal when it was obvious that a man with less than 4 percent of the population behind him could not survive; and, in China, it was obvious to me in March that the country was about to explode, yet the tragic events of June 4th caught our diplomats there by surprise (see "China Warning," this page). Are none of our diplomats going out into the streets? How badly informed are we on this critical area of the world?

The events in China underscore the unpredictable and unstable nature of governments in that part of the world. As in Eastern Europe, the Soviet Union exercises various degrees of ideological influence over its communist "bloc" of Asian neighbors—Mongolia, North Korea, Vietnam, Cambodia, Laos, and China. The United States, too, tries to mold Japan and other democratic nations in its image. Both superpowers are finding that the Orientals have a mind of their own.

I was struck in China by their concept of time. Every official I met with still harbored a deep hatred of the Japanese for invading and raping their homeland. As one official explained, "You Westerners tend to think of 45 or 50 years as a long time. In China, it is regarded as the blink of an eye." And there is a story that Chairman Mao, when asked

## China Warning

*On February 25 [1989], I left Japan for more than 3 weeks to visit China, stopping in Shanghai, Qingdao, Wuhan, and Beijing. In all four cities I met with officials concerned with marine and freshwater affairs. My impression is that marine science is laboring in China. Funding has been severely curtailed, and most of what is available goes into research of an applied nature. Basic science is largely being ignored except in some cooperative international programs. The plight of the professors and scientists in a material sense is very grave. China appeared to me to be a pot seriously in danger of boiling over. More violent upheaval would not be a surprise to this writer.*

—PRR

*Personal communication to the Director  
Woods Hole Oceanographic Institution  
Received March 29, 1989.*

what he thought of the French Revolution, replied: "It's too early to tell." Yet the Chinese realize they must be practical where the Japanese are concerned, and seek financial and technological assistance from the Sunshine Kingdom if they are to overcome their economic problems.

I define the Pacific Region as meaning the countries of the Far East, Southeast Asia, and the Pacific Islands. The focus of my report is on relations between the Soviet Far East, China, Japan, and the United States as they relate to other countries in the area. The term Pacific Rim means all those nations that face on the Pacific Ocean, such as in South and Central America, as well as Asia. The term Pacific Basin is defined as the 14 countries that participate in the Pacific Economic Cooperation Conference.\* For all practical purposes, there are really two Pacific regions that are separate and distinct from each other in terms of culture and problems—that is, the Pacific island nations (see map, pp. 46–47) and the nations of Southeast Asia and the Far East.

In 1905, President Teddy Roosevelt prophesied that the 20th century would be "the Century of the Pacific." Somewhat later (1945), Walter Lippmann dubbed it "the Atlantic Century," and so it has turned out to be. Now many pundits are predicting that the 21st century will finally become

\* The countries in the Pacific Basin that participate in the Pacific Economic Cooperation Conference are Australia, Brunei, China, Indonesia, Japan, Malaysia, New Zealand, Papua New Guinea, the Philippines, Singapore, South Korea, Taiwan, Thailand, and the Pacific Islands.

the Century of the Pacific.

If it is indeed true that history has a tendency to repeat itself, we should recall somberly that this century has not been a peaceful one in the Asia/Pacific Region, given the bloodshed of World War II, the Korean War, the process of the decolonization of the Pacific Islands Region, the recurrent wars in Indochina, the Cambodian or Kampuchean conflict, border clashes between China and the Soviet Union, and Japanese expansionism, to name but some of the actions in Asia that marked the century. Indeed, as we prepare to enter the 21st century, the Pacific Region, while offering the prospect for great economic prosperity, is potentially the most volatile area of the world.

Looking at events in East Asia today, there is certainly cause for concern about what a Pacific Century will mean to the international community at large. Three smoldering questions are: What will a Pacific Region dominated by an aligned and economically dynamic China and Soviet Union mean in the century ahead? Assuming, with the help of the United States and Japan, China and the Soviet Union reach a point where they are no longer preoccupied with economic reform, will they still want stable relations with the West? And, will an economically ever-powerful Japan foster a nationalistic arrogance that will manifest itself in a strategy for an offensive military capability? All these questions have a maritime component.

My central conclusion is that there is a major political and economic sea change under way in the Pacific Region that will affect the course of the world's destiny in the century ahead. While my research focused mainly on major marine concerns in the area, I found these were most always connected to larger political or strategic goals. The establishment of 200-nautical mile Exclusive Economic Zones (EEZs) by many nations in the region, for example, has heightened conflicts over maritime boundaries, seabed resources, and fishing agreements.

The history of U.S. involvement in Asia—one of shifts between the extremes of isolationism and military conflict—is marred by a general failure to grasp unfolding trends. For example, the U.S. failure to perceive where Japanese imperial expansion in the 1930s was leading helped plunge us into the Pacific war. The Korean War and more recently Vietnam are further examples of poorly understood Asian developments on the part of the United States. And make no mistake, Asia will play a pivotal role in America's future in the next century. Thus it is important to fathom the new dynamics that are at play in the Pacific Region.

### The Discovery of the Pacific

The discovery by Europeans of the Pacific Ocean begins with Vasco Núñez de Balboa, a Spaniard, in the year 1513. At that time, Spain and Portugal were competing to discover the Spice Islands, which were believed to lie somewhere off the maps of the world as navigators then knew it, in a remote region known as Asia. In 1513, Balboa, a forceful but

penniless adventurer, found himself the leader of a band of survivors from an expedition to settle the Isthmus of Panama from the Caribbean side. The local Indians, who proved amenable to a mixture of diplomacy and force, told Balboa of a further coast only a few days march away. He thus set off with about 100 followers and forced his way through mountain forests to the shore of the Pacific, which he called the South Sea because the Panama coast runs locally east and west. For years on maps, the Pacific would be known as the South Seas.



*Engraving of Balboa discovering the Pacific in 1513.  
(The Bettmann Archive)*

Balboa wanted to explore his new-found ocean and find the Spicery, thought to be as valuable as gold. He attempted to build some ships on the further coast but got no encouragement. Then King Ferdinand V of Spain appointed a new officer to take over the settlement from Balboa. The two men had a falling-out and Balboa was eventually beheaded.

The Portuguese, meanwhile, had reached Malacca in 1512. According to an accountant, east of Malacca lay a vast, mysterious region of shallow seas and beautiful, productive islands, including the Spice Islands (now known as the Moluccas), which produced the cloves, mace, and nutmeg that the Portuguese had come to find. Northeast lay the south coast of China, source of silk and porcelain then as it is today, and an eager market for island spices.

The first recorded Portuguese to visit China was Jorge Alvarez in 1514. Alvarez purchased, besides silk and porcelain, a quantity of tung oil, which the Chinese used for varnishing ship planks. The initial contact was made in Lin-tin Bay, downriver from Canton, but, because of their unsavory reputation in Malacca, it would be several decades before the Portuguese secured a toehold at Macao, near present-day Hong Kong. Cloves interested the Portuguese more than silk, thus the Moluccas rather than China were their principal interest.

It was a Portuguese soldier-of-fortune, however, who was destined to be the first European to navigate the Pacific under the Spanish flag. His name was Fernão de Magalhães, better known as Ferdinand Magellan. Before setting sail on his historic voyage which gave us the term Pacific Ocean in 1519, he had seen considerable service in the east, principally at Goa on the west coast of India and at the taking of Malacca.

Magellan returned to Portugal in 1513, but failed to secure what he considered adequate recognition or employment. In 1517, he offered Spain his services and very valuable information. With him went a friend, Rui Faleiro, a mathematician and astrologer. They teamed up with Cristobal de Haro, a merchant, financier, and promoter of overseas enterprise, and the Bishop of Burgos, Juan Rodriguez de Fonseca, a politician-prelate who had been responsible in 1493 for fitting out Columbus' fleet.

Each of these four men had an important contribution to make: Magellan, knowledge of the East; Faleiro, plausible geographic theory; Haro, money; and Fonseca, who arranged for Magellan's presentation to the young Charles I, official support.

Magellan set sail in 1519 with five ships, all small or medium-sized merchant vessels, purchased for the expedition on the open market in Cádiz by the royal purveyors. No details are known of their build, rig, or dimensions. The ships contained hawks bells—20,000 of them—and brass bracelets for barter, plus 500 looking-glasses, a quantity of velvets, and more than 1,000 kilograms of quick-silver for general trade. The crew numbered about 250, mostly Spaniards, though many other nationalities were represented, including one Englishman and two Malays. Some of the officers, including all the navigators, were Portuguese, probably selected by Magellan himself.

The major task of exploration began after the fleet reached Patagonia, off what is today Argentina. To get to that point, Magellan had to deal with a mutiny and considerable other discord among the crew. From Patagonia on, the fleet was sailing into unknown waters.

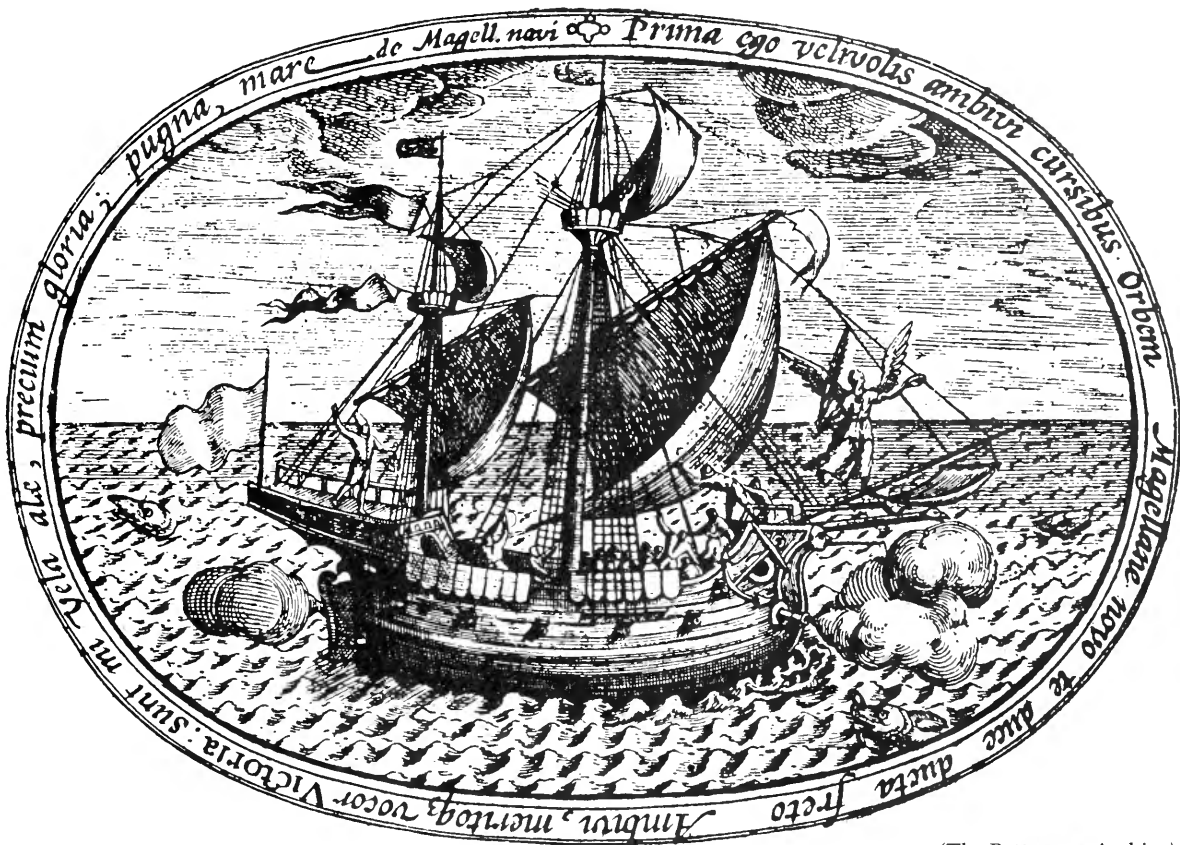
Antonio Pigafetta of Vicenza, Knight of Rhodes, shipped with Magellan as a gentleman volunteer on this perilous voyage. He would end up by being the historian, and 1 of only 18 to survive the horrors of the voyage. "He had a remarkable capacity for survival," J. H. Parry notes, in *The Discovery of the Sea*. "He probably spent more time ashore during the voyage than any other

member of the company; but when his companions were trapped into a murderous shoreside battle, he was on board nursing a previous wound; when he slipped while fishing at night, and fell into the sea, there happened to be rope hanging over the side; when most of the company were prostrate with scurvy, he kept his health (perhaps his assiduous fishing had something to do with this). He had a boundless, somewhat naive curiosity, a capacity for keen observation, a remarkable ear for languages, and a genial manner which made him an excellent emissary in dealing with strange people ashore." He was an independent observer and kept a regular journal with careful notes on everything he saw.

From Patagonia, Magellan sailed to the strait that bears his name. For sailing ships, it is a difficult and dangerous passage with strong tidal currents



(The Bettmann Archive)



Magellan's ship.

(The Bettmann Archive)

and frequent foggy and heavy weather. The eastern part of the strait, from Cape Virgins to Cape Froward, runs between relatively low, grassy banks. The western part is a narrow fjord between ice-capped mountains, a funnel through which the prevailing west wind drives in savage, unpredictable gusts. The distance from Cape Virgins to Cape Pillar on the Pacific is 570 kilometers. Safe passage depended on favoring spring tides and brief periods of easterly winds. In the 16th century Sir Francis Drake made the passage in 16 days, but some navigators took 3 months or more and some gave up in despair.

Magellan's fleet came near to giving up, but made the passage in 38 days. One ship mutinied and turned back to Spain. Magellan, short on food and water when he reached the Pacific, had no notion of the size of the ocean. He probably anticipated a passage across this new body of water to take but a few weeks; in fact, they would be at sea for 4 months before reaching Guam in the Marianas. The crew was reduced to scraping barrels for powdered wormy biscuit, eating rats, chewing sawdust, gnawing leather, and in general suffering all the torments of hunger, thirst, and scurvy. During the entire passage to Guam, the only land they sighted was two small uninhabited islands.

Pigafetta told the story of the passage:  
*Wednesday, 28 November 1520, we debouched from the strait, engulfing ourself in the Pacific Sea. We were 3*

*months and 20 days without getting any kind of fresh food. We ate biscuit, which was no longer biscuit, but powder of biscuit swarming with worms, for they had eaten the good. It stank strongly of the urine of rats. We drank yellow water that had been putrid for many days. We also ate some ox hides that covered the top of the main yard to prevent the yard from chafing the shrouds, and which had become exceedingly hard because of the sun, rain, and wind. We left them in the sea for four or five days, and then placed them for a few moments on top of the embers, and so ate them; and often we ate sawdust from the boards. Rats were sold for one-half ducado [about \$1.16 in gold] apiece, and even then we could not get them. The gums of the lower and upper teeth of some of our men swelled, so that they could not eat under any circumstances and therefore died. Nineteen men died from that sickness.*

During the passage from the strait to Guam, Magellan sailed about 12,000 miles through open ocean without encountering a single storm. Misled by this experience, he called the ocean Pacific.

Magellan sailed through the western Pacific in roughly the same latitude as Samar Island in the Philippines. On reaching the Marianas, Magellan found himself among seafaring people in outrigger canoes with triangular matting sails. Pigafetta described these Micronesians as thieves because they snatched every item of loose gear they could lay their hands on. Dubbing the islands the Landrones, or Thieves' Islands, Magellan continued to

sail on west, finally sighting Samar Island in the neighborhood of the Leyte Gulf, in a week's time.

In the Philippines, the Chinese, Portuguese, and others were already engaged in seafaring commerce. Magellan became embroiled in a dispute between the King of Cebu and the King of Mactan. On a beach on the tiny island of Mactan, 27 April 1521, the explorer became engaged in battle, was repeatedly wounded by the poisoned arrows, spear thrusts, and scimitar cuts of Mactan tribal warriors, and died face down on the sand.

Pigafetta lamented:

*When they wounded him, he turned back many times to see whether we were all in the boats. Then, seeing him dead, we wounded made the best of our way to the boats, which were already pulling away. But for him, not one of us in the boats would have been saved, for while he was fighting, the rest retired.*

On 8 September 1522, only 12 days less than 3 years from the day of departure, 18 of the original crew of 250 sailed into Seville, Spain, in the *Victoria*, the only one of the five original vessels to complete the voyage of Pacific discovery.

### Confucianism, Buddhism, and Shinto

The culture of East Asia is largely rooted in Confu-

religion. It is a compound of ancient Chinese popular cults, ancestor worship, state ritual, and moral precepts. If one hopes to understand the oriental mind, the study of Confucianism and its religious spin-offs, such as Taoism, Shinto, and Buddhism, is a good place to start.

Understanding the oriental mind might seem to some to be a remote pursuit in the study of the Pacific Region, and particularly the oceans. But beliefs are clearly linked to attitudes, such as the worship of whale souls in the Buddhist and Shinto traditions (see *Oceanus*, Vol. 32, No. 1, pp. 52–53), and do have a direct bearing on behavior and how individuals perceive their environment.

Kung Fu-tse or Master Kong, latinized as Confucius, lived in the state of Lu in north China, 551–478 B.C. Of humble rank and largely self-educated, Kung Fu-tse became a teacher asking questions and uttering maxims, sort of a Chinese Socrates. In later life, despite some pupils in high office, Confucius toured the country unsuccessfully looking for a state that would put his ideas into practice. He then compiled what is today known as the Chinese Classics—the *Book of History*, the *Book of Odes*, and the *Book of Changes*, plus the *Annals of Lu*. His main thoughts can be found in a small book called the *Analects*, which emphasizes the importance of propriety in personal and social conduct.

---

**I**n carrying on your government, why should you use killing at all? Let your evinced desires be for what is good, and the people will be good. The relation between superiors and inferiors is like that between the wind and the grass. The grass must bend when the wind blows across it.

—Confucius, the *Analects*

---

Confucianism. On the one hand, this belief instills values such as hard work, thrift, goal attainment, and family loyalty, among others, which are useful behaviors in market economies. On the other hand, it also can translate as deference to authority, resistance to change, respect for ways of the past, aversion to risk, and other values that inhibit market activity. Thus we find a mixture of Confucian elements in Far Eastern societies, some, such as the work ethic, dominating, but others inhibited by the practices of government.

In Japan, some of the elements of Confucianism are found in the Shinto and Buddhist traditions, such as ancestor worship. The average Japanese today is born into the Shinto religion, has a Christian wedding, and is buried in the Buddhist tradition, thereby covering all bases. What part these philosophies play in the economic well-being of East Asian societies is a question for social scientists to answer, but it is interesting to note that many of the values mentioned are absent in Catholic Latin American countries, where economies are generally depressed.

Scholars debate whether Confucianism is a

In the *Analects*, Confucius also states that rulers have duties to subjects as do servants to masters. He adds that a sense of Heaven inspires him, judges his acts, and hears his prayers. The cult of Confucianism grew slowly in China, but, by the 2nd century, emperors adapted his teachings to their purposes. He was touted as a great sage and called "the teacher of ten thousand generations."

### Buddhism

Buddhism began in India, where today it is in decline, but spread successfully to Southeast and Northeast Asia as a missionary religion. The founder was named Siddhartha, but is more generally known by the family name of Gautama.

The son of a king and born into the warrior caste rather than the priestly Brahmin, Gautama was raised (563–483 B.C.—dates commonly accepted by Western scholars, though Chinese Buddhists put him hundreds of years earlier) in Kapilavastu, a city in what is now Nepal. At the age of 29, married and with one son, Gautama was riding outside the

# Voyage To New Frontiers

.....  
**SHINKAI 6500 Deep Submergence Research Vehicle  
Seeks to Unlock Mysteries of the Abyssal World.**



At a depth of 6,500 meters under the ocean surface lies a world shrouded in silence and darkness. A world that remains one of man's last frontiers here on earth. Now set to explore this unknown region is the SHINKAI 6500—the world's deepest diving submersible in operation. With the ability to scan 98% of the earth's ocean floor, this freely maneuverable deep submergence research vehicle will be challengingly tasked with observing plate movements, conducting research on earthquakes, mapping mineral deposits, and identifying entirely new species of marine life.

The SHINKAI 6500—just one more way that Mitsubishi Heavy Industries' state-of-the-art technologies help pave the way to new frontiers.



**MITSUBISHI**  
HEAVY INDUSTRIES, LTD.

Shipbuilding & Ocean Development Headquarters

5-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan Phone:(03)212-3111

palace one day when he saw four signs—an old man, a sick man, a corpse, and an ascetic. These showed him the suffering of the world, and the calm of leaving it.

He then left his wife and child and sought enlightenment. He traveled and tried various teachers for years without success. Finally, near Gaya on a tributary of the Ganges, Gautama sat under a tree called the Bo, the “tree of enlightenment,” and waited. After a day and a night, knowledge came and he understood the rising and passing away of beings, the cause of suffering, the end of rebirth, and the way to Nirvana.

He thus became the Buddha, the enlightened one, and preached his doctrine for some 40 years to small groups of monks and laymen before dying from eating tainted pork. After his death, some 500 monks met in a cave to recite the *Vinaya*, the rules that govern their lives and form the first part of the Buddhist scriptures. From this meeting onward Buddhism spread throughout the world.

At first, Buddhism was opposed in China because it caused young men to withdraw into monasteries and was thought to be contrary to ancestor worship. But despite fierce persecutions still witnessed today in Tibet, Buddhism became a part of Chinese life and exercised a great influence on art and politics, as well as religion.

Today, under Communism in China, there has been extensive restoration of Buddhist centers in the interest of tourism and the preservation of national culture. One of the biggest dilemmas facing both China and Japan today is deciding what to accept and what to reject from the past. A strictly controlled Chinese Buddhist Association was formed in 1953.

Buddhism came to Japan from Korea in the 6th century A.D. The arriving monks absorbed the then religion of the country Shen-Tao, the “Way of the Gods,” as contrasted with the Way of Buddha. Thus dual Shinto was born in Japan whereby deities for one sect comprised earth, rain, wind, mountains, the sea, and harbors. One of the more popular deities is Inari, the rice god, who is represented by the fox. The Buddhist monks took over many of the Shinto shrines and forced the nature-worshipping and faith-healing sect into decline from the 17th century to 1854, when Japan was opened once more to Western influence.

Today Shinto is the state religion of Japan. Emperor Hirohito was buried in the Shinto tradition early in 1989, but the government was quick to point out that he was not a god, as the emperor himself had proclaimed in life. But few citizens probably believed it. In Japanese homes, there are places for Shinto and Buddhist symbols, where incense, leaves, and water are regularly offered.

### Fish Stock Crisis

There is a serious decline in many commercially

important fisheries stocks in coastal regions throughout the Asian and Pacific area, ranging from beyond Thailand to far eastern shores. Overfishing and pollution are the primary causes for the declining stocks, which is causing the fishing fleets of many nations in the area to roam farther afield.

The Asian region produces 23 million tonnes of fish annually, or about 40 percent of the world's total catch. Those stocks that are not declining are usually being harvested to the maximum sustainable extent. This condition points to a major crisis ahead in the near future, with worldwide implications.

Fish provide more than half of the animal protein consumed in Southeast Asia, and as fishing fleets range farther from home, stocks will come under heavier pressure elsewhere. Territorial fishing disputes are already escalating in the region as individual nations seek to protect and patrol their newly proclaimed 200-nautical mile EEZs.

The oceans can only yield a certain amount of fish for consumption each year without stocks going into an overall decline, and we may easily have reached or gone beyond that limit, or soon will. Meanwhile, fish populations are declining or not growing, and the populations of many coastal communities in the region are growing at a rapid rate as impoverished inland farmers migrate seaward seeking a different livelihood, many from the sea itself.

### The Issue's Logic

While fisheries problems are common throughout the Pacific Region, readers will find a first-hand report on the status of stocks in the Yellow Sea and East China Sea, written by Yang Jinsen, one of China's top authorities on that subject. By the same token, offshore oil and gas development is crucial to China's future, and perhaps Japan's. This topic is covered by Wang Longwen in the box on pp. 32–34.

These manuscripts were pledged to *Oceanus* before the June Tiananmen Square events and arrived in our office early in September 1989. In each case, they were sent despite the uncertain political climate in that country in regard to scientific exchanges with the United States.

I would also like to call your attention to the article by Joseph R. Morgan and Norton Ginsburg of the East-West Center in Hawaii on their September 1989 trip to the Soviet Far East to attend a conference on the Sea of Japan and the Sea of Okhotsk.

As the authors note, this conference was an “extraordinary event and indicative of the recently revived interest in the Soviet Union in the Pacific Region.” This article (see page 49) is an important addition to the scant literature on the subject.

Many other articles in this issue are meant to elaborate and expand on points raised in my report, such as the problems of piracy (page 65), pollution, and the testing of nuclear weapons (page 74). □



# The Soviet Far East

Not a great deal is known about the Soviet Far East. Few Westerners have traveled there because for years it has been mainly a strategic military area, particularly for large naval forces. The Far East region comprises about 6.2 million square kilometers and has a long, mountainous coast. The area has large gas and coal reserves. The largest towns include Yakutsk in the interior and Khabarovsk and the port of Vladivostok, the latter near the border with China.

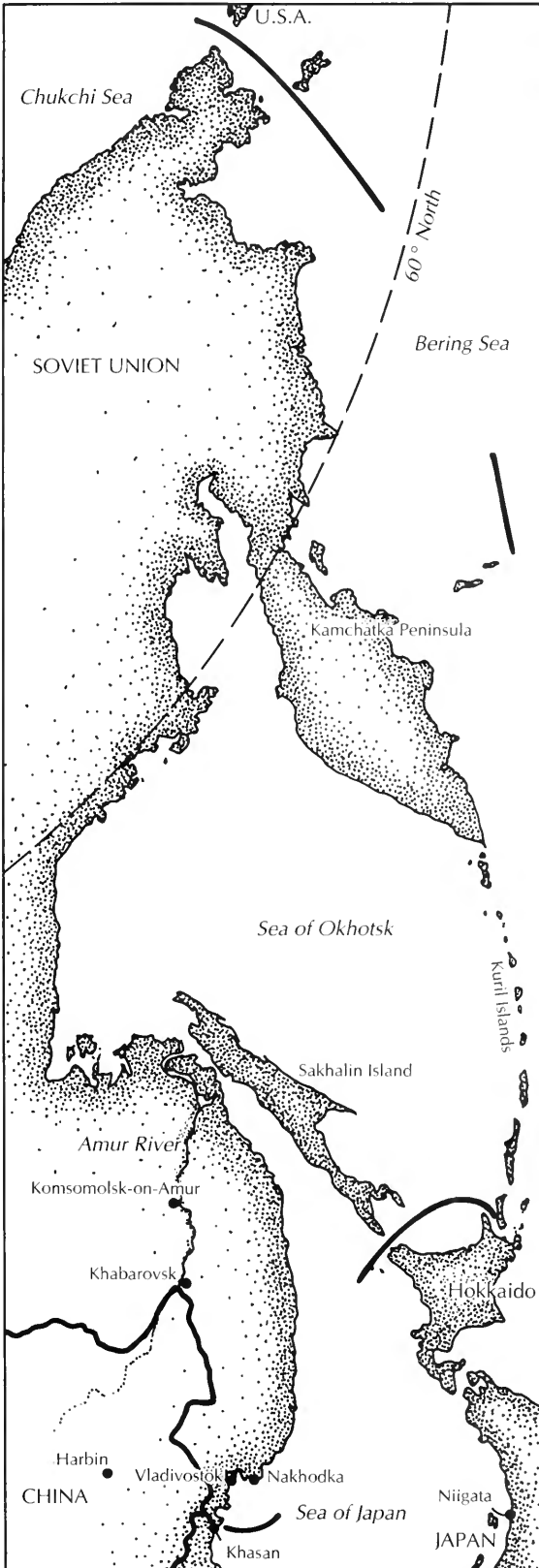
The Soviet Far East is linked to Western and Eastern Siberia. These three regions—an area of 12.6 million square kilometers—make up the whole of what is known as Siberia, an area pregnant with the connotation of *Gulag*, or political prison, in the Western mind. Western Siberia, with a population of about 10 million, is the basin of the Ob, Asia's longest river. This region has enormous reserves of oil and natural gas. The principal towns are Omsk and Novosibirsk. Eastern Siberia, with a population of about 7.5 million, is rich in minerals and hydroelectric power. The largest towns include Krasnoyarsk and Irkutsk.

Siberia thus lies east of the Urals and north of China and Mongolia. There are few economic statistics available for this region, which comprises about two-thirds of the Soviet Federal Socialist Republic.

## Some History\*

Siberia takes its name from Sibir, the capital of the Tatar Khan Kuchum, who was defeated in 1584 by Yermak the Cossack. Pushing aside other semi-nomadic tribes, the Russians proceeded to build a series of fortified settlements called *ostrogs*, and reached the Sea of Okhotsk in 1639.

\* This section on the history of the Soviet Far East was provided by Joseph R. Morgan and Norton Ginsburg of the East-West Center in Hawaii. They are represented in this issue by an important article (see pp. 49–52) on a recent conference in the Soviet Far East on the seas of Japan and Okhotsk.



In the 350 years since then, Russia has been confronted with the issue of how to settle and utilize the vast area brought under its control. It borders six large, semi-enclosed seas—the Laptev, the East Siberian, the Chukchi, the Bering, the Okhotsk, and the Sea of Japan. To be sure, during the 17th and 18th centuries, Russian explorers not only mapped their shorelines and coastal areas, but also crossed into North America. They brought Alaska under Russian control, and extended Russian influence for a time as far south as San Francisco.

About the time of the sale of Alaska to the United States in 1867, it became Russian national policy to attempt to properly settle the Far East region, or at least its more climatically hospitable southern part, with European Russian immigrants. This policy was stimulated by the abolition of serfdom in the Russian Empire in 1861. Poor peasants from European Russia and the Ukraine trekked more than 8,000 kilometers across Siberia to reach this supposed “promised land.”

In 1882, 20 years after the establishment of the Port of Vladivostok, the Russian state supported the transport of settlers by sea, chiefly from Odessa on the Black Sea, to Vladivostok. The hardship of traveling this distance was immense, and migration was a slow, tedious business.

It became clear by late in the 19th century that successful settlement of the Far East, then occupied by scores of thousands of Koreans and Chinese, as well as native Yuit peoples in the north, would require easier transportation than that existing at the time. Encouraged by the treaties of Aigun (1858) and Peking (1860), by which Russia acquired its trans-Amur territories and which established international boundaries between Russia and Imperial China, the Russians launched development of the Great Trans-Siberian Railway late in the century. Construction moved inward from European Russia on the west and from Vladivostok on the east. The railway opened as a single-track line in 1901, with a break at Lake Baykal.

At the same time, the Russians, operating out of Harbin in northern Manchuria, which became a virtual Russian city, completed the so-called Chinese Eastern Railway in 1903. This linked the evolving Trans-Siberian from east of Irkutsk to Vladivostok, thereby saving about 900 kilometers along the mainline. A second mainline was then constructed south from Harbin via Mukden to Port Arthur.

### The Russo-Japanese War

Indeed, the vulnerability of the Far East, due to immensely long distances from Soviet Europe and its sparse population, was underscored by the victory of Japan in the Russo-Japanese War of 1904–5. At the beginning of the war, Russia occupied much of Manchuria, and Japan successfully attacked Russian forces at the warm-water naval station of Port Arthur in February of 1904. This was followed by a number of other battles and defeats at Mukden and elsewhere.

The Trans-Siberian Railway, just completed in 1903, was too slender a transportation medium to

adequately reinforce Russian troops at the farthest end, so to speak, of the Russian world.

Then, in May of 1905, the Japanese fleet defeated the Russian Baltic Fleet, which had sailed from the Baltic Sea around the Cape of Good Hope to reach the Korean Strait on its way to Vladivostok. As a result, Japan acquired the Liaotung Peninsula, what then became the South Manchurian Railroad, as well as the southern half of Sakhalin, which the Japanese renamed Karafuto.

It was not until 1916 that the Trans-Siberian Railway was completed by a land bypass around Lake Baykal, which up to that point was crossed by ferries. Then followed the Russian Revolution and the Great Civil War; American and Japanese troops operating out of Vladivostok collaborated with White Russian forces to seek and maintain control of the Far East region. The area came under the control of the new Soviet government in the early 1920s.

Vigorous development was launched in 1928. By the middle of the century the Trans-Siberian had been mostly double-tracked, and most of it electrified. Since the gauge of the Russian railway is a wide 5 feet (as compared with standard gauge of 4 feet 8½ inches), the load-carrying capacity of the railroad is high. Still, it constitutes only a single lifeline across the 5,000 miles between European Russia and the Far Eastern coast.

In 1932, the city of Komsomolsk-on-Amur was founded. An iron and steel industry, machine manufacturing plants, lumber mills, and the like were established, making it one of the major industrial cities in the Soviet Union. Similar industrialization took place at Khabarovsk itself and to a degree at Vladivostok.

Vladivostok was a great port by almost any standard, but eventually it became closed to international shipping and acted as the Soviet Navy’s major base in the Far East. At the close of the Pacific War, the Port of Nakhodka was established east of Vladivostok to handle both coastal and international traffic. Shortly thereafter, Nakhodka was linked to the Trans-Siberian Railway and has acted since as its eastern terminal.

### The Vladivostok Speech

The catalyst for significant sea change in the East Asia region can be traced to Soviet General Secretary Mikhail Gorbachev’s speech of 28 July 1986 in Vladivostok. He openly called for better relations with China, an initiative confined largely to back room dialogue since 1982. He specifically stated that the Soviet Union was prepared to withdraw part of its forces stationed along the Chinese border and in Mongolia, and from Afghanistan—two “major obstacles” to better relations often cited by China. A third major obstacle, Soviet support for Vietnam forces in Cambodia or Kampuchea, was only briefly mentioned in passing.

The speech, however, marked a major shift in Soviet policy toward Asia from a diplomacy of force to one of economics. It also implied recognition of Japan’s role as an economic superpower. The Soviet leader stated: “The Soviet Union is an Asian and



*Soviet fishing vessels call at Vladivostok. (Tass/Sovfoto)*

Pacific country [because] a large part of our territory lies east of the Urals, in Asia, and the Far East, [and] this vast region's complex problems are close to the Soviet Union, touching it directly." Indeed, almost two-thirds of Soviet territory is located on the Asian Continent with the Far East having a 26,900-kilometer coastline, larger than that of the entire contiguous United States.

Since Gorbachev's Vladivostok speech, the Soviets have sought to improve relations with a number of Asian nations besides China and Japan. Others include the Philippines, Thailand, Indonesia, some Pacific islands, and Australia. In addition, the Soviets would like to gain membership in the Asian Development Bank. The relatively new Soviet National Committee for Asia-Pacific Economic Cooperation has been placed under the leadership of Yevgeny Primakov, Director of the Institute of World Economy and International Relations of the Soviet Academy of Sciences. The institute has about 400 researchers, 50 of whom are devoted to full-time studies of the Pacific Region.

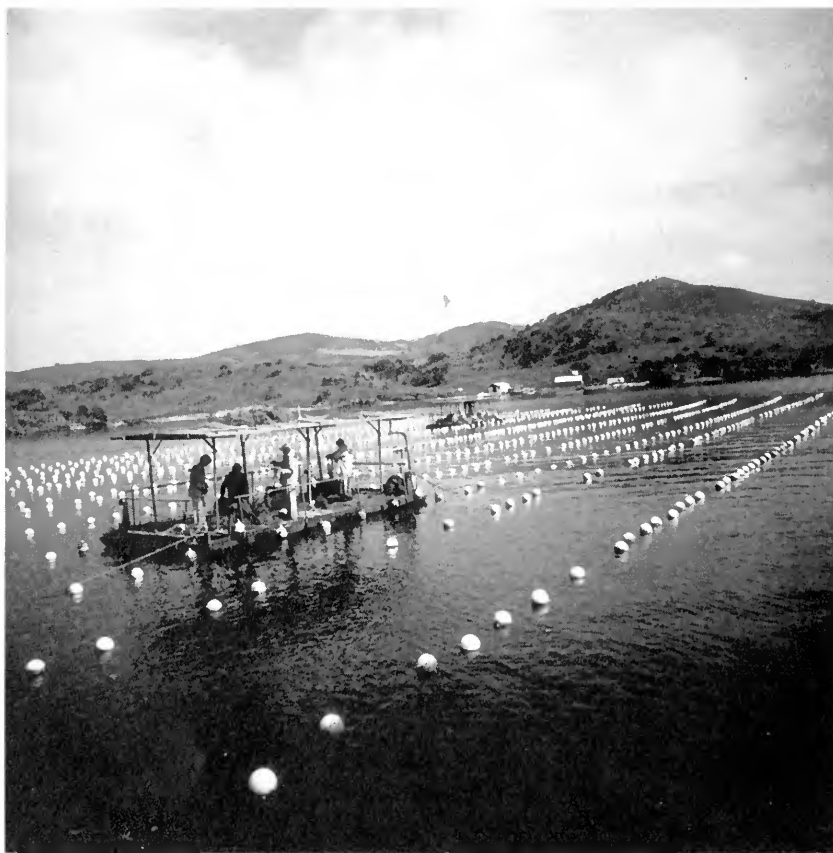
In March of 1988, Primakov was named chairman of the Soviet National Committee for Asia-Pacific Economic Cooperation, a group with representatives from 16 Soviet government, economic, and academic organizations. It is believed the committee is charged with preparing Soviet entry into the Pacific Economic Cooperation Council (PECC), a group of 14 Pacific Basin states, plus the

United States. In May of 1988, Primakov spoke as an observer at the Osaka PECC meeting and acknowledged that the Soviet Union held "incorrect perceptions" about Pacific regionalism and now wanted to be part of this activity.

Some leaders and officials in the occidental world have been quick to embrace Gorbachev's many new international initiatives as a breath of much-needed democratic air in the Soviet socialist system. Asians have been far more skeptical, many adopting a wait-and-see attitude. They are mindful of the fact that the Soviet leader is an avowed Leninist, and thus a believer that politics and economics are a form of war by other means.

In the summer of 1987, the Soviet government announced the drafting of a Comprehensive Far East Development Plan that would hold through the year 2000. The plan was described as an extension of Gorbachev's Vladivostok speech. One of the objectives of the plan is to promote a strong economic base in the Soviet Far East region that would allow greater exchanges with other nations of the Asia/Pacific Region.

The region is a source of fishery and other marine products, such as boats and tars, plus metals and minerals, such as gold and diamonds, and lumber. But national income figures indicate that the area's consumption exceeds its output by nearly 50 percent. Thus, one of the aims of the plan is to



*This seafood farm in the Soviet Far East breeds sea scallops and other marine flora and fauna. (Tass/Sovfoto)*

achieve greater self-sufficiency. For example, it calls for a 30 percent increase in fisheries production: a goal that will affect the harvests of American and Japanese fishermen, among others. (In April of 1989, Japanese officials negotiating an annual fishery agreement in Moscow reported that they were facing substantial quota reductions on salmon fishing, plus a reduction in the number of Japanese vessels allowed to engage in any type of fishing in Soviet waters.) Much larger Soviet increases in Far East development are called for in food, oil, and gas production, and new steelworks are to be built.

### **Fisheries Concerns**

In general, Soviet fishery officials are concerned that their marine resources in the Far East are being depleted, especially salmon, walleye pollock, and several crab species. They also consider that marine resources should be exploited first by the nation that has sovereign rights over them. This has led to ever-increasing restrictions on Japanese fishermen inside, and even outside (areas of the continental margin), the Soviet's 200-mile zone. For their part, the Japanese have imposed severe restrictions on Soviet fishermen in their waters, who mostly fish for sardine and mackerel.

At the present moment, the Soviet Union is a relatively minor trading partner in Asia. Moscow's main trading partners in the region are China, India,

Japan, North Korea, and Vietnam. These five nations account for about 85 percent of Soviet trade in Asia. Japan is the largest trading partner, but accounts for only about 2 percent of total Soviet trade. India is second, Vietnam third, and China fourth. It is interesting to note that in 1960 China reportedly accounted for 21 percent of total Soviet trade.

Gorbachev expanded his Asian policy during a speech in mid-September of 1988 given in the Siberian town of Krasnoyarsk. This time he called for a Sino-Soviet Summit, which was subsequently held in mid-May of 1989, restoring party-to-party relations that had been interrupted for three decades. In his 1988 speech, he also proposed a withdrawal of Soviet naval forces from Cam Rahn Bay in Vietnam in exchange for the abandonment of U.S. bases in the Philippines (a country drawing increasing attention in Soviet/Asian diplomacy); normalization of relations with Japan (in limbo because of a dispute over the ownership of four islands off the northern tip of Japan now occupied by the Soviets); development of economic relations with South Korea; and establishment of a regional security forum and negotiations to limit naval activities in the Pacific, among others. In this context, it is interesting to note that the Soviet Union has normalized relations with every major country in the world except Japan, although back room talks may soon change this.

*The Port of Vostochnyy near Nakhodka is the connecting link to the BAM railway and European Russia. Japanese companies helped modernize the port. (Sovfoto)*



### Special Economic Zones

Economically speaking, the Soviet Union faces some enormous problems in attempting to develop Soviet East Asia. An example is the Trans-Siberian Railway. Under the czars, the railway was completed in 11 years at an average rate of 650 kilometers of track a year. The Baykal Amur Magistral (BAM), a new Trans-Siberian Railroad, was inaugurated by Leonid Brezhnev in 1974. Despite better equipment and 50 percent more workers, the average rate is 310 kilometers a year and it is still far from complete.

The Soviet Union would like to develop the Far East by establishing special economic zones (SEZs) similar to those established in China during the last 10 years (see page 24). They also hope to attract joint ventures with businessmen from other countries. This plan—and to date it is little more than just that—faces many obstacles, such as high joint-venture taxes, the inconvertibility of the ruble, and uncertainties associated with the supply of raw materials and a limited labor pool.

Soviet planners have identified five possible sites for SEZs—Khasan, near the juncture of the North Korean, Chinese, and Soviet borders; Nakhodka, a port near Vladivostok, which already has freight, fishing, and oil port facilities; Grodekovo, on the rail line near the Chinese border; along the Amur and Ussuri rivers; and near Khabarovsk. A Japanese company is floating a proposal to build business facilities, hotels, and air- and seaports in Khasan and Nakhodka. The Soviets would provide the land, Japan the capital and expertise, and China and North Korea the labor. The objective is to create a “Singapore” in the Soviet Far East.

In the SEZs, Soviet enterprises and cooperatives would be allowed to import consumer goods, begin direct exports and ties with foreign firms,

enjoy tax benefits on profits and reinvestment, and use hard currency earnings for “social development.” The SEZs would permit preferential custom duties, licensing of foreign economic transactions, and reduced taxes—actions designed to appeal to Japanese and Korean investors.

Yurii Merinov, the Communist Party First Secretary of the Port of Nakhodka, has warned against creating an SEZ. “Of course, foreigners can build their enterprises here, but they will have nobody to work at their plants,” he says, speaking of the chronic labor shortage. In addition, a general lack of housing, poor wages, few consumer goods, poor schools, and governments that make financial decisions in Moscow plague the region.

On 7 February 1989, a Soviet television program conducted a discussion on “The Asian-Pacific Region: Problems and Prospects for Development.” In general, it was agreed that the Asia/Pacific Region would be the center of world trade in the next century; that the lack of a Siberian infrastructure must be overcome rapidly for the Soviet Union to share in the region’s prosperity; that a new convertible ruble must be established; and that development of the region needs foreign investment and management.

One Japanese businessman, S. Ota, the president of Toho Seimei, said in an interview that he was prepared to invest \$4 billion in the region to create a “Far Eastern Singapore.” His plans called for the latest communications facilities, computer and satellite links, and an ultramodern airport. A. Soto of the Association of Japanese-Soviet Trade, speaking in another interview, pictured the region dotted with hotels and golf courses with thousands of tourists spending large sums of money.

The response to these programs was a flood of angry correspondence. “We would rather let the land go to waste than let foreigners in,” was a frequent comment.



*Gorbachev inspects a Soviet nuclear submarine of the kind operating out of the Soviet Far East in the Pacific. (Tass/Sovfoto)*

While joint ventures are the cornerstone of the Soviet Far East development efforts, relations between Moscow and Tokyo are cool as the result of the Northern Territories issue (see page 38), Japanese economic sanctions in the wake of the Afghanistan invasion, and Toshiba Machine Company's export of sensitive submarine parts to Soviet-bloc countries. In 1981, Soviet-Japan trade totaled \$5.28 billion. By 1988, it had reached \$5.89 billion, an increase of only 11.6 percent. As of January 1989, there were only 8 Soviet-Japan joint ventures as compared with 28 for Finland and 26 with West Germany.

Without access to the Japanese market—particularly for timber, coal, and gas—the Soviet plan for East Asia development and economic expansion stands little hope of success. Japanese capital, technology, and foreign exchange are essential to attaining Gorbachev's desired goals for the region and for the overall Soviet economy.

One of the Soviet-Japan projects is a boat factory in Khabarovsk. About 50 percent of the plywood boats will be exported and the rest will be used in the Soviet Union. In addition, there are several joint fishing ventures. Nippon Suisan Kaisha signed a contract in December 1988 to establish the Okhotsk Fishery in Khabarovsk, and the

The Mitsubishi Corporation, meanwhile, plans to establish a sea urchin processing plant.

There also is an interesting three-country marine deal in progress. In January 1987, the Tokyo Maruichi Corporation entered into an agreement with China and the Soviet Union. Under this agreement, China will repair five or six large Soviet fish-processing ships of 18,000 tonnes. Maruichi will supply China with machine parts and the equipment needed to do the repairs. The Soviets pay China for the repair work with marine products or canned fish, and Maruichi buys some of these products from China at low cost with foreign currency. The price of the repair is 6 million rubles per ship. At present, some 60 ships need repair. Thus, this business might last for 10 or more years.

### **The Soviet Navy's Role**

Since the 1970s, the Soviet Union has deployed 25 to 35 percent of its forces in Asia. Whereas land and air power play major roles for the Soviet Union in Europe, in Asia the key battlefield is the Pacific Ocean, and the Soviet Pacific Fleet is poised for any confrontation in that arena.

Strategically, the Soviet Far East has been a base for fomenting Communist revolution in Asia

from the 1920s through the 1940s, and a channel for Soviet aid to the new Communist states in the 1950s. It also has been a military headquarters for the modern superpower, which, militarily deadlocked in Europe, has eyed expansionism in the Pacific Region since the 1960s.

For Soviet leaders, the main security threats in the Far East are the United States, China, and Japan. Taking advantage of the Russian civil war of 1918–1920, Japan moved troops into Siberia and eventually established a territorial base in the puppet Manchurian republic. Although it lost that foothold with the recovery of Russian military power in the 1920s, Japan repeatedly probed the Russian and Mongolian borders during the 1930s, trying to extend its growing East Asian imperial domain from Korea to China.

From 1985 to 1987, there were reports that the Soviets were engaged in a large-scale naval buildup in the Pacific. Its fleet in these waters became the largest of four such units (845 warships of a total of about 3,080). The Soviets gained port facilities in North Korea and Vietnam, and sought advantages for fishery activities and marine scientific missions with some Pacific island nations (widely interpreted by U.S. analysts as having military implications).

In 1988, signs appeared that the Soviet military posture was changing in the Far East in response to Gorbachev's economic initiatives. The Soviet leader promised to reduce forces by some

200,000 men in the area, with 30 percent cuts in international patrols by the Pacific fleet, 20 percent cuts in most categories of warships, and a 15 percent cut in the number of Soviet naval combat aircraft since 1986.

These promises of cutbacks have been confirmed by high-ranking U.S. naval officers. But, they are tempered by the fact that large numbers of Soviet ships were approaching obsolescence in any event, particularly submarines. (Some 200 are reportedly 30 years old.) Still, the Soviet military force in the Far East, even with these reductions, is formidable and continues to be modernized. The ratio of Soviet to U.S. forces in the region is 20 to 1 in ground forces, 1.5 to 1 in air forces, 2 to 1 in submarines, and 4 to 1 in total naval forces. The Soviets reportedly have 120 to 140 submarines in the Pacific, 48 of which are nuclear-powered, according to the Soviet Defense Minister. The latter figure does not include submarines carrying strategic ballistic missiles.

One Japanese scholar has noted that 85 percent of the Soviet military force stationed along the Chinese border is engaged primarily in aiding economic activities in the region and not in guard duties. He wonders what effect the cutbacks will have on the economy of the area, particularly in the agriculture of the region near Mongolia, where most of the troop reductions will occur. One effect has been to bring more Chinese labor into the Soviet Far East. □

## North and South Korea

Recent events have led to small improvements in the relations between North and South Korea, but this area of East Asia remains potentially explosive. There is considerable sentiment in the United States and in South Korea that the United States should withdraw its forces from the peninsula, about 43,000 servicemen, mostly stationed along the notorious 38th parallel.

The sentiment in the United States comes largely from those who see a gradual withdrawal as a necessary step toward budget deficit reductions. The sentiment in South Korea comes largely from those who seek a reconciliation with the North, and who manifest their demands by large-scale violent demonstrations in the streets. The United States began to soften its policy toward North Korea in 1987; it lifted a ban against diplomatic contacts with the North in an effort to reduce tension on the peninsula and reopen a North-South dialogue.

The U.S. move followed a series of military

agreements between the Soviet Union and the Pyongyang government. These agreements included the granting of air rights to pass through North Korean air space on northbound flights to Siberia originating from Cam Rahn Bay in Vietnam, thus facilitating resupply of units there. This prompted China to allow three U.S. vessels to make a port call at Qingdao in a display of old-fashioned gunboat diplomacy, the first such port call in 37 years.

In 1986, the Japanese Kyodo News Service, quoting an East European diplomatic source, reported from Beijing that North Korea had granted Soviet naval vessels the right to use the Port of Nampo on the west coast of the Korean Peninsula. The Soviets, if the report was true, thus gained access to North Korean ports on both sides of the peninsula, having already won rights to enter Wonsan. This was disturbing to the Chinese. In 1988, the Soviet Pacific Fleet visited Wonsan for the

fourth time in four years, while North Korean ships visited Vladivostok.

Despite U.S. efforts to reduce tension, the Soviet Union has continued since 1985 to contribute to a large-scale military buildup of North Korean forces along the 38th parallel, which serves as a boundary between North and South. In *North Korea at The Crossroads*, published by the Japan Institute of International Affairs, Hideshi Takesada, a professor at the Japan Institute of Defense Studies, writes:

*There has been a constant increase in military strength since the 1960s, but the buildup since 1985 is quantitatively and qualitatively greater than anything seen before. An increase in ground forces and the introduction and early combat deployment of MiG 23s, increase in Antonov-2 and MI-helicopters, more ships and tanks, and acquisition of a chemical warfare capacity are a few salient examples. . . .*

*As a result, North Korea has acquired the capability to inflict greater damage on its opponent. It has (1) increased its surprise attack capability, (2) increased the capability to wage a blitz war, and (3) gained the capability to carry on an independent war effort for a longer period of time.*

In October of 1989, the Bush Administration reported that North Korea had a nuclear reactor in operation at Yongbyon. It said the reactor, developed by the Pyongyang government on its own, was of 1950s vintage and has been in operation for about 2 years. It expressed concern that North Korea might be trying to develop nuclear weapons.

The reactor was described as a graphite model using natural uranium fuel. North Korea signed the Nuclear Nonproliferation Treaty in 1985, but has not ratified it. The treaty provides for on-site inspection.

The continuing North Korean military buildup comes at a time when the economy of the country is hurting. (Food is still rationed.) Also, a transition is taking place in the leadership of the country from President Kim Il Sung, in power for 40 years, to his son, Kim Jong Il. While published economic statistics are minimal, it is known that the marine sector is one of 10 major targets selected for improvement during the Third-Seven-Year Plan, covering the years 1987 to 1993. A 6.8-million-tonne increase in fisheries products is sought (to reach 10 million tonnes), as is a 2.7-million-tonne increase in fish harvests. It is interesting to note that a shipment of shellfish was the first item of trade going from North to South Korea when exchanges began in 1988.

In general, the relations between the Soviet Union and North Korea can be characterized as warm and friendly, while the relations between China and North Korea could be called good but reserved. Japan, largely following the U.S. lead in Korean policy, is cautiously trying to open up trade with the North, while contributing at the same time to the booming economy in South Korea, which is beset by serious labor unrest over wages and benefits.

On 20 January 1988, the United States re-

scinded the policy of permitting contacts with North Korean diplomats. This was in response to the bombing of a Korean Airlines passenger plane over Burma in November of 1987 with the loss of 115 people in what it termed a "state-sponsored act of terrorism." However, behind the scenes it continued to encourage opening a dialogue between North and South.

## Developments in the South

The successful Olympic Games in the fall of 1988 enabled newly inaugurated South Korean President Roh Tae Woo to gain a larger degree of popularity while pursuing a "northern policy." Hungary, already trading with the South, agreed before the games to establish formal relations with Seoul, a pioneering move that drew an angry response from the North. Yugoslavia next decided to open a trade office in Seoul and other Eastern European nations were considering similar moves. Trade also opened up with China (likely to top \$3 billion in 1989) and the Soviet Union. All these moves appeared likely to push North Korea into a more conciliatory posture after more than 3 decades of tense confrontation on the peninsula.

South Korean military strength is seen by some to be technologically greater, especially in fighter aircraft, than the numerically stronger forces of the North. Nevertheless, there is unlikely to be any large-scale American withdrawal until at least 1995, or perhaps even 2000.

The extent of anti-Americanism, largely fomented by student groups, is difficult to assess in South Korea, but it appears to have grown in intensity each year since 1985. This is particularly linked to a growing debate over the nuclear issue. The United States will not confirm or deny the presence of nuclear weapons in South Korea. It is generally thought that at least 150 U.S. nuclear warheads are deployed there, despite the unlikely event that they would be used in any conflict.

South Korea generally regards Japan with suspicion, although trade relations between the two countries remain strong. The beginning of 1989 saw a downturn in the South's shipbuilding industry, which has heavy investment from Japanese sources. Fishing agreements between the two countries have seen smaller quotas for the Japanese, but joint offshore oil development projects in the East China Sea appear to be going smoothly.

## Marine Science

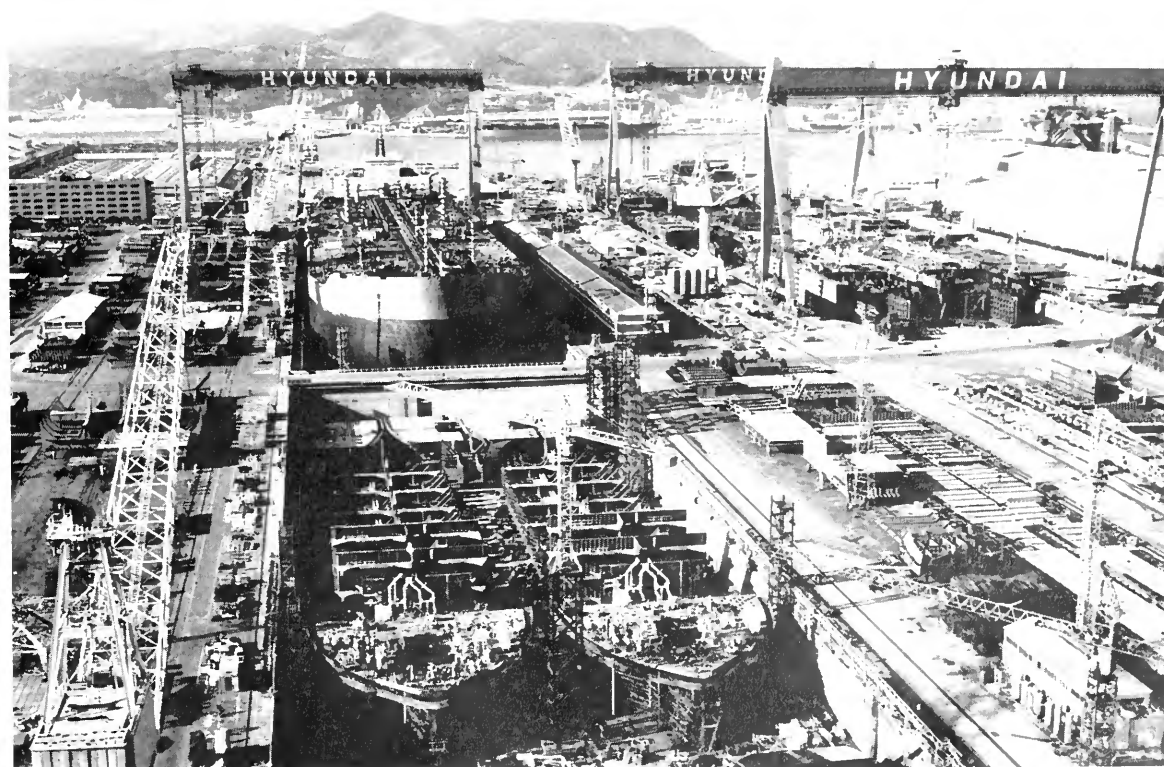
The Korea Ocean Research & Development Institute, with headquarters at Ansan near Seoul, engages in oceanographic research in the seas adjacent to the Korean peninsula. The institute also participates in a number of international programs, such as exploration with the United States for polymetallic manganese nodules in the Pacific, and maintains a station in Antarctica.

The domestic focus of South Korean marine science is on aquaculture and mariculture, tidal

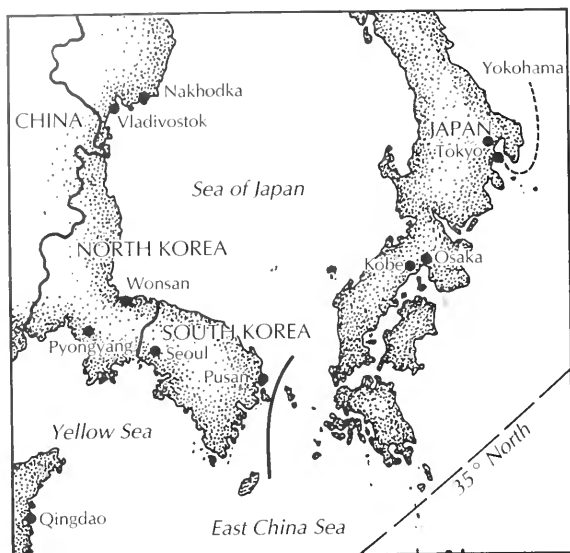




*Pusan is the second-largest city and principal port of South Korea. (Courtesy of Korea National Tourism Corporation)*



*Ulsan is also a port city, and is home to Hyundai Corporation's shipbuilding facility and automobile plant (not shown). (Courtesy of Korea National Tourism Corporation)*



about 40 Korean carriers owning 988 vessels, exclusive of fishing vessels. Their gross revenues for that year were \$2.4 billion. Korea's shipbuilding and repair industry, although expected to face reduced capacity in the coming decade, generated about \$2 billion in gross revenues in 1987, and accounted for 55,000 jobs.

In 1987, the government passed the "Basic Act on Marine Development and Law." This act is aimed at contributing to the enhancement of the national economy through marine resource development. It established a committee chaired by the Prime Minister to work out a long-term development plan. One result is a plan for an artificial island at Pusan similar to the Japanese island at Kobe that is now one of the largest container-ship facilities in the world. The size of the Korean island will be much larger than that at Kobe, which was built 16 years ago.

In addition to the "northern policy" mentioned earlier, the present government is also pursuing a "West Coastal Zone Development Policy" to spur the development of ocean resources. The west coast is considered to be the most favorable area for land reclamation projects. It is an area, too, that has been largely neglected during the rapid economic development of the last two decades.

Historically, ties between the west coast of South Korea and the east coast of China have been very strong in terms of trade and maritime transportation. South Korea's exports and imports with China have quadrupled since 1981. In 1987, trade amounted to \$1.1 billion. □

power generation, environmental protection and pollution assessment, and coastal zone management

Founded in 1973, the institute plans to augment its present research fleet with a large research vessel and a new mother ship for its manned submersible *Haeyang 250* early in the 1990s. The institute is active in biological, chemical, and physical oceanography, plus geology, ocean economics, environmental engineering, marine biotechnology, and policy studies connected with the Law of the Sea. In 1989, the institute had a staff of 199 people. Plans call for 501 by 1991.

### South Korean Ocean Policy

"South Korea is really a geopolitical island," explained Seung-yong Hong, head of the Ocean Policy Department affiliated with the Korea Institute of Science & Technology, and a visiting Research Fellow at the Woods Hole Oceanographic Institution. "It is surrounded by three seas and North Korea. Thus it is a maritime nation with high socioeconomic potential for the oceans under its jurisdiction." South Korean ocean policy is primarily focused on coastal zone development, offshore oil and gas, shipbuilding and shipping, fisheries, and marine mineral resource development.

In 1987, the Korean ocean sector accounted for 9.5 percent of the gross national product (GNP), or approximately \$11 billion. By comparison, the U.S. ocean industry in the same year contributed 2.6 percent to the GNP. South Korea hopes to increase its ocean industry revenues to \$22 billion by the year 2000, and \$39 billion by 2010.

Fisheries account for a large portion of the GNP figures. In 1987, the figure was \$3.2 billion, of which \$1.7 billion represented exports. The fishing industry provides 255,000 jobs.

More than 161 billion tonnes in foreign trade is annually conveyed by sea. In 1987, there were



*Hongdo Island is part of the South Korean Archipelago National Park. (Courtesy of Korea National Tourism Corporation)*



## Still a Bitter Sea

"We have no past, no present, and no future," a Shanghai resident said, shortly after the tragic events of 4 June 1989 in Tiananmen Square in which demonstrators for a greater measure of socialist democracy met the harsh realities of the Communist dictatorship's club and bullet. The forces of science and technology played a role in these

*Above, Mikhail Gorbachev, Deng Xiaoping, and Raisa Gorbachev at the May 1989 summit meeting in Beijing. (Tass/Sovfoto)*

---

**T**he Sea's a right bastard but wonderful too. Don't think of it as blue. It can be any color—red, white, blue, yellow—beautiful colors people ashore could never imagine. If you've never been to sea you've never lived. You're just tied to your hand-basin.

—A sailor from Shanghai  
*In Chinese Lives: An Oral History of Contemporary China*

---

events that saw China once again take two steps backward after a decade of a giant step forward.

Radios, computers, fax machines, satellites, and a decade's worth of jet-setting tourists, plus the more than 40,000 Chinese students and scholars studying in the United States, are just a few of the forces of science and technology that have influenced the economic progress of China and spawned desires for a greater measure of democracy.

As historian Paul Kennedy has remarked in *The Rise and Fall of The Great Powers*, "It is only a matter of time" before China exerts its influence as a great economic power. When that time arrives, quite possibly sometime in the Pacific Century, the Middle Kingdom will dominate world events.

The China of today has an enormous task before it. Economic reform has brought about rampant inflation, which in turn has brought an added measure of bitterness to an ever-increasing sea of discontented humanity. (Inflation figures in 1988 ranged from 18 [official] to 36 [unofficial] percent, although figures in late 1989 indicated a slowing trend.) A two-tiered money system has created a rampant black market and a way of life whereby quality foreign and domestic goods are only available to those who deal in the black market. This system breeds widespread corruption.

While applied science in China has been treated fairly well, especially in space applications, basic science has been neglected during the last few years. Nowhere is this more true than in the marine sciences, where mariculture enhancement and offshore oil and gas development are often priorities—and are expected, where profitable, to fund minimal basic research efforts.

The top pay for a senior marine scientist is in the neighborhood of \$80 a month. No wonder many Chinese exist to send their children abroad for advanced study. Few return, even though China desperately needs and counts on this trained cadre. A recent study by the Chinese Academy of Sciences found that funds for basic research decreased by 13 percent every year between 1985 and 1987. During the same period, inflation was very high.

### Strategic Considerations

In broader terms, China represents a pivotal strategic country in the region for the United States on the Asian economic/military chessboard. The largest share of the world's population resides within its borders, so it has great potential for U.S. manufacturers. By the same token, an economically thriving Soviet Union and China could subjugate

the Pacific Region almost at will, without firing a shot. Only the treaty obligations of Japan and the U.S. would seriously stand in the way. It is no secret that little love is lost between China and Japan, and for that matter, between the Soviet Union and Japan, despite increasing economic ties. Vivid recollections of Japanese militarism weigh heavily on all sides.

The spring events in China served to push that country closer to the Soviet Union. Indeed, it can be argued that Gorbachev was the big winner of the May summit, which brought the two countries' leaders into closer contact after two decades of discord. Certainly, the Tiananmen Square blood-bath conveyed a message to politically astute Russian citizens—that you can only push democratic reform in the Communist system so far. This lesson was forged in the streets of Hungary and Czechoslovakia in the 1950s and '60s. Recent events in Eastern Europe, however, indicate that the desire for democratic reform can no longer be suppressed by force, at least in some bloc countries.

The Tiananmen Square events have given the army a greater role to play in the political future of the country. Whoever emerges as the country's leader after Deng Xiaoping will need the support of the military.

Militarily, the Chinese People's Liberation Army, which includes the Navy and Air Force, has approximately three million men under arms, although reductions are reportedly being made. There are signs that China has ambitions to project itself eventually as a sea power.

Historically, China has confined itself largely to being a coastal marine nation. In 1436, an imperial order banned the construction of seagoing ships, and Cheng Ho's great "blue water" warships were laid up to rot. Today there is talk of constructing an aircraft carrier, and Chinese fishing boats have been active off the African Coast for the last 4 years.

According to a professor at the U.S. Naval Academy, China had only one or two ships in 1974 that could transport troops. By 1981, their ships could handle a regiment of 7,000 men. In 1988, their capability was a whole division, or approximately 20,000 men.

After the Sino-Soviet summit in May of 1989, in a display of old-fashioned show-the-flag diplomacy, U.S. warships pointedly visited Shanghai, while a Chinese destroyer made a historic first port call in the United States. All this is remarkable, when you consider that ancient China gave the world gunpowder, the compass for navigation, paper, and printing. And, oh yes, the rudder to steer by, later followed by the Great Helmsman (Mao).

While China's defense posture is geared to preventing a massive Soviet attack across its northern borders, the Chinese recently became concerned about Soviet encirclement by sea. Under Chairman Mao's relatively recent leadership, Chinese coastal cities were thought to be "pots and

---

The enemy approaches, we retreat.

The enemy halts, we move in.

The enemy tires, we attack.

The enemy retreats, we pursue.

—*The Mao Credo of Guerrilla War*

---

I'm doing my bit for society so I guess I haven't wasted my life. I've got a stake in socialism. As I said, I just go along with the mob, so I guess I feel the same as everyone else: the country has a future. We're all in it together. I'm not touting any party line, it's really what I think. Give me a bit of credit. You shouldn't take all that badmouthing I do too seriously—deep down I know what's what. Only the Communist Party can pull things round. Real Communists are okay. I can't make any comparisons. There are tons of other young workers like me about. Some are more political than me, others worse. I'm just Mr. Average.

—In *Chinese Lives: An Oral History of Contemporary China*

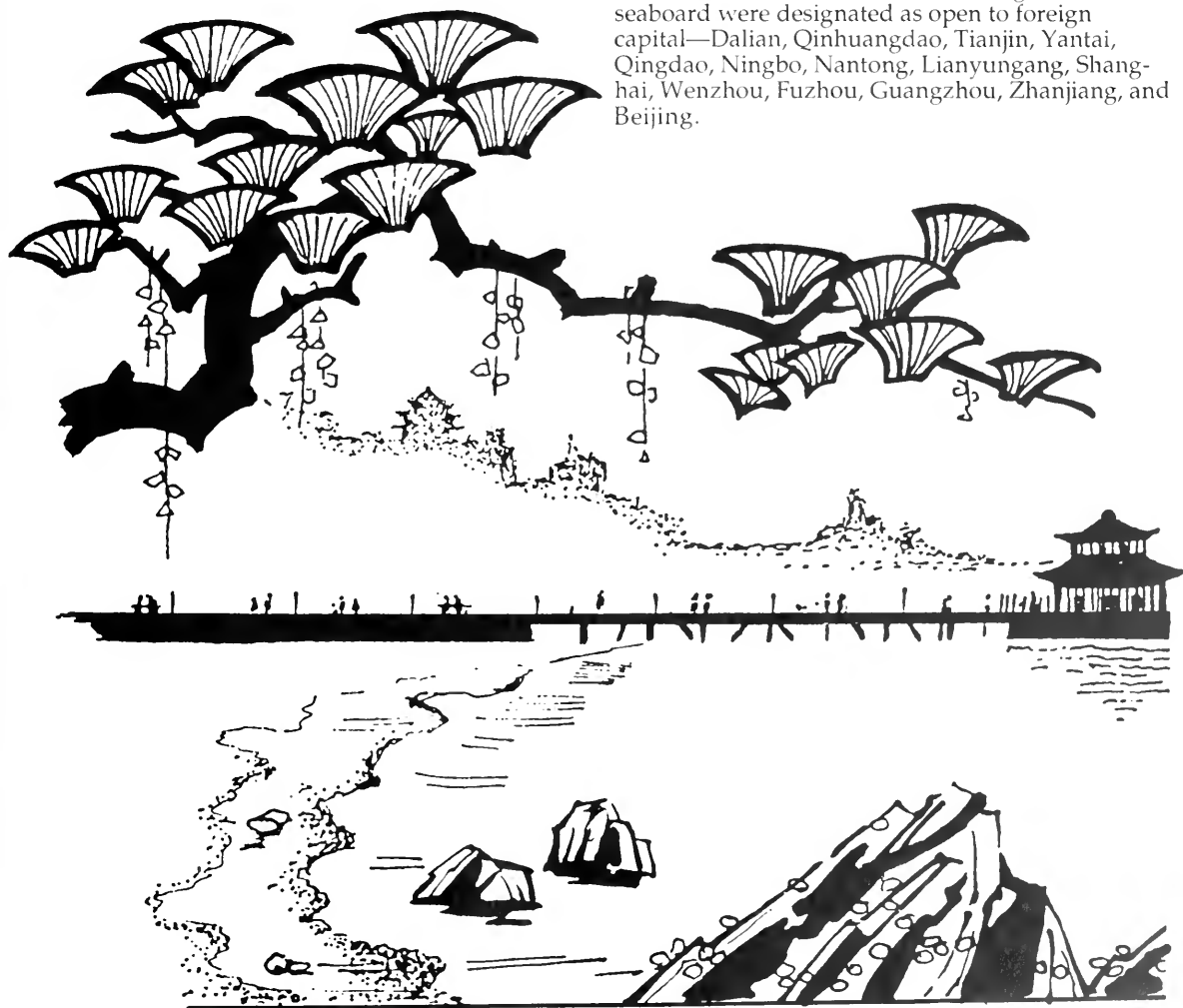
pans" that could be surrendered in a protracted war. But today China's coastal zone is divided into five special economic zones (SEZs) that are at the forefront of the nation's modernization drive.

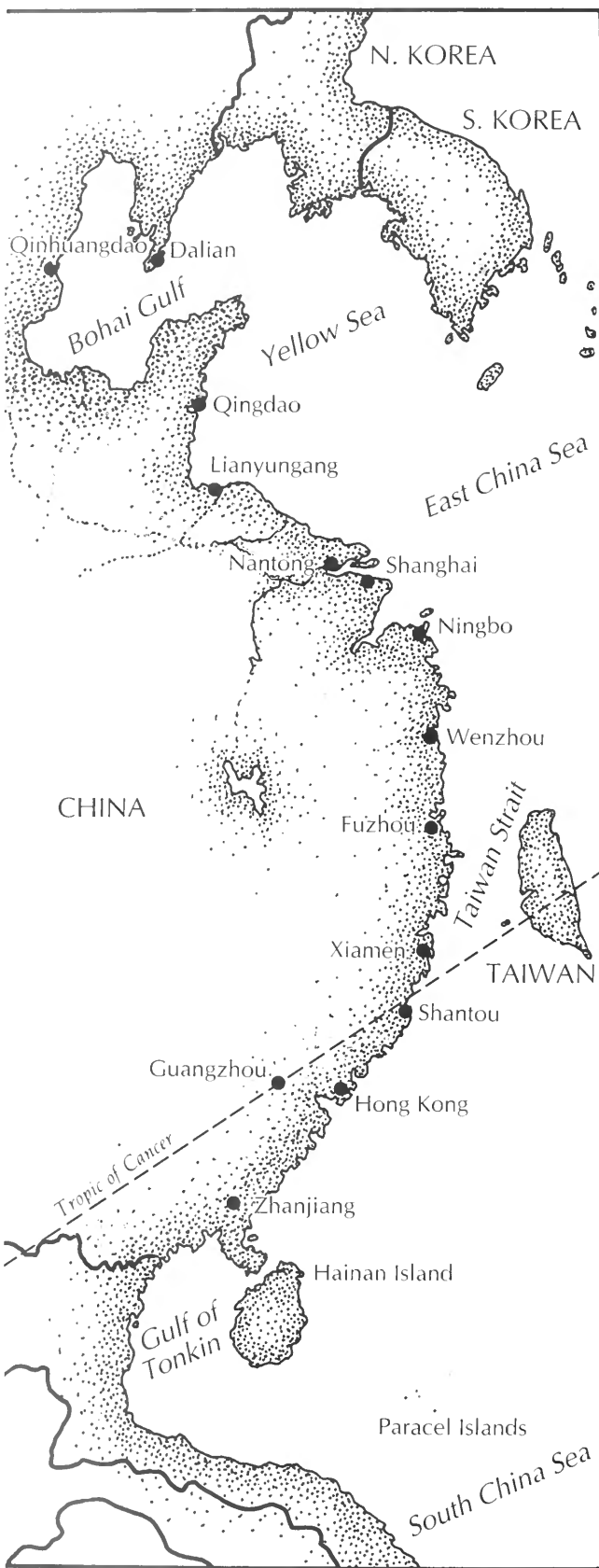
### Emphasis on Coastal Economic Regions

Four of China's SEZs were established in 1979. They are located around Shenzhen, Zhuhai, and

Shantou in Guangdong province, and at Xiamen in Fujian province. Early in 1988, Hainan Island was made a province and declared the fifth SEZ.

In addition, in April of 1984, China designated its coastal areas as prime regions for economic development. A large percentage of China's population lives in the coastal regions. The people there are among the best educated and most highly trained workers. Fourteen cities along the eastern seaboard were designated as open to foreign capital—Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Ningbo, Nantong, Lianyungang, Shanghai, Wenzhou, Fuzhou, Guangzhou, Zhanjiang, and Beijing.





Also, in 1985, three river deltas, one in Guangdong's Pearl River area, Fujian's river triangle, and Shanghai's Yangtze River region were designated economic zones. These coastal cities and river deltas, although not having the same status as the SEZs, are allowed the same low taxation rate (15 percent) for projects involving foreign investment.

### The Chinese Navy

The People's Republic of China keeps a wary eye on the Soviet naval presence in Vietnam (about 20 warships on average), particularly at Cam Ranh Bay, but also at Da Nang. Vietnam still has 1.2 million men under arms, and is considered by China to be its number-one enemy. Each side has about 300,000 troops stationed along their common border.

According to U.S. Navy analysts, the primary threats to China posed by the Soviet Navy include strategic strikes by Soviet nuclear submarines, bombardment and blockade of coastal cities, and cutting China's lines of communication with the West. A former U.S. Secretary of the Navy, John Lehman, Jr., has written that the United States sold China four of its sophisticated Mark 46 torpedoes in 1985, which are used mainly to destroy other submarines. It also has been reported that discussions have been held with the Chinese on the refitting of destroyers and cruisers with anti-submarine warfare equipment.

China's limited budget is the biggest stumbling block to naval modernization—that and a navy that at the highest levels is really controlled by army generals. The Chinese Navy, however, ranks third in the world in terms of manpower, and has approximately 2,000 ships, mostly coastal patrol craft that cover 18,000 kilometers of coastline. A flourishing economy most likely will mean a greater share of the Gross National Product (which showed a healthy increase of 11 percent in 1988) for the military and therefore the navy. Still, today's coastal forces are sizable (see table, page 30).

In the 1980s, the Chinese navy began to upgrade its fleet. It now has 115 submarines with great range and offensive capability, plus 19 missile destroyers. In addition, it has 34 frigates assigned to protect increased overseas shipping, plus 9 large tankers that allow operations far from Chinese coastal bases. Chinese naval vessels have been spotted recently in the North and South Pacific, as well as near Antarctica and in the Indian Ocean.

Added to this has been the rapid growth in recent years—17 percent in the past 20 years and 25 percent in the last 10—of China's merchant fleet. In 1977, it ranked only 14th in the world in terms of the number of ships; today China is fourth.

### Coastal Resources

In terms of its coastal resources, there is good news and bad news. The good news is that offshore oil finds are on the increase, promising increased revenue in the future for both China and foreign



*Above, Chinese navy on maneuvers. At left, marines in formation at dockside. (Eastfoto)*



*At left, workers examine clams that produce big pearls at the Lingshui Pearl Farm on Hainan Island, Guangdong Province. Below, a view of Shanghai's shipbuilding industry at the Jiangnan Shipyard. (Eastfoto)*





*Researchers from the Aquatic Products Research Institute in Shandong Province check scallops bred in coops on a marine farm. (Xinhua News Agency)*



## Bathtub Nights

*My visit to China was very rewarding from both a professional and cultural point of view. We visited many temples, the Forbidden City, the Great Wall, and the Ming Tombs. Night found us at the Peking Opera, and at the acrobat theaters in Shanghai and Beijing. In addition, we visited Peking University.*

*One particularly bitter cold night in Qingdao found Ruthann [my wife] wrapped up in blankets in the bathtub where she slept despite the leaking ceiling because it was the only room with heat thanks to the hot water pipes. The wind came right through the cracks in the windows of our room on the 11th floor of a relatively new hotel (about 10 years old).*

*But our real introduction to the old China was a 30-hour train ride from Qingdao to Wuhan, where we visited the Institute of Hydrobiology and saw the rare Yangtze River freshwater white dolphins. Our train adventure would make a book in itself. Except for a Chinese from Hong Kong, we were the only foreigners on board.*

—PRR  
*From a report to the Fulbright Commission.*

### The Strength of the Chinese Navy

<b>Total Personnel:</b>	300,000
Coastal Defense Force	38,000
Marine Force	4,500
Naval Air Force	30,000
All other forces	227,500
<b>Submarines:</b>	115
Strategic	1
Tactical	113
Trial Missile Launching	1
<b>Destroyers:</b>	19
<b>Frigates:</b>	34
<b>Coastal combatant craft:</b>	~430
<b>Corvettes:</b>	~10
<b>Missile craft:</b>	235
<b>Torpedo craft:</b>	~185
<b>Patrol craft</b>	~420

#### DEPLOYMENT AND BASES

- North Sea Fleet:** Coastal defense from Korean border to south of Lianyungang.  
Bases: Qingdao (headquarters) Dalian, Huludao, Weihai, Chengshan. Nine coastal defense districts.
- East Sea Fleet:** Coastal defense from south of Lianyungang to Dongshan.  
Bases: Shanghai (headquarters), Wusong, Dinghai, Hangzhou. Seven coastal defense districts.
- South Sea Fleet:** Coastal defense from Dongshan to Vietnamese border, plus Paracel and Spratly Islands.  
Bases: Zhanjiang (headquarters), Shantou, Guangzhou, Haikou, Yulin, Beihai, Huangpu, plus Paracel and Spratly outposts. Nine coastal defense districts.

SOURCE: *Asia 1989 Yearbook*, Review Publishing Company Ltd., Hong Kong.

companies (see box, pp. 32-34). These companies are risking large sums in the development of these fields, mostly in the East China Sea, the Bohai Gulf area, at the mouth of the Pearl River, and around Hainan Island in the South China Sea.

The bad news is that domestic consumption of oil is on the increase, necessitating a cutback in exports. News of major oil and gas finds on land in interior provinces is being reported frequently in the Chinese media.

As far as nonfuel resources are concerned, there are many seashore placer zones along the coast and some 120 known deposits in them. Economic minerals are mainly zircon, ilmenite, monazite, rutile, and diamonds. Liazhou Bay in northeastern Shandong Province holds particular promise for placer gold because some 200 gold deposits have been recorded in the nearby area.

Many fisheries in the Bohai Gulf, the Yellow Sea, the East China Sea, and the South China Sea are dwindling. Scientists in China's Environmental Agency say pollution is the main cause of the dwindling harvests, although overfishing remains a close second. Industrial waste products are prime culprits. On the plus side, some mariculture on land is thriving, especially scallop and prawn culture in the Qingdao area.

The dwindling pelagic and demersal stocks are causing China to reevaluate its fishing agreements with neighboring countries, particularly Japan and South Korea. Japan, a nation that counts fish as one of the mainstays of its diet, is finding that its distant-water fisheries are under severe pressure from a shrinking ocean commons with the almost global move to a 200-nautical mile Exclusive Economic Zone. At its newly established Institute of Marine Strategic Development Planning in Beijing, China is weighing the merits of a 200-mile declaration. They also would claim sovereignty beyond 200 miles, to the edge of the continental margin.

### Disputes Over Islands

China claims most of the islands in the South China and East China seas. The view of the Chinese People's Republic is that the natural prolongation of the land should determine ownership of the continental shelf. The East China Sea covers approximately 770,000 square kilometers and has an average depth of 370 meters. The South China Sea is five times bigger than the East China Sea and has an average depth of 1,212 meters because of a deep basin in its northeast portion.

In the East China Sea, the Senkaku Islands (in Chinese the Daiyutai, a group of several coral islands with large offshore oil potential) are the subject of dispute between China, Japan, and Taiwan. In the South China Sea, the Paracel Islands are claimed by China, Taiwan, Vietnam, and the Philippines, while the Spratly Islands are also claimed by these four states, plus Malaysia and Brunei. In mid-March of 1988, Chinese and Vietnamese naval vessels became engaged in battle when the Vietnamese vessels tried to land troops on one of the Spratly islets. The Vietnamese vessels were sunk in the engagement.

Some members of the Institute of Oceanology, Academia Sinica, at a banquet in Qingdao, China. Front: J. Y. Liu, immediate past-Director of the institute and Senior Scientist of Marine Biology; the author; C. K. Tseng, former Director and graduate of Scripps Institute of Oceanography; Ruthann, the author's wife; and Y. S. Qin, current Director. Back: anonymous public relations interpreter; Gao Liang, Associate Professor of Geology; and S. H. Wang, public relations interpreter. (Courtesy of author)



Perhaps the single most important issue between China and the United States is the question of the future of Taiwan. With the Chinese patiently waiting for the return of Hong Kong in 1997 from the British, and Macao in 1999 from the Portuguese, it would seem that Taiwan might eventually succumb to pressures for reunification with the mainland as well.

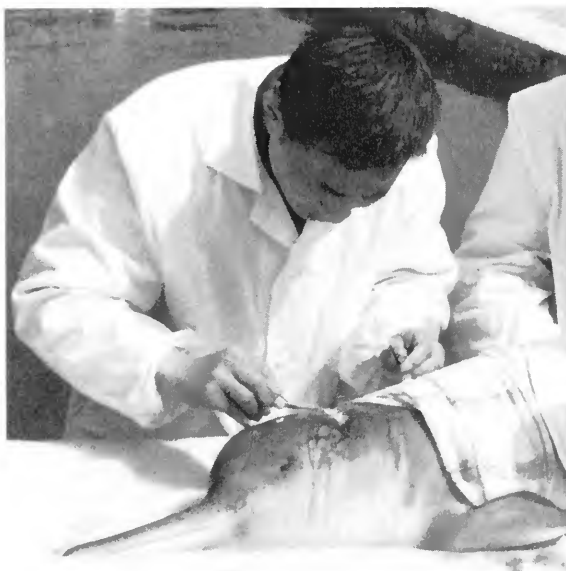
Taiwan, now the 12th-largest trading partner in the world with foreign-exchange reserves approaching \$80 billion, was experiencing a thaw in its relations with the mainland before the Tiananmen events, but now everything is on hold. Some travel restrictions had been removed in 1988 and early 1989, and there were signs of increased informal trade (through Hong Kong), now in the vicinity of \$2 billion a year.

China wants the United States, whose involvement with the island's future extends back to the days of Admiral Perry, to use its considerable influence to bring about peaceful reunification with the mainland. The Asian Development Bank suggested in 1988 that Taiwan change its name to "Taipei, China." This was quickly rejected by the Taiwanese government, which said it would never accept the notion of being a local government of China.

### The Three Gorges Dam

Environmentalists in China appear to have won a temporary victory after six decades of debate about building a dam on the Yangtze at Three Gorges. On 3 April 1989, the Deputy Prime Minister announced that the project would be postponed 5 more years to allow further discussion of its environmental consequences.

Proponents have argued that the dam will



Scientists from the Institute of Aquatic Biology dress the wound of a Yangtze freshwater river dolphin, or baiji, that was hurt during capture. These dolphins, about 300 in number, are threatened with extinction. (Eastfoto)

control flooding that in the last 60 years has killed 330,000 people and ruined numerous crops, and also provide much needed electricity, which is now in short supply for industry. Among environmental losses that would be sustained if the dam were to be built are the area's famous scenery, extinction of the sturgeon population, and the extinction of the already-endangered Chinese freshwater dolphin species. In addition, a million or so people would have to be relocated. □

# China's Exploration and Development

*Early in the 1960s, China began exploring for oil high up on the mountains, down below under the sea, and buried under the plain. It was at that time that China first established its own offshore oil teams. China lacked capital for modern offshore oil equipment then, and its exploration team also lacked much necessary experience. In particular, owing to the conservative open-door policy of that time, it was difficult for China to obtain foreign expertise and information for offshore oil exploration and development. All of this affected the development of China's offshore oil industry.*

*Apart from some advanced offshore oil equipment imported during the mid-1970s, China relied basically upon its own resources for offshore oil exploration from the mid-1960s to the late 1970s. During that period, China drilled nearly 100 wells, mainly in the Bohai Gulf and the South China Sea; performed some seismic work; discovered some oil- and gas-bearing structures; and built several shallow-water wells, and offshore production and storage facilities.*

*It has now been 10 years since China began cooperating with foreign oil companies in offshore exploration and development, and the open policy has succeeded in bringing vitality to the development of China's offshore oil industry. By the end of 1987, there were three rounds of bidding, and various bilateral negotiations on external cooperation in the exploration of more than 150,000 square kilometers of sea area. China has signed 37 oil contracts and 3 geophysical exploration agreements with 45 companies from 12 countries. According to specific exploration and development needs, China National Offshore Oil Corporation has established four regional oil companies, four professional companies, and ten or more jointly operated contracting service companies.*

## **The Offshore Geology of China**

*The total area of the shelf of China is about 1.3 million square kilometers. According to our explorations, there are seven offshore sedimentary basins that have oil and gas potential. The*

*first three are in the Bohai Gulf, southern Yellow Sea, and East China Sea; and four—the Pearl River-mouth, Qiong Southeast, Yinggehai, and Gulf of Tonkin—are in the South China Sea.*

*There are seven hydrocarbon source-rock formations in these basins, and sedimentary depressions with good hydrocarbon generation conditions have been found in the Upper Paleozoic, Jurassic, Cretaceous, Paleocene, Eocene, Oligocene, and Miocene formations. The Cenozoic is better than the Paleozoic and Mesozoic according to the exploration data.*

*A number of oil- and gas-enriched structures have been found in areas of Liaodong Bay, Bohai Gulf, the East China Sea, the Pearl River Basin, and the Gulf of Tonkin. These areas are large with numerous drillable structures, but most of them have not yet been drilled.*

*Other favorable areas yet to be explored include the Leizhou depression in the southern part of Bohai Gulf, the Nanbao, Beitang, and Qikou depressions in the western part of Bohai Gulf, the East China Sea basin, the Dongchao depression in the Pearl River basin, the southeast Hainan basin, the western part of Yinggehai basin, and southeast part of the Gulf of Tonkin. Geological and geophysical data suggest that there are good source-rocks and traps of various types in those areas, thus providing basic conditions for large and medium oil- and gas-fields.*

## **Bohai Gulf Basin**

*The Bohai Gulf basin comprises about 70,000 square kilometers of water with a depth of 20 to 30 meters. Its deepest point is about 70 meters. The Shengli oilfield is connected with Dagang oilfield, both are in the southern Bohai, and are tectonically related to the Liaohe oilfield.*

*Preliminary estimates indicate that more than 93 billion tons of hydrocarbon may have been generated in the Bohai source-rocks. The oil and gas generated in the Bohai has not migrated very far, although many channels exist for lateral migration of oil and gas. Because of the many tensional faults in the area, favorable conditions exist for vertical migration of oil and gas. Thus, oil and gas are*

# of Offshore Oil and Gas

*distributed widely in the Bohai Gulf basin.*

*Recently, several high-production wells have been found in Liaodong Bay, among them, one has an average daily production of about 630 cubic meters of oil and 500,000 cubic meters of gas.*

*The Chengbei oilfield has a geological reserve of 26 million cubic meters and a recoverable reserve of 5 million cubic meters. It is expected to produce for 15 years with an annual output of 0.44 million cubic meters. Two areas of the oilfield are connected by a 66-kilometer subsea pipeline. Thus the crude oil produced in one area can be transferred to the other area and then be shipped out.*

## **Southern Yellow Sea Basin**

*The southern Yellow Sea basin is located in an intracontinental shallow sea of about 380,000 square kilometers in area. The oil-generation potential of the southern Yellow Sea has gradually become clear, and some crude oil and good source-rocks have been discovered in this large sedimentary basin. The potential source-rocks here are very thick, but not quite thick enough, so there has not yet been any commercial development in the southern Yellow Sea.*

*The author suggests that what has been called the uplift area would be a sound candidate for exploration because Upper Paleozoic, Late Cretaceous, and Paleocene source-rocks are within the reach of advanced drilling technology. Other potential oil- and gas-bearing zones in the southern Yellow Sea are the Paleozoic and Triassic formations that lie below the Cenozoic basin. These formations are in turn composed of three sets of oil-generation, -reservoir and -capping formations.*

## **The East China Sea**

*The East China Sea is a shelf sea between Asia and the Pacific of about 770,000 square kilometers in area. It is wide—600 kilometers—in the north, and narrow—340 kilometers—in the south, with an average water depth of 72 meters. There are marginal trenches, submarine canyons, and a series of normal faults in the sea that form a terraced relief.*



A marine oil-drilling derrick being built at the Dalian Shipyard in Northeast China. (Eastfoto)

*Drilling data reveal that the continental shelf basin is characterized by broadly distributed source-rocks, a high abundance of organics, and shallow oil-generation sills. The five searchwells already drilled reveal a great number of oil- and gas-bearing formations. Two of the five wells produced industrial oil and gas, and all fully demonstrate the hydrocarbon prospect of the East China Sea shelf basin.*

*Recently the petroleum resource exploration in the East China Sea has drawn much attention the world over because the East China Sea shelf basin is large, and its developed depressions are rich in organic materials*

(Continues on next page)

favorable for oil and gas generation. There are numerous Tertiary, Mesozoic, and even Paleozoic potential source-rocks; good reservoirs; and many large structural traps in the basin. Oil and gas exploration and development in the East China Sea are very important to the economic development of East China.

#### **Pearl River Basin**

The Pearl River basin is on the northern shelf of the South China Sea, and covers about 170,000 square kilometers. The water in the basin is shallow in the north and deep in the south. The sediments are mainly Cenozoic, with a total thickness of more than 10,000 meters.

The basin is characterized by "double-decker" structures, which, because of their large scale, perfect closure, and encirclement by hydrocarbon sources, are the main oil-bearing traps in the basin. Sixteen oil and gas fields have been discovered in the basin. The Cenozoic sediments have good source-, reservoir-, and cap-rocks, as well as favorable hydrocarbon traps.

The major characteristic of hydrocarbon accumulation in the Pearl River basin is that hydrocarbon expelled from Eocene source rocks migrated through various paths up to the cap-rocks, and then continued to migrate laterally for long distances toward massifs. Most of the hydrocarbons should have migrated toward massifs, and be trapped there in drape structures, reefs, and carbonate banks.

#### **Qiong Southeast Basin**

The Qiong Southeast basin is on the southwest part of the northern shelf of the South China Sea, near Hainan Island. The basin covers an area of 36,400 square kilometers, with sedimentary rocks to a thickness of more than 10,000 meters. There are four sets of source rocks and three types of reservoirs in the basin, along with generating, bearing, and capping combinations of different types, and numerous traps of different kinds.

A big gas field was discovered in the basin by ARCO China, Inc. in one of the eight wells they have drilled since 1983. The field is

located in 100 meters of water about 100 kilometers south of Hainan Island. It is classified by world standard as a super-giant gas field. The gas is essentially dry and sulfur-free.

#### **Yinggehai Basin**

The Yinggehai basin covers an area of about 50,000 square kilometers, and has Tertiary sedimentary rocks thicker than 10,000 meters, and two sets of source-rocks which may be good prospects for oil. Formerly, the Yinggehai basin was combined with Qiong Southeast basin as an integrated basin, so the basic geologic features and hydrocarbon-generation prospects of the Yinggehai are probably similar to the Qiong Southeast.

#### **Gulf of Tonkin Basin**

The Gulf of Tonkin basin covers an area of more than 30,000 square kilometers. Petroleum exploration activities are now mainly carried out in the central depression, an area of approximately 19,000 square kilometers, which appears to be a good prospect for oil and gas. The first exploration well, drilled in the early 1960s, discovered an oil-bearing bed. Afterward, eight wells were drilled in four different types of structures, and six of these wells in three of these structures obtained oil or gas.

During the last 4 years, 30,000 kilometers of high-precision digital seismic lines were recorded, and 20 exploration wells were drilled. In two high-yield wells in the Gulf of Tonkin basin, daily oil output was more than 1,300 cubic meters. Five hydrocarbon-bearing structures have been found, four of them may be developed. The geological petroleum reserves in the basin may be up to 100 million tons, and the associated natural gas reserves may be up to 10 billion cubic meters. From the study of general petroleum geology, the six oil and gas fields discovered already are evidence of the good potential for oil and gas development in the Gulf of Tonkin basin.

—Wang Longwen  
China National Offshore Oil Corporation  
Shanghai, China



## Japan:

The white chrysanthemum  
Even when lifted to the eye  
Remains immaculate.

—Matsuo Basho, 1644–1694

## The Chrysanthemum Curtain

---

Heaven says nothing, and the whole earth grows rich beneath its silent rule. Men, too, are touched by heaven's virtue; yet, in their greater part, they are creatures of deceit. They are born, it seems, with an emptiness of soul, and must take their qualities wholly from things without. To be born thus empty into the modern age, this mixture of good and ill, and yet to steer through life on an honest course to the splendors of success—this is a feat reserved for paragons of our kind, a task beyond the nature of normal men.

—Ihara Saikaku, 1642–1699, in *The Japanese Family Storehouse*

---

---

Subconsciously we have stored away in the back of our minds tags and ends of anti-Japanese statements, the while we have repudiated the conclusion based upon them. There is no question but that as a nation our former rather sentimental friendship toward the Sunrise Kingdom has cooled. Not knowing the best, we suspect the worst, and the background for a national sentiment is slowly crystallizing.

—James Francis Abbott, *Japanese Expansion and American Politics*, 1916

---

A foreign journalist stationed in Japan once remarked in jest that, "Japan is the only democratic country where communism works." As with the imbibing of much good wine, there is a certain amount of truth that trips from the tongue in the journalist's remark.

Japan has reached its status as an economic superpower precisely because the government has controlled the national will through a single political party for the last 34 years, and has subtly orchestrated the strategy of industrial recovery. As Clyde Prestowitz, Jr., points out in his insightful book *Trading Places*, in Japan power in matters of trade and international economic expansion rests more with the government ministries than with the politicians, particularly the Ministry of International Trade and Industry (MITI).

The Japanese Prime Minister turned to MITI in the spring of 1989 to forge an economic cooperation agreement with countries in the Pacific Region. Although Japan is today the world leader in pledging foreign aid, Pacific nations complain that Japanese pledges can often take several years to actually materialize. In fact, many countries are still waiting for funds pledged several years ago.

A U.S. version of MITI would incorporate many of the functions of the Commerce, Energy, Defense, and Justice departments, plus the Office of the U.S. Trade Representative, the Export-Import Bank, the Small Business Administration, the National Science Foundation, the Overseas Private Investment Corporation, and the Environmental Protection Agency. MITI is staffed with the brightest graduates produced by Japan's universities, particularly from Tokyo University, which might be compared to a combination of Harvard, Stanford, Berkeley, and our top engineering schools. MITI is imbued with the samurai spirit in which there is only one winner in any battle. It also essentially has been guided over the years by the same people who ran the industrial works both before and during World War II.

The political nature of Japan, however, is changing. The Liberal Democratic Party has been forced to field three different prime ministers in 1989 alone, in the wake of scandals and unpopular farm and tax programs. This has opened the door to the Japan Socialist Party for the first time in postwar history. A stronger role for the Socialists—long critical of Japan's treaty with the United States, champions of the government of North Korea, and

advocates of nationalization of some businesses—could add to the sense of malaise that permeates the relationship between Japan and the United States.

### Defense and Trade

The cornerstone of the relationship between Japan and the United States is defense. The core of this relationship can be found in the Mutual Security Treaty of 1951 in which they acknowledged that both countries share common strategic interests and objectives in the Western Pacific.

Today there is a tendency on the part of both nations to link defense and economic issues. A good example was the dispute over the FSX Fighter. Some members of the U.S. Congress thought they would be giving away vital technology to Japan. They feared it would both increase Japan's military capability and provide the ability to manufacture advanced commercial airliners that would be competition for U.S. aircraft companies.

We sometimes forget that the 1951 treaty allowed Japan to concentrate on economic revival while leaving defense of East Asia largely to the U.S. nuclear umbrella. For the United States, Japan represented a strategic barrier that could limit Soviet naval movement in the Pacific through the blocking of four key straits off the Japanese archipelago.

Japan also served, and still does, as a staging ground for deployment of U.S. forces to vital areas in times of conflict, as during the Korean War. During the postwar period, Japan built up a considerable defense force and now ranks between third and sixth in the world (depending on how you assess the figures) in yearly budget expenditure. This defense force—one is reminded of Mike Ditka's remark that the best offense is a good defense, a point proven time and time again by the Chicago Bears football team—consists of 50 destroyers (twice as many as in the U.S. Seventh Fleet) and almost 300 aircraft. The Japanese naval forces have a mandate to protect sea-lanes 1,850 kilometers from Japanese territory, which is beyond the range of satisfactory air cover.

The 1988 annual White Paper Report issued by the Japan Defense Agency stated the Maritime Self-Defense Force had embarked on the construction of an Anti-Submarine Warfare Center in Yokosuka to be completed in 1990. In the wry notice, it was stated that the new center was being constructed "to cope with the increasing quietness



of recent submarines." The sale of critical strategic parts by the Japanese Toshiba Machine Company, a subsidiary of the Toshiba Corporation, to the Soviets led to an uproar in 1986; the United States disclosed that the parts made Soviet submarines quieter and thus more difficult to detect.

There is a cry from some quarters in the United States that Japan should now share more of the defense burden in East Asia in light of its strong economic position in the world. I feel that would be a mistake. A large Japanese defense force would cause justifiable apprehension in China and the Soviet Union, not to mention among other nations in the Pacific Region.

While public sentiment in Japan is probably against any action that would increase the military capabilities of the country, a handful of politicians and MITI actually direct the destiny. In late May of 1989, a leading Japanese industrial organization, the Federation of Economic Organizations, urged the Japanese Defense Agency to increase to 5 percent from 2.1 percent the amount allowed in the military budget for research and development, to bring it on par with major western advanced countries. Federation officials took the position that Japan should develop its own defense technology instead of relying on the United States. At present, the total Japanese defense budget is slightly more than 1 percent of the gross national product, compared to 6 to 7 percent in the United States.

### Politics and the Feudal Past

In April of 1989, Japanese Prime Minister Noboru Takeshita resigned after a poll pointed to support by only 3.9 percent of the public. The public's disenchantment was the result of a bribery-for-favors scandal that reached into nearly all corners of government—the worst such scandal in Japan's postwar history.

In a sign that Japan's feudal past lies just below the surface of everyday events, Takeshita's personal secretary for 30 years committed suicide after the resignation in what was generally interpreted as an honorable act to atone for his master's disgrace. A year before the suicide, the aide, Ihei Aoki, left a telling message in his high school alumni newsletter: "Behind the scenes of this peaceful democracy are the same bloody power struggles to the death that were waged time after time by medieval warlords."

An interesting detail reflecting on how badly informed the U.S. government is on matters in Japan appeared in the *International Herald Tribune* of April 27 when a *New York Times* correspondent wrote that Takeshita's resignation caught U.S. officials off guard. "The U.S. Embassy in Tokyo had been telling officials in Washington that Takeshita would survive because he was a wily, experienced politician and because there was no obvious candidate to succeed him." There is obviously a need for improved political weather forecasting in this part of the world.

The Japanese penchant for copying and improvement extends to politics. In the case of

Prime Minister Sousuke Uno, it was a copy of the Gary Hart syndrome. The Prime Minister fell when a part-time geisha described her relationship with the married father of three children.

The geisha labeled the Prime Minister as "pompous, crude, vain, and by Japanese standards cheap." He paid her only \$2,300 a month to live on. But his biggest fault—unforgivable—was that he failed to give her a parting gift when the relationship ended.

---

Japanese enjoy the solitude found in crowds. It's how we discover ourselves.

—Pachinko (Pinball) Parlor Operator

---

The Japanese imported pinball from America in 1920. It is now a national pastime called pachinko with parlors almost everywhere you look. The chairwoman of the Japan Socialist Party, Takako Doi, was recently named Pachinko Woman of the Year.

But pachinko parlors in Japan have been linked to the underworld and to the government in North Korea, which has reportedly funneled money through the parlors to support the Socialists. Many parlors are operated by Koreans. Pachinko money also has gone to support the present Prime Minister Toshiki Kaifu, a former Minister of Education.

### Social Questions

Japan is certainly an enigma. Its ambiguous nature is rooted in the language, where almost as much can be determined by what is not said as by what is. This is difficult for most westerners to understand, especially those in the United States who shun ambiguity and pride themselves on their ability to communicate with straight talk or clear prose. Because of the many subtle levels of politeness, you are never sure if you are dealing with the real face or the final mask in dealings with the Japanese.

A sign of the strong pressure in Japanese society to conform to the norm surfaced in May of 1989 in the press. Three teen-aged girls were suspended from school because they refused requests from their teachers to dye their natural red hair black, to conform with the majority.

The Americanization of Japan has been under way for some time. As Kamei Shunsuke pointed out in the January-March 1989 issue of the *Japan Quarterly*, "Many of the same problems plague both societies: the breakdown of social systems because of an unhealthy emphasis on technology without regard for the human factor; destruction of the environment; confused morals; insufficient welfare systems; a troubled younger generation; inadequate recognition of women's rights; and the needs of the elderly. The issues of industry and trade are self-

evident." As in China, some of the largest questions to be dealt with in Japan are what to keep and what to reject from the past.

### A Growth of Arrogance

The strength of nationalist sentiment in Japan is difficult for a foreigner to assess, but signs do appear occasionally in the press. In April of 1989, for example, it was reported in the *Daily Yomiuri* that a "head-on collision" was feared between U.S. and Japanese nationalists, or right-wingers, over the FSX issue. The Fellow Thinkers' Council on Fundamental Issues, a group of 43 nationalist policy makers within the ruling Liberal Democratic Party and members of the Japanese Diet, filed a petition with the Cabinet Secretary stating that Japan should develop the FSX by itself.

The head of the council, in a separate statement said, "The U.S.-Japan relationship is actually one of slave and master." Another comment heard was, "If the United States doesn't want to give the technology away, that's fine. We don't need it." A recent growth of arrogance has begun to bloom in Japan fed by the nutrient of economic prosperity.

Almost all government and business decisions in Japan are made by consensus, and he who commands the headlines commands the national consensus. Thus the press, which is essentially a handful of national newspapers, as opposed to America's many regional dailies, is subtly co-opted by ministries, such as MITI. Reporters assigned to cover MITI have formed their own press club, which identifies with the ministry. Leaks are fed to club members and some are appointed to councils and committees within the ministry in an advisory capacity. Thus the press becomes a tool in creating a national consensus for the measures proposed by the ministry.

Another example of media control was the Japanese TV coverage of the Emperor's death and subsequent funeral. The question of the Emperor's role in World War II was largely avoided. The average Japanese knows little about the everyday life of their Emperor, and the strict control of news about him is sometimes good-naturedly referred to as "The Chrysanthemum Curtain."

Some Americans think that the Japanese enjoy a higher standard of living than people in America. This is not so, at least by some American measurements. Most Japanese live in very small houses with minimal heating facilities. Many commute long distances to work (some administrators at the Japan Marine Science and Technology Center [JAMSTEC] where I was based traveled five hours a day to and from the office), and put in long hours on the job (many agreements are consummated in the social hours following the official work day).

Further, the cost of living is very high, especially for food. (Probably everyone has read about the \$40 melons, but I was surprised by the fact that the Prime Minister pays \$115 apiece for his ties.) In fact, when I sat down to think of one thing in Japan that costs less than in the United States, I drew a blank, although on reflection one can

perhaps buy an umbrella for less. Foreign goods are usually 30 to 50 percent higher than domestic brands, which makes it easy to understand why consumers largely buy Japanese products.

### The Northern Territories Issue

The greatest source of friction between Japan and the Soviet Union is over what Japan refers to as the Northern Territories. These territories comprise the islands of the Habomai Group, Shikotan, Kunashir, and Etorofu, and are situated off the northernmost island of Hokkaido. They have a total land area of 4,996 square kilometers.

On 9 August 1945, at the end of World War II, the Soviet Union entered into a state of war with Japan. By the beginning of September of that year, Soviet troops had occupied both the Kuril Islands and the Northern Territories. Some 16,000 Japanese citizens lived in the Northern Territories at the time of occupation. Waters around the disputed islands abound with various species of fish and other marine products and the islands are said to be rich in sulfur, silver, and gold.

For the Soviet Union, however, the islands represent a strategic area for the passage of warships (430 passages through the Soya Strait in 1988), particularly submarines, into the Pacific Ocean. The Soviets also have military bases and airfields on three of the islands—Shikotan, Kunashir, and Etorofu—which they have been reinforcing in recent years.

In early 1989, there were reports of backdoor negotiations on this issue whereby Japan would get back two of the four islands in exchange for an undisclosed amount of money. Japan's legal claim to the islands involves the Yalta Agreement of 11 February 1945, the Potsdam Declaration of 26 July 1945, and the San Francisco Peace Treaty of 8 September 1951. The U.S. position on the islands fluctuated until 1956 when it took the legal position that the territories, indeed, belonged to Japan. It reiterated this position on 23 May 1957 after a U.S. plane was shot down by the Soviets over Hokkaido.

Recent events in Eastern Europe have been applauded by Japanese officials who sense economic and political advantage in the new liberalization trends. Should the Soviets and Japanese now reassess their position and come to some sort of accommodation on the Northern Territories issue, popular Japanese sentiment might swing toward the Russians and away from America.

Ultra-conservatives in Japan are so irritated by American trade pressures that, despite being strong anticommunists, they now advocate more cooperation with the Soviet Union, including the sharing of advanced technology with military applications. A strong Japanese-Soviet alliance would give Tokyo considerable leverage in its trade negotiations with Washington.

### Fisheries Under Pressure

Japan's fisheries, especially its "blue water" fleet, are under heavy pressure. The long-distance fisheries are decreasing because of recent actions by the



*Above, tuna inspectors cut into their work at Tsukiji, Japan's largest fish market where workers process about 1,815 tonnes of tuna daily. (Photo by William Andress) At right, another worker cuts tuna for market. (Photo by Richard B. Levine)*

Soviet Union and the United States to limit foreign fishing within their 200-nautical mile zones. Perhaps as a result of this pressure, the imports of fishery products in Japan in 1987 were the highest in recorded history, reaching 2.08 million tonnes. Meanwhile, domestic fisheries production, mainly in offshore areas, continued to grow along with coastal fisheries and mariculture efforts.

Japan now accounts for more than 30 percent of the world's imports and is the largest importer of fisheries products. The United States is second in imports. The two countries account for 50 percent of the world's imports value. In Japan, the per capita seafood consumption is more than 36 kilograms per year, compared with 6.8 in the United States.

There is considerable friction between the United States and Japan over salmon and tuna fisheries, and the hunting of whales for "scientific research" (see *Oceanus* Vol. 32, No. 1, pp. 45-51). The Japanese driftnet fishery for squid has a high incidental catch of porpoises and North American salmon. South Korea and Taiwan also have driftnet fisheries (see article, pp. 60-64).

Japan has a territorial sea of 12 nautical miles and a 200-nautical mile fishery zone. It has not formally declared an Exclusive Economic Zone.





*The author and Japanese colleague finish inspecting a new manned submersible, the Shinkai-6500, at Mitsubishi's Kobe plant. The submersible is the deepest-diving manned vehicle in the world, capable of working at 6,500 meters, giving it access to 98 percent of the world's seafloor. (Courtesy of author)*

## Marine Science

Japan is clearly the leader in the Pacific Region where marine science is concerned. In the spring of 1989, it put the world's deepest diving manned submersible, the *Shinkai-6500* through sea trials, along with its new mother ship, the *Yokosuka*. Both are state-of-the-art vessels, operated by JAMSTEC, giving Japan access to 98 percent of the world's ocean floor.

There are joint-project proposals now in the wind between Japanese and Americans for the construction of a fleet of manned submersibles with 11,000-meter capability. The possibility of Japan building a drill ship with greater capabilities than the *JOIDES Resolution*, America's deep-ocean drill ship that has collected invaluable information on the origin of ocean basins, also has been floated. The Japanese operate the world's largest SWATH (Small Waterplane Area Twin Hull) vessel as a research platform because of its stable characteristics. (Where a single-hull ship will roll 30 degrees in heavy seas, the SWATH vessel rolls only 5 degrees.)

Japan—a nation of 140 million people crammed into basically four islands smaller in size than California—also is the world leader in innovative use of ocean space, ranging from artificial islands as ports (Kobe) to international airports (Osaka), and offshore power plants and energy storage facilities (see *Oceanus* Vol. 32, No. 3, and Vol. 30, No. 1). Fishery enhancement designs are constantly being upgraded and experimental facilities (Toyama Bay) are testing the twin concepts of ocean thermal energy conversion (OTEC) along with harnessing the deep-water upwelling of nutrients for both electric power and enhancement of mariculture farms ashore.

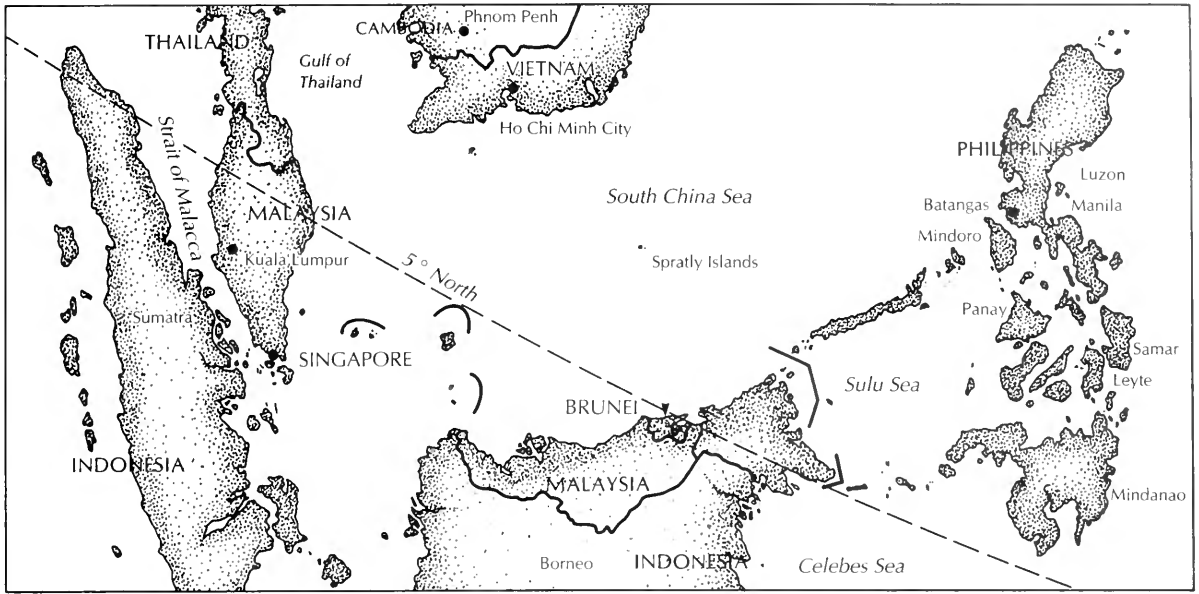
In the key area of direct funding of research and development (R&D), the Japanese government plays a smaller role than that of the United States. In 1986, the Japanese government contributed 21 percent of all R&D funds, compared with 48 percent in the United States. Japanese industry provided 69 percent of all R&D funds in that year compared with 48 percent by U.S. industry. Industry thus plays a more dominant role in science R&D in Japan.

JAMSTEC, however, has experienced a sharp decline in industry funding to the point where it gets most of its funding today from the government.

Japan also places a greater emphasis on engineering training than we do in the United States. In the 22-year-old bracket, 4.4 percent of the graduate population received engineering degrees as compared with 1.9 percent in the United States.

## Shipbuilding Revival

The shipbuilding industry in Japan is experiencing a robust revival. Cruise ships are being built, along with tankers and hydrofoil vessels for a number of foreign owners at Sumitomo, Kawasaki, and Mitsubishi yards around the country. The industry had been in decline with Japan exporting its expertise to other countries where it was cheaper to build ships, such as China and South Korea. But now MITI has determined that the security of the nation again rests with its heavy industries, especially shipbuilding. □



# The Philippines

The Soviet Union appears to be increasing its influence with the Philippine government, a target of intense diplomatic initiatives. The United States, it would seem, is in danger of losing two of its key military establishments in the Pacific Region: Subic Naval Base and Clark Air Force Base. These two bases serve as training, transit, logistics, and repair centers. In the event of war in Asia involving American commitments, the bases most likely would be expanded to support military activities.

The United States now pays the Philippines \$481 million a year for base rights, plus aid packages that make the deal worth nearly \$1 billion a year. The agreement is up for possible review in 1991, with the United States reportedly seeking a 25-year term of renewal.

In March of 1989, the Philippine Department of Trade and Industry gave the Soviets permission to repair 120 of its fishing vessels in Philippine shipyards in exchange for approximately \$8.4 million. In the past, the Soviets had requested repair rights for its vessels at a shipyard near the U.S. naval base at Subic Bay, and U.S. officials had claimed the move would allow Moscow to gain intelligence about U.S. naval activities in the Pacific Region. Two shipyards, one a subsidiary of the state-owned Philippine National Oil Company and the other privately owned, are interested in doing the Soviet repair work on the central island of Cebu and in Batangas Province south of Manila.

On the one hand, Gorbachev has reportedly assured Philippine President Corazon Aquino that he is not supplying guns to the communist guerril-

las who contest control of about 20 percent of the countryside. On the other hand, captured Philippine Communist Party documents reportedly show that the Soviet leader would like to heal a long-standing rift that drove the party to seek Chinese aid while adopting a Maoist strategy that called for armed and political warfare.

## Prawn Exports Growing

Although the general economy is suffering from an external debt of \$29 billion even while expanding, there is good news on one front. The country's fastest-growing export is prawns, mainly to Japan. The Philippines ranked sixth in 1988 in terms of cultured prawn production, behind China, Ecuador, Taiwan, Indonesia, and Thailand. The Philippines exported \$207 million worth of fresh fish in 1987, a substantial increase over the previous year's total of \$143 million.

The U.S. Ambassador to the Philippines, Nicholas Platt, recently wrote: "Poverty remains widespread. Rural infrastructure must be rebuilt after years of neglect; roads, water, and air transport facilities desperately need rehabilitation to open economic opportunities for isolated regions. Lack of affordable power limits development in rural areas. Modern communications are almost nonexistent outside the big cities. Irrigation systems have been neglected. Rural water and sanitation are inadequate, and there are great needs in health and education." The ambassador went on to comment that the economic recovery now under way is not yet self-sustaining. Should it falter, he warned, anti-

democratic forces would gain the upper hand.

### Soviet Offer Assessed

A professor at the U.S. Naval Academy, Robert Rau, commented in Singapore in an interview with the *Straits Times* in the spring of 1989 that Gorbachev's offer to scrap Soviet bases in Vietnam if the U.S. were to pull out of the Philippines was a one-sided deal. The professor said the Soviet bases at Da Nang and Cam Rahn Bay provided the Soviets with an air capability for patrols in the South China Sea, and for the crews to rest and train.

Rau said the Soviets use Cam Rahn Bay as a stopover for ships in and out of the Indian Ocean, and for refueling and resupply. They also have stations there to track ships in the South China Sea.

But despite all this, Rau maintained that the Soviet presence in Vietnam was on a much smaller scale than the U.S. presence in the Philippines, which is intended not only to maintain the security of the Philippines and the United States, but also the member nations of the Association of South East Asian Nations (ASEAN)—the Philippines, Malaysia, Singapore, Thailand, Indonesia, and Brunei.

The professor stated that the U.S. bases in the Philippines, while important, could be moved to other locations in the Pacific Region. He indicated that all U.S. bases worldwide were linked financially since one country's negotiating position was often based on arrangements made with other countries and the United States had a financial limit beyond which it would not go. □

# ASEAN

The main diplomatic activity of the Association of South East Asian Nations (ASEAN)—representing Malaysia, Singapore, Thailand, Indonesia, the Philippines, and Brunei—is directed at seeking a solution to the strife in Cambodia. At the same time, officials are preparing to play a bigger military role in the defense of the area.

Plans reportedly call for Malaysia and Singapore to acquire new missile-armed warships and aircraft capable of protecting sea lanes in the South China Sea. And closer military contacts are forecast between Indonesia, Malaysia, and Singapore. These three nations border the Strait of Malacca, a key gateway to the Indian Ocean and a large factor in Soviet strategic economic and naval planning.

The countries of ASEAN view China with suspicion, whereas the West sees a strong and modernizing China as a counterweight to Soviet expansionism and a force for stability in the area. ASEAN nations see Chinese policy as motivated primarily by national self-interest with a threat of future military and economic aggression. Much of the fear of China has been generated by past support for guerrilla movements funneled through ethnic Chinese.

In Malaysia, for example, 33.1 percent of the population is ethnic Chinese. In Indonesia, the percentage is 2.8, and in Thailand, 13. Thus, the feeling of threat originates from the image of China as a latent giant, and from the real potential of influence through overseas Chinese and Chinese descendants. The ASEAN countries are also uneasy over Chinese claims of sovereignty over the South China Sea.

The Soviet Union, meanwhile, realizes that the ASEAN nations foster the concept of a "Pacific Community." The Soviets would like to forestall the

realization of such a concept because they believe the community would be centered on the United States and Japan. The Soviets believe that Indonesia and Malaysia are against such a concept, while Thailand and Singapore are for it. The Philippines have adopted a neutral stance, while Brunei has shown no interest.

### The Strait of Malacca

Nearly all commercial and naval sea traffic between the Indian and Pacific oceans, including oil supplies for Japan, pass through the Strait of Malacca, or through several deep-water passages among the Indonesian islands. ASEAN officials have stated their concern about Tokyo's growing self-defense force, which now is under a mandate to guard sea lanes out to 1,850 kilometers, a distance that extends almost to the northern Philippines. Similarly, officials are concerned about the intentions of Vietnam, the Soviet Union, and China in the area.

Noting the likelihood of a reduced U.S. naval presence in the Pacific Region in the future, due to fiscal restraints, a senior Malaysian naval official told a conference on ASEAN military cooperation in Singapore in the spring of 1989 that ASEAN navies should operate as a single task force if the situation

Ethnic Chinese Residents In Southeast Asian Countries in 1981

Country	Resident Ethnic Chinese	Percent Ethnic Chinese
Brunei	54,150	25.4
Burma	466,000	1.4
Indonesia	4,116,000	2.8
Malaysia	4,214,282	33.1
Philippines	699,000	1.5
Singapore	1,856,237	76.9
Thailand	6,000,000	13.0
Vietnam	1,000,000	1.9
Total	18,405,669	5.2



*An oil rig with living quarters, production platform, and wellhead platform (at end) in the Lalang oilfield. The Indonesian State Oil Company, Pertamina, contracted this island and surrounding offshore acreage in the Strait of Malacca to Hudebay Oil, Ltd. for commercial oil drilling. (Eurasia Media Co., Ltd.)*

demanded it. He proposed dividing the South China Sea into "zones of control" patrolled by one or more countries. He also advocated buying similar equipment and weapons, along with common operational procedures. Another official acknowledged that ASEAN maritime forces would never be as strong as China's or Japan's, but nevertheless could provide a permanent supplement to a reduced U.S. presence in the region.

### **The Fishing Wars**

On the fisheries front, Indonesia has introduced stringent regulations governing foreign tuna fishing in its Exclusive Economic Zone (EEZ). In 1974, there were 1,100 foreign tuna vessels operating in Indonesian waters. In 1988, the number was 15. In addition, the government has decreed that all tuna caught within its EEZ must be landed in the country for marketing and processing. And at least 30 percent of the crews must be Indonesian nationals. (In April of 1989, neighboring Australia arrested six Indonesian boats for illegally fishing in its waters. In the previous year, nine boats were confiscated and about 100 Indonesian fishermen deported.)

Malaysia has taken similar steps to gain greater control over its tuna fishery. There are some 1,000 foreign fishermen reportedly languishing in Malaysian jails after failing to pay fines imposed for fishing illegally in Malaysian waters. This has caused strained relations with Thailand, the home of many of the jailed fishermen.

Malaysia has tried to ease the situation by agreeing to a joint tuna fishing project with Thai-

land, based out of Kuantan. The project remains essentially Thai because Malaysia has found it impossible to recruit its quota of crewmen, who fear Thai reprisals.

### **The Boat-People Tragedy**

One of the greatest tragedies in the South China Sea in recent years has been the flood of Vietnamese boat people attempting to reach the shores of ASEAN nations, or Hong Kong (see article, page 65). Many have drowned in the process, and those who have survived end up in former leper colonies, crowded factory buildings, army warehouses, or other camps guarded by barbed wire. At least one voyage included the desperate act of cannibalism.

In March of 1989, ASEAN issued a statement to the effect that Vietnamese refugees fleeing by sea would no longer be automatically eligible for resettlement. A screening process now separates those refugees fleeing for fear of political persecution from those seeking a better livelihood abroad. Thailand has been pushing off Vietnamese boats attempting to land since early 1988, or sending refugees to austere camps on the Cambodian border. Hong Kong instituted a screening process in June of that year.

### **Call For an Asia/Pacific Forum**

In 1987, the Soviet Chairman of the Afro-Asia Coordination Committee named the Soviet Union, China, the United States, Japan, India, Indonesia, Vietnam, the Philippines, Thailand, Pakistan, Bangladesh, Afghanistan, Burma, Canada, Austra-

## Tropical Indonesian Ornaments

*Indonesia's fishing industry does more than catch tuna or farm shrimp; from its wild populations, Indonesia exports tropical ornamental fish. Their prismatic colors and highly evolved shapes determine whether they may grace the aquariums of the most demanding markets—the United States, Japan, and West Germany.*

*More than 37 species of ornamental fish flourish in Indonesian waters and broaden the export industry for local fishermen. Fishing for these aquarium-bound species made a small splash of \$1.6 million in the total pool of \$475 million for all Indonesia's exported fish products in 1987. As with all other fishing in Indonesia, this type has been greatly encouraged by the government since 1987 to increase the production capacity and income of fishermen, step up exports, and expand employment opportunities.*

*These tropical Indonesian ornaments come to swim in public and home aquariums (the second-most popular hobby in the United States). The exported, dimorphic species of red wrasse, *Coris gaimard*, clearly displays why. Continually pleasing to the aquarist, the red wrasse changes from the juvenile form with white spots on a red background, to the adult*

*shape with a blue-spotted body, yellow tail, and green-striped, mauve-colored head.*

*In artificial worlds, the dazzling damselfish, Pomacentridae, and the "Lord," *Coris angulata*, delight captivated—though less-captive—audiences. In wild populations, these species live in coral reefs of the Bali Strait.*

*Such unusual colors and features created a worldwide export trade demand of \$63 million in 1987. The most common Indonesian species is the moon wrasse, *Thalassoma lunare*. In confined quarters, this easy-to-keep, peace-loving omnivore is striking, with an iridescent green body, purple-red head and fins, and blue and orange tail.*

*The clownfish is one of only a few ornamental marine species bred in captivity. There is concern that the wild catch Indonesia exports annually (530 tonnes in 1987) cuts into the breeding populations. Many coastal countries, such as Malaysia, are now slating areas for marine parks.*

*These sanctuaries will encourage photography, swimming, and scuba-diving, but prohibit fishing, water-skiing, speed-boat racing, and any collecting of coral and aquatic life.*

—Laura T. Praderio

lia, and New Zealand as the countries in the Asia/Pacific Region. Certainly a curious list from the point of view of those nations in the region that were passed over, such as North and South Korea, Singapore, Malaysia, and the newly independent island nations.

The chairman also called for an Asia/Pacific Forum, allowing 10 or 20 years for its preparation. This appears to be one of the long-term goals of the Soviet Asian/Pacific policy. It also is supporting denuclearization of the South Pacific.

Where does Japan fit into this picture? A long-time political observer of the region commented in the *Asian Wall Street Journal* of 26 April 1989 that, "Because there has been no spectacular overt expression of Southeast Asian anti-Japanese feeling since 1974 (when a visit by the Japanese Prime Minister sparked anti-Japanese riots in Indonesia, Thailand, and Malaysia), Japan appears convinced that relations are sound. Responsible client states do not bite the hand that feeds them. The Japanese, however, are still widely viewed as

selfish and exclusive promoters of Japanese interests whose racial and cultural arrogance only increases with their wealth."

The writer, George Hicks, went on to comment that, "Japan is one of the world's greatest countries—free, law-abiding, and fully deserving of its marvelous economic achievements. But that wealth has not brought friends, and Japan's breathtaking economic progress has not been matched by parallel social and cultural change. With one foot in the modern economic world and the other mired in the feudal past, Japan cannot play the role in the world that its economic power commands. An economically open Japan no longer is an issue. But whether Japan—given its inegalitarian perception of other cultures—can meet the challenge of its emerging international responsibilities is much more doubtful." □



# The Pacific Island States

There are many thousands of islands in the Pacific Ocean. They can generally be divided into continental islands, high islands, low islands, and atolls. The majority of people who inhabit these islands are broadly classified as Melanesians, Polynesians, and Micronesians. Many of the islands are politically dependent; others are independent states.

New Guinea is an example of a continental island created by volcanism. Its foundation of sediments is intruded by granites and has been overlain by lavas. The high islands, such as Hawaii, the Samoas, Tahiti, and the Marquesas, are the peaks of the largest volcanoes in the world. Mauna Loa in Hawaii, for example, rises more than 9 kilometers above the ocean floor and is more than 200 kilometers in diameter.

Low islands consist of raised atolls and volcanic islands that have eroded over time. Raised atolls are coral reefs that have been elevated above modern sea level by accumulated coral fragments and marine sediments. Such islands include some of those in the Marshall, Caroline, and Kiribati groups. Examples of low volcanic islands include Aitutaki in the Cook Islands, and Wallis Island.

Atolls are reefs that are roughly circular in shape. They are composed of coral limestone and within each there is a lagoon of calm water. It is generally believed that these atolls developed on the tops of inactive volcanoes that no longer protrude above sea level. Atolls are commonly no more than 3 meters above the high-tide level.

Melanesians occupy the larger islands in the southwest Pacific, such as New Guinea, the Solomon Islands, Vanuatu, Fiji, and New Caledonia. Polynesians are settled over a wide range of islands from Hawaii in the north to Easter Island in the southeast and New Zealand in the southwest. They also inhabit the major groups of Tonga, Samoa, and the Society and Cook islands. Micronesians live in the northern, central, and western Pacific in the Mariana, Caroline, Marshall, Gilbert, Phoenix, and Line groups.

Politically, the area is very diverse. Dependent states governed wholly or partially by central governments include the Pitcairn Islands (Britain), Wallis and Futuna (France), and Hawaii (U.S.). Other dependent states that are internally self-governing include Tokelau, the Cook Islands, and Niue (New Zealand); Norfolk Island (Australia); French Polynesia and New Caledonia (France); and the Federated States of Micronesia, the Marshall and Northern Mariana islands, Palau, Guam, and American Samoa (U.S.).

Independent states include Western Samoa (formerly belonging to New Zealand); Nauru (Australia); Tuvalu, Solomon Islands, and Kiribati (Britain); and Vanuatu (Britain and France).



*The traditional fishing boat of the Pacific islands was an outrigger canoe. (Photo by John Dixon)*

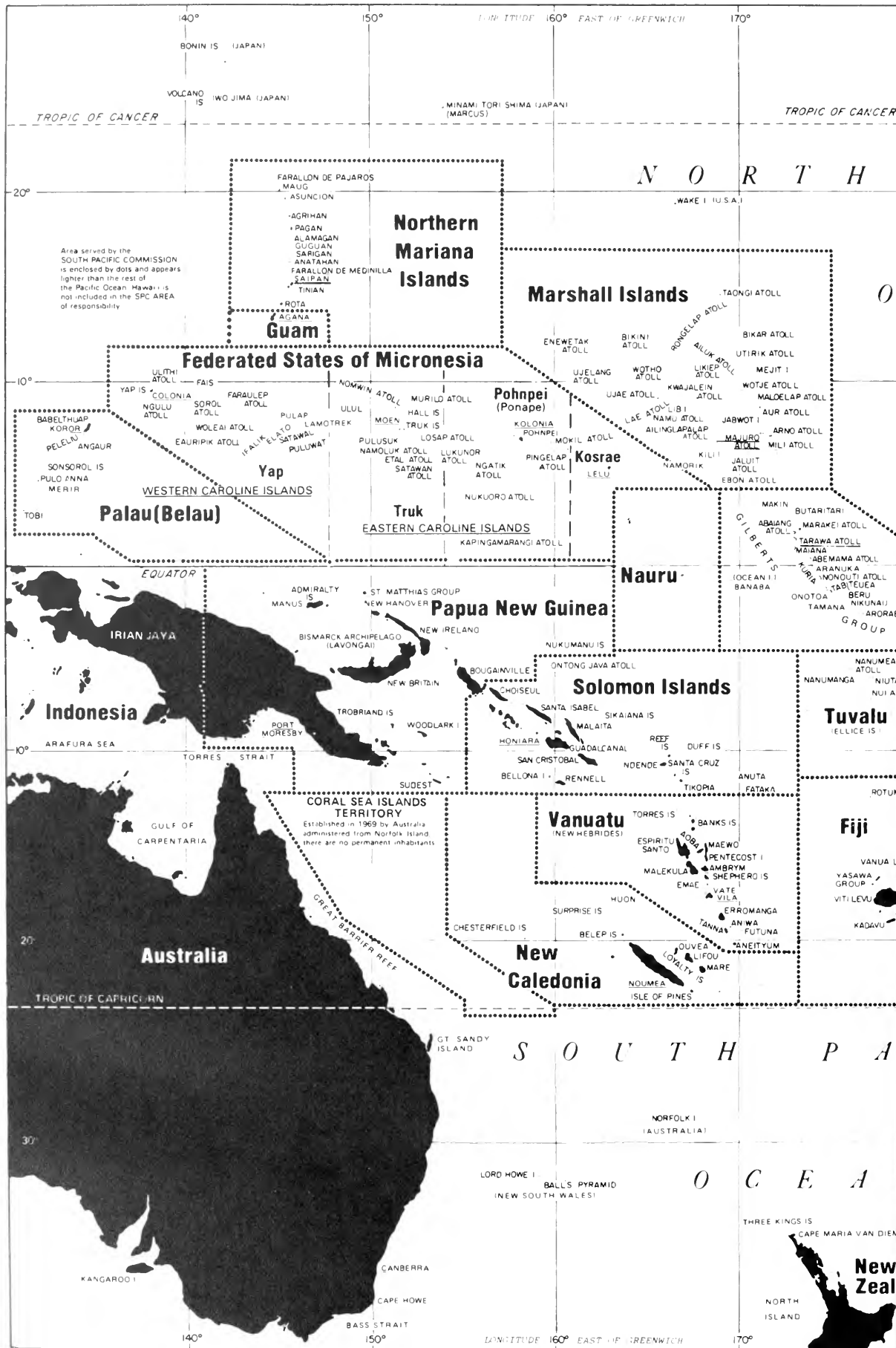


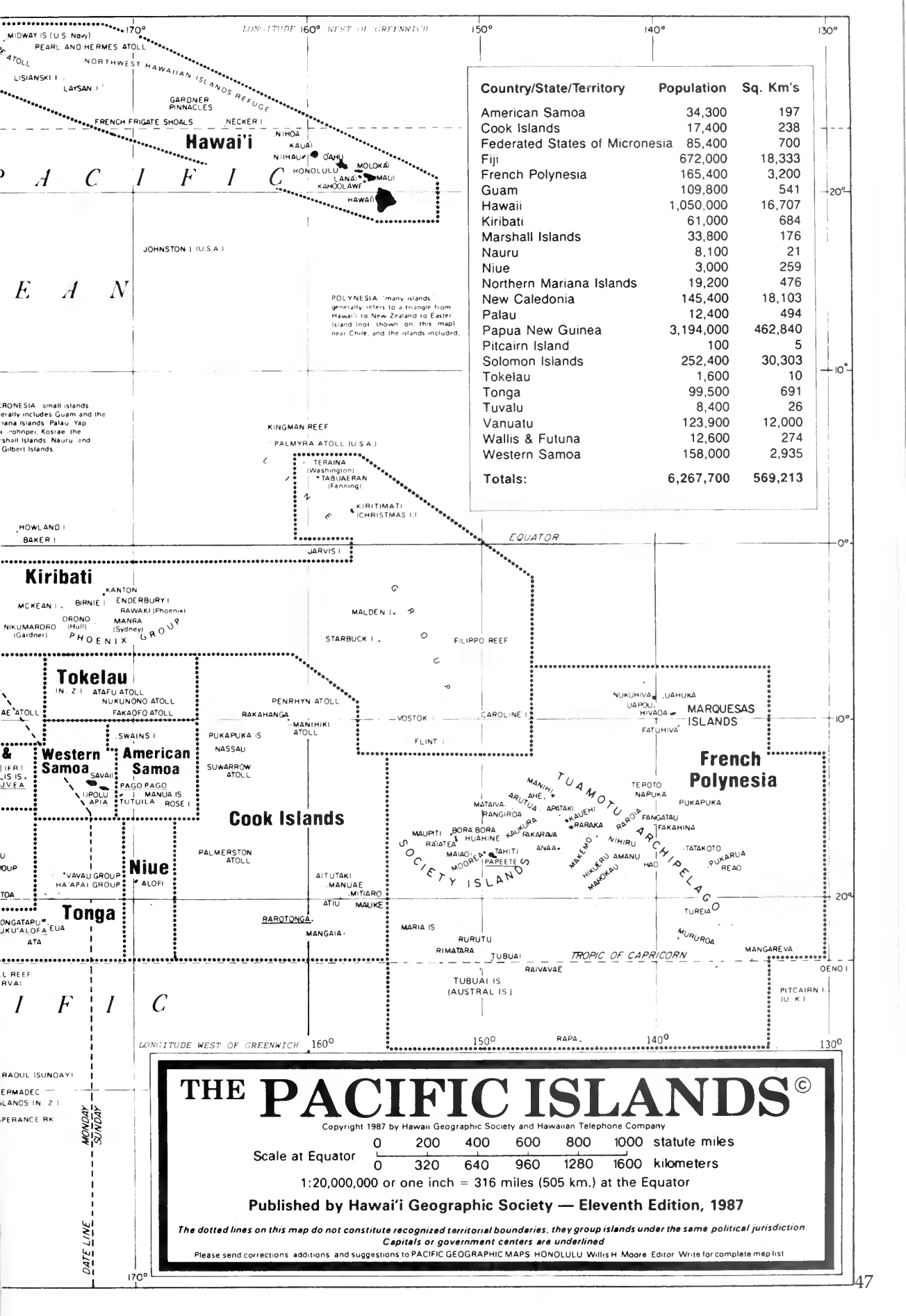
*Today, island fishermen can use Japanese-built, twin-hulled boats. (Photo by John Dixon)*

## Fishing and Trade

Approximately a third of the world's tuna catch is taken in the central and western Pacific oceans, mostly by fishing fleets based in Japan, the United States, the Philippines, South Korea, and Taiwan. With the establishment of Exclusive Economic Zones (EEZs), however, island countries in the region have been seeking a piece of the action, turning from traditional coastal fishing for local consumption to commercial fishing for export markets.

Because fisheries are very important to island nations, they have tended to dominate their foreign relations, particularly those with the United States and the Soviet Union. In return for a payment (usually less than 5 percent of the market value of the fish harvested), island nations license foreign vessels to fish in their EEZs for a specified period





Country/State/Territory	Population	Sq. Km's
American Samoa	34,300	197
Cook Islands	17,400	238
Federated States of Micronesia	85,400	700
Fiji	672,000	18,333
French Polynesia	165,400	3,200
Guam	109,800	541
Hawaii	1,050,000	16,707
Kiribati	61,000	684
Marshall Islands	33,800	176
Nauru	8,100	21
Niue	3,000	259
Northern Mariana Islands	19,200	476
New Caledonia	145,400	18,103
Palau	12,400	494
Papua New Guinea	3,194,000	462,840
Pitcairn Island	100	5
Solomon Islands	252,400	30,303
Tokelau	1,600	10
Tonga	99,500	691
Tuvalu	8,400	26
Vanuatu	123,900	12,000
Wallis & Futuna	12,600	274
Western Samoa	158,000	2,935
<b>Totals:</b>	<b>6,267,700</b>	<b>569,213</b>

POLYNESIA (many islands generally refers to a triangle from Hawaii to New Zealand to Easter Island (not shown on this map) near Chile, and the islands included.

**Hawai'i**

**Kiribati**

**Tokelau**

**Western Samoa**

**American Samoa**

**Cook Islands**

**Niue**

**Tonga**

**French Polynesia**

**SOCIETY ISLANDS**

**TUAMOTU ARCHIPELAGO**

**MARQUESAS ISLANDS**

**THE PACIFIC ISLANDS<sup>®</sup>**

Copyright 1987 by Hawai'i Geographic Society and Hawaiian Telephone Company

Scale at Equator  
 0 200 400 600 800 1000 statute miles  
 0 320 640 960 1280 1600 kilometers

1:20,000,000 or one inch = 316 miles (505 km.) at the Equator

Published by Hawai'i Geographic Society — Eleventh Edition, 1987

The dotted lines on this map do not constitute recognized territorial boundaries. they group islands under the same political jurisdiction. Capitals or government centers are underlined.

Please send corrections, additions, and suggestions to PACIFIC GEOGRAPHIC MAPS HONOLULU Willis H. Moore, Editor. Write for complete map list.

of time. In some cases, these arrangements have been a source of conflict.

The Soviet Union began seeking access to several Pacific island EEZs in the early 1980s. It was not until 1983, however, that it scored its first success: a one-year agreement with Kiribati that gave Soviet vessels the right to fish for \$1.5 million. The agreement was not renewed in 1986. However, in December of 1986, the Soviets signed a fishing agreement with Vanuatu that not only allowed for fishing, but for port and onshore access too.

The Soviets also have negotiated with Papua New Guinea, Tuvalu, and Fiji. Fiji turned down a Soviet offer in January of 1989 to conduct a geological survey around the island because it was suspicious of Moscow's "real intentions" in making the offer. In general, the United States, Australia, and New Zealand regard the Soviet fishing efforts and offers of oceanographic assistance as an opening gambit toward seeking more political influence in the region.

The United States has sought improved relations in recent years throughout the Pacific Region. In 1986, it reached a fisheries access agreement with 16 island countries. The agreement provided for a \$60 million payment spread over 5 years, \$10 million of which is to be paid by the tuna industry and \$50 million by the U.S. government.

Under the treaty, the United States promised that its fleet would obey the laws of island nations. It also pledged that it would not resort to economic retaliation in the event of a boat seizure.

The commercial potential of coastal island fisheries, however, is limited. Because the volcanic islands lack large continental shelves, little nutrient runoff from the small land masses accumulates to enrich coastal waters.

China, meanwhile, has established diplomatic missions in Western Samoa, Fiji, and Papua New Guinea. It also has instituted small aid and trade programs in the region, which reportedly have been well received. Several island leaders have visited Beijing in recent years.

#### Nuclear-Free Zone Issue

In 1985, 11 members of the South Pacific Forum—the most important regional organization—signed a nuclear-free zone treaty. The treaty did not prohibit the passage of nuclear ships, nor aircraft carrying nuclear weapons through the area or port calls by such vessels. It did, however, signal the growth of strong antinuclear sentiments in the region (see article, page 74).

In 1986, eight island countries ratified the treaty. Several others declined because they viewed it as too weak an instrument. Subsequently, the South Pacific states asked the world's nuclear powers to sign three protocols. The Soviet Union and China signed two of the protocols, while the United States and Britain decided not to sign any.

In the Marshall Islands, Bikini and Enewetak atolls were used by the U.S. government in the late

1940s and 1950s for experiments with nuclear weapons. A dispute over resettlement of inhabitants of these atolls has simmered for many years. The United States set up a trust fund of \$150 million to settle claims resulting from these tests. Full resettlement for inhabitants of Bikini atoll was not resolved until April of 1988.

In 1985, the entire population of Rongelap atoll was forced to resettle on Mejatta atoll, after radiation levels, raised by the tests at Bikini, were found to be still dangerous.

Today another atoll in the Marshall Islands, Kwajalein, is used as a target for unarmed missiles fired as tests from Vandenberg Air Force base in California. The United States has rented the test and missile-tracking site for \$170 million paid over 30 years. It has also earmarked a further \$80 million for atoll development projects. □

### Help!...Woman Overboard!

Our intern, Laura, is leaving, and we need to replace her ASAP! If you have excellent English skills and a strong background in science, **Oceanus** has a place reserved for you. The position is unpaid, but the experience is invaluable.

For more information contact the Asst. Editor:  
Tim Hawley at (508) 548-1400, ext. 2393



### The Third International Orca Symposium

March 9th - 12th, 1990

•••

Newcomb Theater,  
Royal British Columbia  
Museum

•••

Victoria, British Columbia  
CANADA

For more information, write or call:  
The Whale Museum  
P.O. Box 945, Slot RWO  
Friday Harbor, WA  
98250, USA

## *A Conference on the Seas of Japan and Okhotsk*



*(Courtesy of Joseph R. Morgan)*

# Notes From Nakhodka

by Joseph R. Morgan and Norton Ginsburg

**A**n extraordinary event of interest to readers of *Oceanus* took place in the Soviet Far East in September of 1989. The Environment and Policy Institute of the East-West Center in Honolulu and the Pacific Oceanological Institute of the Far Eastern Branch of the Soviet Academy of Sciences cosponsored a conference on the seas of Japan and Okhotsk.

The conference was held in Nakhodka, in the Soviet Far East, from September 17 to 22, and was attended by more than 100 participants. The fact that the Russians hosted this important conference can be viewed as indicative of their recently revived interest in the Pacific Region.

The focus of the conference was on the Sea of Japan—the Soviet Union, South Korea, North Korea, and Japan share the shores of this semi-enclosed sea. At the 11th hour, the Sea of Okhotsk was added to the agenda, an initiative on the part of the Soviet sponsors.

This development was unexpected because the Sea of Okhotsk has been viewed in the past by the Soviet Union as its own "lake." The only non-Soviet territory is the northern coast of the northernmost Japanese island of Hokkaido; this bounds part of the southern shore of the sea. The rest of this large, semi-enclosed sea has Soviet coastal borders. Although there are areas of high seas within it, most of the resources of the sea's waters and underlying ocean bottom are under Soviet control. These will continue to be so under the Exclusive Economic Zone and Continental Shelf Provisions of the 1982 UN Convention on the Law of the Sea, when and if it is finally ratified.

---

*Joseph R. Morgan is a Research Associate and Assistant Director of the Environment and Policy Institute, East-West Center, Hawaii. Norton Ginsburg is the Director of the institute.*

Willingness to discuss aspects of the Sea of Okhotsk—its oceanography, fisheries potential, and threatened and endangered species—is an example of *glasnost*, a refreshing indication that there is less secrecy in Soviet relations with nearby countries.

The conference was attended by several representatives from North Korea, who came at the specific request of the Soviet sponsors. Since the conference was also attended by a number of South Korean scholars and bureaucrats, an opportunity was created for scientists and policymakers of the two Koreas to discuss a number of topics. Among these were the physical oceanography and marine geology of the two seas, fisheries, shipping, preservation of threatened species, pollution problems, and offshore hydrocarbon potentials. Topics such as overlapping maritime claims and military strategic issues were not addressed.

### Positive Results Indicated

Both Chinas, the People's Republic and Taiwan, were also represented at the conference. Neither entity fronts on the seas under discussion, but China has a special interest in the Sea of Japan. Its international boundary with North Korea and the Soviet Union lies only 20 miles up the Tumen River, which flows into that sea. The participant from Taiwan was a specialist in offshore hydrocarbon resources and exploitation.

International agencies, such as the UN Environment Programme, the International Oceanographic Commission, and the International Maritime Organization also were represented. The two languages employed were Russian and English, with simultaneous translation provided by the hosts, with variable results. Obviously, many of the participants had to present their papers and carry on discussions in languages not their own, and much, no doubt, was therefore lost in translation. This is a chronic problem at all international conferences, but it pointed out the wide range of cultural variation within the East Asian seas region.

The East-West Center has sponsored two prior international conferences on East Asian seas, one in Honolulu in 1987 on the Yellow Sea, and the second at Niigata in Japan in 1988, also on the Sea of Japan. These, however, were not attended by the Soviets or the North Koreans.

Judging the success of a conference of this nature is difficult, but on the surface at least the evidence is positive. There seemed to be genuine desire on the part of the Soviet Union, Japan, and South Korea to forge increased numbers of joint ventures and trade links across the Sea of Japan, and to further develop port facilities and merchant fleets to carry cargoes.

There was unanimous agreement that a number of marine pollution problems—fortunately not yet widespread—need to be considered and controlled by some form of joint or harmonized action. There also was recognition that some vulnerable animal species need to be protected, as well as some still-pristine environments with important tourism potential.

There was talk of some joint scientific research programs, which obviously would have to focus on more-or-less basic research, rather than on issues that might have immediate economic or military implications.

The conference attendees approved the appointment of an ad hoc working committee that would meet periodically to follow up on conference recommendations, recommend priorities, and suggest ways and means for further regional cooperation and dialogue.

### Gorbachev Plays a Pacific Tune

The Russians have always had a rather romantic vision of the Far East, whether Arctic-oriented or Pacific-oriented, but they have not attempted deliberately, until very recently, to maximize use of their location along the Pacific coast. However, with the new reformist regime in Moscow, this situation appears to be changing dramatically.

In July of 1986, in a speech at Vladivostok, Mikhail Gorbachev appealed not only for a more efficient use of all Soviet resources, both natural and human, but also for rapprochement with China and an increasing involvement with the burgeoning economies of the Pacific Rim.

Within a year or so after this speech, tensions along the Sino-Soviet border were much reduced by the withdrawal of the many Russian troops from the borderlands and by negotiations with the Chinese.

Moreover, in 1987, the Far Eastern Branch of the Soviet Academy of Sciences was established in Vladivostok, building upon the earlier and much more modest Far Eastern Research Center there. As reported by academician Victor Ilyichev, its growth was phenomenal, and now it consists of 25 research institutes, one of which is the Pacific Oceanological Institute.

This institute supervises a large scientific fleet and a network of nature preserves and stations. All this symbolizes a commitment on the part of Moscow to build a long-term fundamental academic establishment, along with material infrastructure, in the Far East region.

A year-and-a-half ago, Vladivostok opened up to international shipping, although it has not yet been significantly used for international purposes; and the port at Nakhodka was greatly expanded. In addition, a new port, Vostochnyy, has been established some 20 kilometers east of Nakhodka, though on the same bay—Amerika Bay. Plans call for the two ports to be integrated in the future.

### "EEZ" Takes On A New Meaning

According to the Soviet newspaper *Izvestia* on 20 September 1989, the government approved a new Economic Enterprise Zone between Nakhodka and Vostochnyy, covering some 320 square kilometers. Plans call for a new international airport in the zone that will be built on an existing military airport base.

This decision is in keeping with a number of recent Soviet pronouncements arguing for the establishment of special economic zones in the Far

(continued on page 52)

## Getting There Is Half the Fun!

**A**ctually nothing could be farther from the truth. Although the Pacific Oceanological Institute has its headquarters in Vladivostok, the conference was held at Nakhodka, a relatively small (population about 180,000) port city 150 kilometers distant.

Vladivostok, the largest city in the Soviet Far East (population about 650,000) and until a year or so ago closed to foreigners, does not have an international airport and lacks adequate hotel and conference facilities, even for a modest undertaking of the size of the Conference on the Seas of Japan and Okhotsk—a little more than 100 souls.

To get to Nakhodka from Honolulu, one has to fly to Japan, thence from Niigata to Khabarovsk via Aeroflot. The trip continued by train from Khabarovsk to Nakhodka over the last leg of the Trans-Siberian Railroad, a distance of 850 kilometers, requiring 15 hours under rather primitive conditions.

There are only three flights a week from Niigata to Khabarovsk. The opening of the Vladivostok airport to international traffic, which is currently planned, would help greatly to make the Soviet Far East a more vital part of the Pacific Rim.

### **Overnight Trip on a Research Ship**

After three days of conference discussions, the participants were taken on a one-day visit to Vladivostok. The Soviet sponsors chose to transport the attendees overnight by sea, rather than by bus, which would have taken about three-and-a-half hours over a fairly rough two-lane road.

The voyage was on the RV Akademik Aleksandr Nesmeyanov, an impressive Soviet oceanographic research ship. The Nesmeyanov has more than 70 individual staterooms for research scientists, as well as accommodations for the crew. At 6,100 tonnes, it is large for a research ship, about three times as large as a typical U.S. ship designed for similar work.

There are a number of spacious, well-

equipped laboratories aboard, and the scientific gear-handling equipment is impressive. The ship design features a standard A-frame on the fantail, which in the case of the Nesmeyanov is large and clearly capable of handling heavy weights. The bridge is modern, with remote engine controls and automated ship-handling and navigational equipment.

### **New Port Facilities**

Vladivostok is a large, busy port with some interesting features. The harbor is well protected from the elements, and pier facilities are generally adequate for the current traffic load. The port at any one time contains surface vessels of the Soviet Navy, part of the Far East fishing fleet, and a number of research ships.

The Soviet submarine fleet is tucked away out of sight, but no attempt is made to inhibit photography of surface ships, which included destroyers, frigates, and a helicopter-carrying cruiser. Merchant ships of generally modest size abound at the numerous piers. All fly the Soviet flag, since the port of Nakhodka, which is much smaller and far less busy, handles the international traffic.

New port facilities have recently been completed at Vostochnyy, across Amerika Bay from Nakhodka. Vostochnyy has a modern, state-of-the-art container terminal, facilities for handling coal and timber products, and a radar-controlled navigational control facility. The latter is clearly not yet needed, since the port has attracted little international traffic thus far.

The container terminal at Vostochnyy is linked to the Trans-Siberian Railway by a recently completed spur, which authorities predict will enable containerized cargo to reach Moscow in 15 days. The ultimate aim of the new port facilities is to use the railway as a "land bridge" to carry containers originating in Asian and Pacific countries across the Soviet Union.

—JRM & NG



*A view of Vladivostok. (Photo by Mark J. Valencia)*

(continued from page 50)

East region. These will facilitate joint project development with other countries—particularly neighboring ones—of technology transfer, trade expansion, and overall economic development throughout the region.

Meanwhile, Soviet sea transport capabilities have been considerably enhanced. The major institution for that purpose is the Far Eastern Shipping Company (FESCO), based in Vladivostok, which has a total of 205 modern vessels displacing approximately 2 million tonnes. Most of its ships are relatively small; the average tonnage is 10,000 tonnes, but their variety is considerable.

The fleet consists of 9 cargo-passenger ships, 20 container vessels, 14 refrigerator ships, 11 bulkers, 18 ice-breaking transports, 81 all-purpose vessels, 24 timber carriers, 16 timber packet carriers, several lighter vessels, and 2 wood-chip carriers. In addition, 8 other ships of about 9,000 tonnes are chartered annually from foreign companies.

Although most of the trade carried on by FESCO is domestic rather than international, it advertises its services for transportation as far away as India and Australia. At present, Japan is its primary target. There are more than 3,000 Soviet ship calls a year to Japanese ports, as well as some 500 Japanese ships that visit Soviet ports annually.

### **Long-Term Strategic Prospects**

Soviet interest in the Pacific is directed toward enhanced trade and scientific relationships among the countries bordering the Seas of Japan and Okhotsk, particularly Japan, but also including China, even though it is not technically a riparian state. In all cases, the volume of Russian trade with neighboring countries is quite small, but it is increasing at a rapid rate.

There is much optimism, too, that such trade will expand massively and that joint ventures

dealing with both marine-related and land-based resources will accompany it. The Russians are interested in expanding the already-important function of the Trans-Siberian Railway as a “land bridge” across Eurasia to Western Europe. The new Economic Enterprise Zone between Nakhodka and Vostochnyy will facilitate that potentially profitable function, and will help link Japan and probably South Korea to Western European markets. The Russians also appreciate the potential for direct trade with South Korea as well as joint ventures with that capital-rich economy, but their door is also open to collaboration with their ally, North Korea.

Understandably, Japan is seen as the most likely major trading partner and investor in the Soviet Far East. There is a long history of limited collaboration and modest trade between Japan and the Soviet Union. There are a number of major barriers to regional economic development between the two countries, however, not least of which is the so-called “Northern Territories” issue (see page 38).

The second issue that bothers the Russians is the strategic alliance between Japan and the United States, which obviously is directed primarily against the Soviet Union. A few years ago the Soviet press carried many articles about this problem, which has continued to come up in high-level discussions between Japan and the Soviet Union. But, given the policy of “openness” in international affairs as promoted by Gorbachev, it is probable that this issue will fade to insignificance.

Meanwhile, Japanese opinion on the potential for collaboration with the Soviets has fluctuated enormously. In the early 1970s, for example, there was great interest on the part of the Japanese in exploring for and exploiting the offshore hydrocarbon resources of Sakhalin Island, but the decline in oil prices has greatly mitigated that enthusiasm.

Also during the early 1970s, the prefectures of Honshu that face the Sea of Japan formed “The Alliance for the Promotion for the Japan Sea Coastal Region,” which included all 12 of the Japan sea prefectures other than Hokkaido. Hokkaido also has become deeply interested in expanding relations with the Soviet Union. In fact, the first Soviet consulate in Japan was established in Sapporo in 1967. Despite these moves, however, most Soviet-Japanese seaborne trade today is carried out through Japan’s Pacific ports.

Strategically, the Soviet Union recognizes the development of the Pacific Basin as a major source of growth in the world economy; and it wants to participate in that growth. Meanwhile, it is believed that despite the lowering of military/strategic tensions in the western Pacific, the Soviet Pacific Fleet has continued to maintain its strength and might even have expanded somewhat in the last several years. What this means remains to be seen.

The importance of the Nakhodka conference is that, for the first time, a dialogue has been opened to implement constructive research policies on the potentials for better management of the marine resources of the seas concerned, within the context of regional development prospects and international relations. □



# Opportunities in Oceanography

at the Woods Hole Oceanographic Institution



Landsat image of Cape Cod



Launching a sediment trap  
off the R/V Knorr

*Physical Oceanography*  
*Marine Geophysics*  
*Chemical Oceanography*  
*Marine Geology*  
*Applied Ocean Physics*  
*and Engineering*  
*Biological Oceanography*  
*Marine Policy and*  
*Ocean Management*

- Graduate Programs with the Massachusetts Institute of Technology
- Postdoctoral Fellowships
- Summer Student Fellowships
- Minority Traineeships
- Internships

For further information, write to:  
Education Office  
Woods Hole Oceanographic Institution  
Woods Hole, MA  
02543  
(508) 548-1400



# Caldron in The Sea

*On a rare clear day, Kraternaya Bay and the Pacific Ocean beyond shimmer in the sun. (All photographs by Michael V. Propp)*

*Marine creatures find a volcanic oasis amid the chilly waters of the North Pacific*

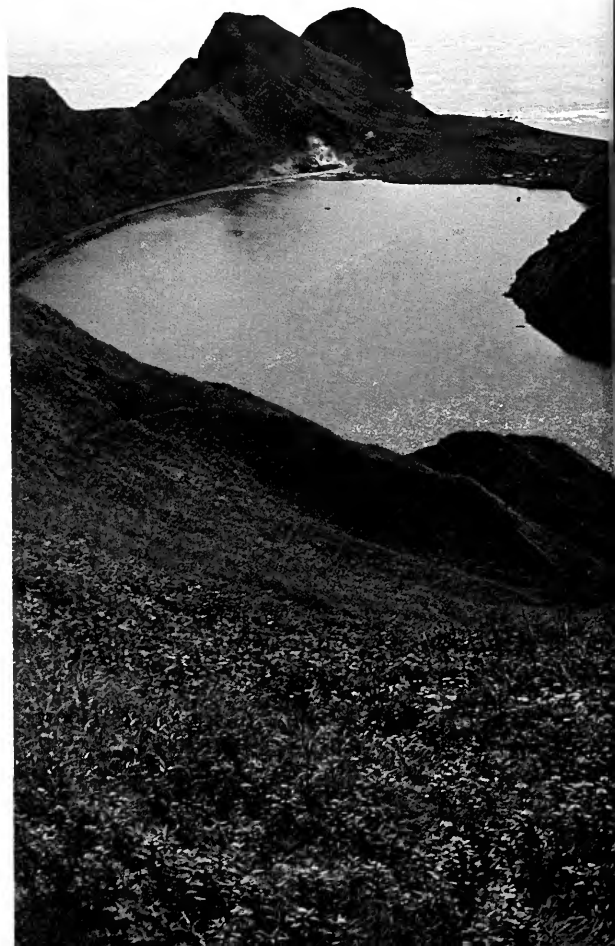
by Michael V. Propp  
and Vitaly G. Tarasov

**T**he Ushishir Islands, Yankich and Reponkich, lie midway in the Kuril Island chain, which stretches from the tip of the Kamchatka Peninsula to northern Japan. Because they are surrounded by the Pacific Ocean on one side and the cold waters of the Sea of Okhotsk on the other, the two tiny islands are shrouded in dense fog during spring and summer. In the fall, typhoons batter them, and winter brings heavy snowfalls, making the islands some of the most inhospitable and isolated places on Earth.

In the center of Yankich Island, a spectacular bay lies hidden behind a high circular ridge. Linked to the sea by a narrow passage to the south,

---

*Michael V. Propp is Head of the Laboratory of Productivity at the Institute of Marine Biology in Vladivostok, USSR. Vitaly G. Tarasov is a biologist at the institute. This article is reprinted from Natural History magazine, August, 1989; © 1989, the American Museum of Natural History.*





the bay is a submerged volcanic crater warmed by the Earth's heat.

When a Russian named Ivan Cherny first visited Kraternaya Bay in 1769, he noted that on its southeastern shore sulfur-colored rocks with a yellow scum and two hot springs issued from the Earth:

"At night, young puffins flying toward the sea over these springs often fall in the water, overcome by the heat and sulphur fumes. The poor birds stew there, and soon only their feathers are seen in the water. . . the air is charged with sulphur, and fierce heat belches forth from the land in loud bursts." With volcanic steam rising from the springs and only seabirds nesting on the grassy slopes or an occasional arctic fox to be seen, the uninhabited island must have appeared as desolate to Cherny as it does today.

### Shamanistic Rites On the Good Earth

Cherny also wrote of the visits by the Ainu to the volcanic springs. The Ainu, who inhabited a few of the Kuril Islands, as well as Hokkaido, the northernmost island of Japan, came to the Ushishir Islands (an Ainu name meaning "good earth") to perform shaman initiation rites.

Before becoming a priest charged with powers to control good and evil spirits, a young man would throw a piece of wood stamped with his personal brand into the boiling springs near the edge of the bay and make his wishes for the future. A platform was then built over the steaming waters with timber imported from other islands, and the shaman initiates, dressed in ceremonial furs, were bound to it. Intoxicated by the poisonous gases and heat, and tortured by nightmares, they had to remain there for three days and nights. The Ainu believed that a man who endured the torture would be able to face any evil spirit and divert disaster from his tribe.

In 1985, we, too, were attracted to Yankich Island by the volcanic springs. As members of a scientific team from the Institute of Marine Biology in Vladivostok, we were the first to explore the waters of Kraternaya Bay and study the effects of volcanic activity on marine life.

Geologists have shown that the boiling springs that once served to initiate Ainu shamans have their origins in plate tectonics, the slow-paced movements of vast segments of the Earth's thin skin. The Pacific plate moves northwest a few centimeters each year, and at the Kuril Trench its leading edge is subducted beneath the Eurasian plate. As it descends into the hot mantle, some of the Pacific plate melts and rises. Where the lava breaks through the crust, it erupts on the sea floor, gradually building the volcanic islands of the Kuril chain. Alaska's Aleutian Island chain, as well as the island arcs stretching along the Pacific Ocean's western boundary down to New Zealand, were also formed in this way.

### Two Domes that Cherny Missed

According to Georgii Gorshkov, a Soviet volcanolo-

gist, Yankich Island and its neighbor, Reponkich Island, are remnants of a single volcano, Ushishir, which once formed a much larger island with gentle slopes. Ocean waves, assailing Ushishir from all sides, cut into the volcanic rock, leaving only the steep-sided central crater (Yankich Island) and an outlying portion of the volcano (Reponkich Island).

The last major eruption, judging from the radiocarbon dating of organic matter beneath a layer of pumice on the bottom of Kraternaya Bay, was about 10,000 years ago. Since then, extrusions of lava have raised four domes from the floor of the bay. (Two of the domes form small islands, and the fresh appearance of their rock indicates that they were emplaced fairly recently, probably after 1769, since they are missing from Cherny's careful description of the bay.) For the most part, however, Ushishir has remained quiet. The thermal springs are the only reminder of the magma still present deep beneath the islands.

When volcanologists estimated that only 2 percent of the heat flowing from the volcano's deep interior was escaping as hot water from the vents along the bay's shore, they guessed that additional thermal springs might be found on the bottom of the bay. Below the water and the thick marine sediments that fill the crater, the circular fault pattern outlined the core of the island that slid downward to form the crater.

After consulting with the volcanologists, we decided that the intertidal areas and deep waters close to the crater rim were likely spots to find volcanic springs and study their associated sea life. The unusual marine ecosystems that thrive near hydrothermal vents have become a major area of research since 1977, when American oceanographers aboard the submersible *DSV Alvin (Oceanus, Vol. 31, No. 4)* descended to great depths on the Galápagos Rift in the eastern Pacific. Here they found tube worms, large clams, and other exotic creatures living around vents in the ocean floor where jets of water emerged, heated to several hundred degrees Celsius by submarine volcanism. Unlike most life on Earth, which depends on the sun's energy to power photosynthesis and produce food, vent organisms thrive in total darkness. The deep-sea organisms are supported solely by bacteria that use energy released from oxidizing hydrogen sulfide in the hot volcanic waters to build the organic molecules necessary for life. Following the discovery on the Galápagos Rift, scientists have located many similar deep-sea hydrothermal vent communities in ocean rift systems around the world.

### Springs Correspond to Fracture Zones

Unlike the explorers of the deep-sea vents, who needed expensive submersibles to descend to the ocean ridges, we needed only scuba equipment to reach the bottom of the relatively shallow waters of Kraternaya Bay. On our first dives, we found hot water and gases issuing from numerous fissures on the bottom of the bays, as well as large areas where the bottom sediments were heated as the waters seeped upward through them; these two types of

springs were in the waters near the crater's rim and corresponded to the fracture zones suggested by the seismic surveys.

No vents were found near the middle of the bay where the water is almost 60 meters deep, but several strong discharges were located along one crack at a depth of 21 meters. A profusion of colorful marine life was thriving on the bottom, particularly near the emerging volcanic water and gases. Although there were some similarities to the deep-sea vent communities, none of the strange tube worms or large vent clams of the deep-sea faunas were found in Kraternaya Bay. Instead we found a coastal marine ecosystem powered by a mix of typical photosynthesizing algae and plankton and chemosynthesizing bacteria.

Many of the microorganisms that are the basis of Kraternaya Bay's food chain form mats on the crater floor as they do elsewhere in the ocean where light reaches the bottom. These mats contain a large variety of photosynthesizing algae and sulfur-oxidizing bacteria growing together in loose association. Their composition depends on how much sunlight they receive and on the temperature and chemistry of the water emerging from nearby springs, which may vary widely.

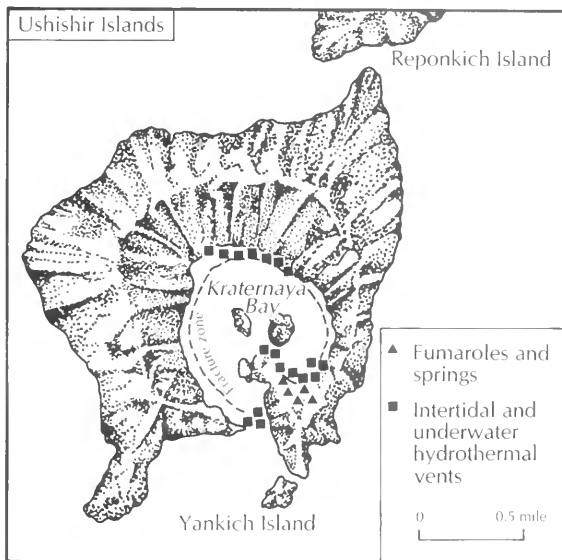
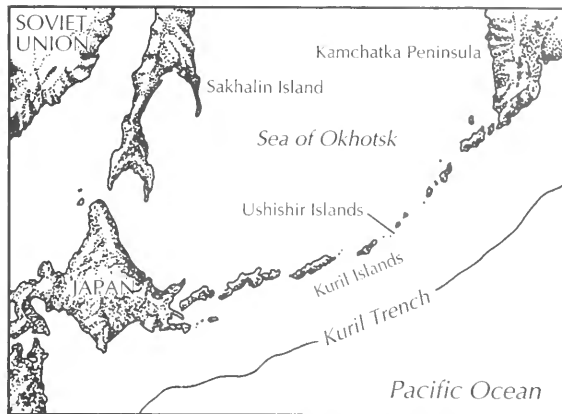
The spring waters circulate deep within the island's porous rock after being drawn in from the cold seas. As they are heated and rise up through the fractures to the surface, they become charged with volcanic gases and enriched with sulfides, metals, and other elements dissolved from minerals in the rocks. Upon discharge into the bay, the volcanic waters cool as they mix with seawater, but near the vents the water may range from 10 to 40 degrees Celsius. These temperatures are quite warm compared with the 4-degree waters outside the bay.

### The Importance of Being Chemosynthetic

In the intertidal areas and in the shallow waters near the shore of the bay, photosynthetic microorganisms, such as cyanobacteria (formerly called blue-green algae), purple bacteria, and algae, predominate in the mats. Also, an unusually large number of diatoms (photosynthetic protozoans with silica shells) contribute to the mats, which may be more than 30 centimeters thick.

At deeper levels and under rocks where sunlight does not penetrate, chemosynthesizing bacteria become more important. These bacteria also dominate the cracks where the hot volcanic waters discharge and the concentration of sulfides are the highest.

Sulfides are toxic to most organisms. In higher animals the effect of sulfides is comparable with that of cyanide. In the blood, sulfides bind to the hemoglobin molecules, displacing the oxygen that they normally carry; because the blood is no longer able to transport oxygen throughout the body, respiration is prevented. Most of the poisonous sulfides are removed from the water almost immediately after emerging from the vents; oxidized by the bacteria and by contact with the



seawater, the sulfides are converted to nontoxic elemental sulfur, which settles onto the mats, coating them with a white film. In this state, the sulfur is used again by other bacteria that convert it to sulfate, the end product.

Two species of archaeobacteria recently discovered at the deep-sea vents were also present here. (Studies of their genetic material, conducted by other researchers, suggest that archaeobacteria are fundamentally different from other bacteria; and because they are found living in extreme conditions similar to those of primitive Earth, they may represent a more ancient form of life.) Unlike the other chemosynthesizing bacteria, archaeobacteria do not need oxygen to burn sulfur; all they require is elemental sulfur and hydrogen. Living in the bottom sediments and in crevices rich with sulfur, they can survive at temperatures as high as 70 degrees Celsius.

### The Benefits of Volcanic Waters

Plankton, consisting of photosynthetic algae, bacteria, and protozoans, also contribute heavily to the bay's primary food production. They too benefit from the volcanic waters, which contain important



*Delicate sulfur crystals grow around the mouth of a fumarole on the bay's shore.*

inorganic nutrients, such as phosphorus and nitrogen in the form of ammonia.

At the surface of the open ocean, these essential nutrients are limited, restricting the growth of plankton; only near shore and in areas of upwelling, where nutrients are brought to the surface from the bottom, are high concentrations of plankton found. Because Kraternaya Bay is a relatively closed system, with only a narrow, knee-deep channel connecting it to the sea at low tide, both inorganic and organic nutrients are continuously recycled in the bay providing ideal conditions for the reproduction of microorganisms.

Each year since 1985, expeditions from the Institute of Marine Biology have returned to study the ecosystem in Kraternaya Bay, where the energy available for life is used in interwoven and constantly changing pathways. Because of the movement of tides and rising volcanic water, the bay lacks well-defined water layers, making accurate estimations of production and destruction of organic matter in this complex environment extremely difficult. Although we are unable to measure precisely the relative roles of chemosynthesis and photosynthesis in the bay, the dense population of organisms covering the bottom is

evidence of its high production of organic matter.

The food produced in this rich environment is transferred up the food chain by a variety of single-celled animals that live in the mats and waters and consume the bacteria and algae. Those protozoans that are known as flagellates feed on the mat products by night and propel themselves with tiny, whiplike appendages to the surface, where they use self-contained chlorophyll to photosynthesize additional food during the day. Many invertebrate larvae and tiny crustaceans also dwell in the bay, feeding on the smaller planktonic organisms, and nematode and polychaete worms graze in the mats.

The large invertebrates that cover the bottom of the bay often exceed in density the animals found in tidal areas along the coasts, but they are not as diverse. Only 150 species are found in the bay, about half the number found in the surrounding seas. Most are previously known species, such as sea urchins, barnacles, and sponges, that have the ability to adapt well to constantly changing conditions.

#### Numerous Tube Anemones Near the Vents

A few new species were found in the bay, however. Among them are conspicuous bright-red sea cucumbers, *Psolus*, which form a dense cover on the bottom rocks, and a white species, *Eupentacta*, previously known only from the Aleutian Islands. At deeper levels, large anemones of the genus *Cerianthus* live on the muddy bottom, each in its own long, curved tube, to which it retreats at the slightest movement in the water. The tube anemones are particularly numerous near the vents, along with a new species of clam of the genus *Macoma*.

One species found in the bay, a clam in the genus *Axinopsida*, has been shown to have a symbiotic relationship with chemosynthetic bacteria living in its gills; the clam filters hydrogen sulfide from the water for the bacteria, which, in turn, contribute organic nutrients to their host. Like the large clams found around the deep-sea hydrothermal vents, *Axinopsida* may have evolved a special molecule that transports sulfides to the bacteria without poisoning itself. As work continues on the bay's biology, we hope to confirm other such symbiotic relationships and perhaps determine the mechanism the clams have evolved to avoid the toxic effects of hydrogen sulfide.

In contrast to the animals surrounding the deep-sea hydrothermal vents, where almost all the organisms were previously unknown, those in the bay do not differ significantly from their relatives in other coastal areas. But the few new species are of great interest to specialists in invertebrate zoology and evolution. As the bay is geologically young, these new species may have evolved rapidly from coastal relatives in order to cope with this unusual environment.

Given the relatively brief time allowed for the evolution of new species specifically adapted to conditions in the crater, however, the possibility exists that some of the animals may have evolved in

*A garden of tube anemones thrives on a bacterial mat at the bottom of the bay, more than 18 meters down. The animals disappear down their tubes at the slightest disturbance. A white, cobweblike film of sulfur from nearby hydrothermal vents coats the mat.*



the vicinity of distant volcanic vents and been transported by currents to the bay. At deep-sea vents, the organisms have evolved to fill these isolated volcanic niches and cannot survive elsewhere. New vents are populated by recruits in the form of larvae or spores that drift on bottom currents from well-established communities. The same species are often found at hydrothermal vent sites located hundreds of miles apart along the ocean ridges.

### **Beauty Alone Justifies the Journey**

We are planning another expedition to the Kurils next year. And since the island chain has at least 100 volcanoes (about a third are listed as active) and more than 100 known submarine volcanoes, we hope to find additional coastal, and perhaps deep-water, volcanic-vent communities. One was, in fact, already found two years ago off Kunashir Island in the southern Kurils, where bacterial mats and dense populations of anemones were discovered offshore at the foot of the Mendeleev Volcano. And last year, mats were found in several more localities around Kunashir Island at depths of less than 12 meters.

Although other places may increase our scientific understanding of these ecosystems, none are likely to match the beauty and solitude we

found at Kraternaya Bay. The calm and peace that reign here during our short summer visits remind us of high mountain lakes in tranquil weather. The steep cliffs, overgrown with grasses of various colors and towering more than 1,000 feet above the water, protect the bay from strong ocean winds.

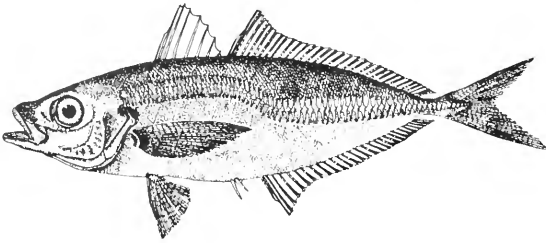
Seals and sea otters, which thrive among the thick kelp beds of the Kuril Islands, find shelter in the bay when storms rage along the open coasts. The rocks that stand as sentinels at the entrance of the bay are animated with stormy petrels, guillemots, puffins, and other seabirds, numbering in the hundreds of thousands. Arctic foxes run among the boulders that lie scattered about the islands, searching for prey. Without fear of man, these animals approached us closely, often nibbling at our rubber diving suits, which seemed to attract them.

The islands are a rare memorial to undisturbed nature. Except for a few scientific expeditions, the Ushishir Islands are rarely visited by humans. In 1987, Yankich Island was designated a protected nature preserve; along with animals and plants, microorganisms and protozoans are also protected here, a rare practice in natural preservation. A sacred place for the Ainu, where the shaman initiates faced the most evil spirits nature could provide, Yankich has become a permanent memorial to the wild. □

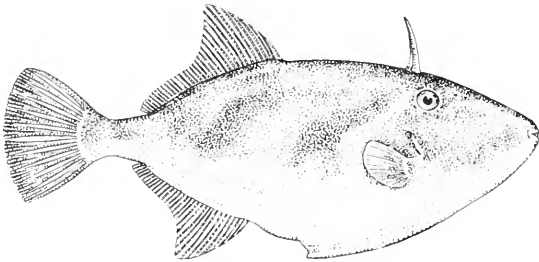
*Marketable fish ignore conflicting claims and international law*

# The Fisheries of the Yellow and East China Seas

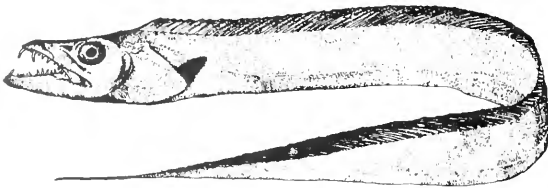
by Yang Jinsen



*Horse mackerel, Trachurus japonicus*



*Black scraper, Navodon modestus*



*Hairtail, Trichiurus leptrurus*

As is the case with all of the world's coastal nations, fishing is extremely important to China. Two of the major Chinese fishing grounds are the Yellow Sea and the East China Sea—seas also fished by North and South Korea, Japan, and Taiwan. Recent improvements in fishing technology seriously affect the fish stocks in these shallow seas, and unless all these countries cooperate to manage the fisheries, each nation stands to lose a substantial source of food and income.

There is no systematic information on fish stocks of the Yellow and East China seas. According to sporadic reports from China, Japan, and the UN Food and Agriculture Organization, more than 10 economically important species migrate seasonally through the jurisdictional waters of Japan, China, and Korea.

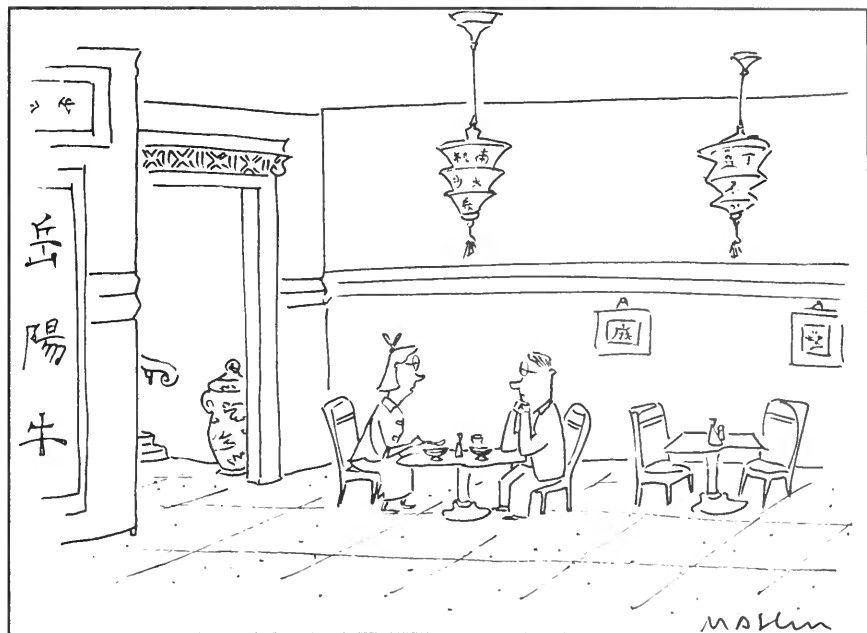
Their migration patterns are influenced by the major currents that flow through the seas. The Kuroshio—Japanese for “black current”—brings warm water northward through the East China and Yellow seas. It is a branch of the North Equatorial Current. As it enters the East China Sea, it is some 300 kilometers wide, 200 meters deep, and moving 50 to 75 kilometers a day. The Kuroshio's warmth makes it an excellent wintering ground for many species.

The Yellow Sea Coastal and Warm currents flow through the western and northern Yellow Sea. These are colder than the Kuroshio, but rich in nutrients and thus ideal spawning and breeding grounds for fish and shrimp in the spring and summer. The richest fishing grounds are between the seas, where the warm and cold currents mix.

---

*Yang Jinsen is Deputy Director of the China Institute for Marine Development Strategy in Beijing. He also is a Council Member of the China Society of Oceanography.*





"A prawn—Hunan style—for your thoughts."

The total catch in the two seas increased from 2.7 million tonnes in the 1970s to more than 4 million tonnes in the 1980s. But according to Chinese estimates, the maximum sustainable yield may be only 2.55 million tonnes (0.87 in the Yellow Sea and 1.68 in the East China Sea).

Such overexploitation contributes to a qualitative decrease in yield. So while the total catch continues to increase, its composition is changing. Smaller, faster-growing, low-value fish

have replaced the larger, longer-lived, higher-quality fish. The dominant species in the 1950s and early 1960s was the small yellow croaker, while Pacific herring, chub mackerel, and large yellow croaker became more common during the 1970s. Then, black scraper took over during the 1980s. The hairtail, however, has always been abundant. Chinese fisheries biologists fear that living resources may become exhausted in the future, which could lead to international fisheries conflicts.

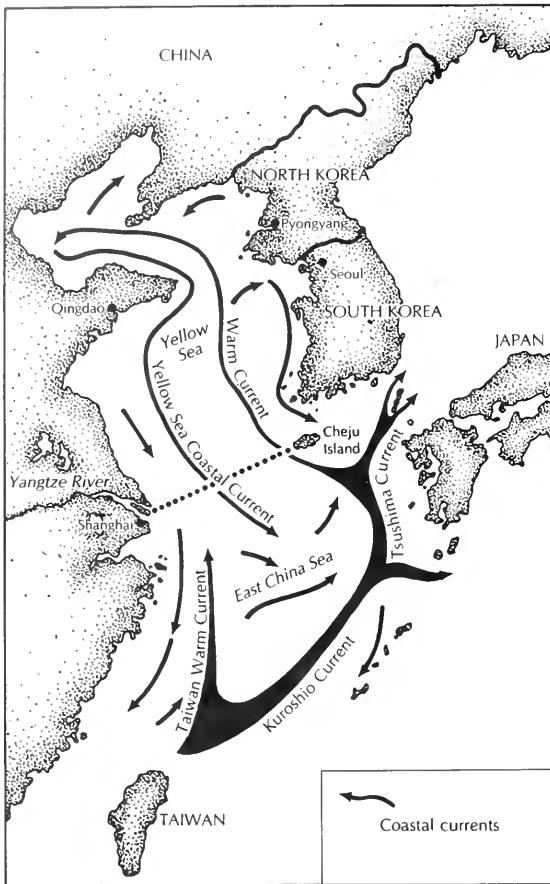
Major Fisheries of the Yellow and East China Seas

Species	Range	Highest Yield (in tonnes)	Present Yield (in tonnes)
<b>Chub mackerel,</b> <i>Scomber japonicus</i>	Most of Yellow and East China seas and the Pacific coast of Japan.	China: 54,000 (1974)	China: 37,000; Japan: 470,000*
<b>Japanese anchovy,</b> <i>Engraulis japonica</i>	Yellow, East China, and Philippine seas, Sea of Japan, and North Pacific Ocean.	Japan: 244,180 (1975); South Korea: 176,820 (1975)	Not available
<b>Hairtail, <i>Trichiurus lepturus</i></b>	Yellow and East China seas	China: 570,000 (1974); Japan: 37,803 (1980)	China: 425,000
<b>Lizard fish, <i>Saierida tumbil</i></b>	Southern and western Yellow Sea; and northern, central, and western East China Sea	China: 160,000 (1972-76)**	China: 25,000
<b>Black scraper,</b> <i>Navodon modestus</i>	East China Sea	China: 300,000 (1987)	China 140,000; South Korea: 140,000; Japan: 3,395
<b>Spanish mackerel,</b> <i>Scomberomorus niphonius</i>	East China and Yellow seas	China: 60,000 (1984)	Japan: 10,000; South Korea: 20,000
<b>Pacific herring, <i>Clupea pallasii</i></b>	Central Yellow Sea	China: 200,000 (1972)	China: 5,000
<b>Small yellow croaker,</b> <i>Pseudosciaena polyactis</i>	Southern Yellow, and eastern East China seas	China: 200,000 (1957)	China: 35,000
<b>Large yellow croaker,</b> <i>Pseudosciaena crocea</i>	East China and Yellow seas	China: 196,000 (1974)	China: 10,000
<b>Horse mackerel,</b> <i>Trachurus japonicus</i>	Southern Yellow and East China seas	Japan: 415,000 (1965)	China: 10,000; South Korea: 26,000
<b>Prawn, <i>Penaeus orientalis</i></b>	Bohai Gulf and Yellow Sea	China: 43,000 (1979)	China: 6,000; Japan: 1,000; South Korea: 1,000

SOURCE: Yang Jinsen

\* Includes catch from the Sea of Japan.

\*\* Annual average over the 5 years.



Warm currents flow northward through the East China Sea and the Yellow Sea, while cooler currents flow southward. The richest fishing grounds are near the center, where the warm and cold currents meet.

### Conflicting Claims and Definitions

To conserve and manage these fisheries effectively, all the bordering countries must cooperate. The UN Convention on the Law of the Sea specifically calls for international coordination in regions such as the Yellow and East China seas in Article 63: "Where the same stock or stocks of associated species occur within the Exclusive Economic Zones (EEZs) of two or more coastal states, these states shall seek either directly or through appropriate regional or subregional organizations, to agree upon the measures necessary to coordinate and ensure the conservation and development of such stocks. . ."

But relations have never been close enough between these Asian countries to permit friendly joint regulation of the fisheries. One striking example of the awkward politics in the region exists between China and Taiwan. Each claims sovereignty over the other. Since neither recognizes the independence of the other, they have no diplomatic relations, let alone fisheries agreements.

In addition to the region's generally shaky political relationships, disputes have often broken

out over who has the right to fish where. The geography of the area makes it impossible for each country to simply declare its own 200-nautical mile (370-kilometer) EEZ. The width of the Yellow Sea ranges from about 195 to 665 kilometers, and the East China Sea is only 780 kilometers across at its widest point. If all the bordering countries were to declare such EEZs, their claims would overlap.

Existing jurisdictional claims\* within the Yellow and East China seas are quite confusing because they differ from nation to nation, and the exact details are not given out freely. North Korea is the only nation that has declared an EEZ, but since the sea is so narrow its actual claim can only be to a line equidistant from China rather than the full 200 miles. South Korea claims a 22-kilometer territorial sea; it has not yet declared an EEZ for fishing or economic purposes, but may do so soon. China acts as though it has fisheries jurisdiction beyond 22 kilometers, even though it has not made any claims beyond its territorial seas. Japan has a 200-mile fishery zone, but only on the Pacific side; to avoid conflicts with China and South Korea it has not staked any claims within the East China Sea. (Japan is not entitled to any claims in the Yellow Sea since it has no coast there.)

### Agreements at Various Levels

Over the years, China has made bilateral fisheries agreements with Japan and North Korea. The fisheries relationship between China and Japan since the 1950s can be divided into three periods: conflict; relaxation; then, competition and cooperation.

The conflict period was from 1949 to 1954. Fishing disputes occurred continuously, and China seized more than 150 Japanese fishing vessels operating along its coastal waters. The relaxation period was from 1955 to 1974. Since the two countries did not have diplomatic relations, the governments would not meet to settle disputes. Instead, fisheries organizations within the two countries (the Japan-China Fisheries Council of Japan, and the China Fisheries Association of the People's Republic of China) came to nongovernmental agreements, the first in 1955, the second in 1963, and the third in 1965. China and Japan agreed to create protection areas. To conserve fish they seasonally closed trawling in some of these areas, seasonally restricted the sizes of boats and types of gear allowed in others, and set minimum allowable sizes of common fish.

In 1972, Japan and China normalized their relations. Three years later, the governments signed a fisheries agreement, heralding the period of competition and cooperation that has lasted to the present day. This treaty retains the protection areas of the earlier private arrangements. It also puts a

\* Under international law, a coastal state is entitled to sovereignty over an area 22 kilometers from its coastline; this is called its "territorial sea." If the country wants exclusive control of fisheries, it may claim a fishery or economic zone of up to 200 nautical miles.

(continued on page 64)



## THE WORLD'S MOST SILENT SUPPORT SHIP FOR DEEP-SEA RESEARCH, SURVEY AND EXPLORATION

The "SHINKAI 6500" system was developed by JAMSTEC (Japan Marine Science and Technology Center) subsequent to the "SHINKAI 2000" system, which has been operating successfully. The new system consists of the submersible "SHINKAI 6500," the support ship "YOKOSUKA" and a base.

The main engine and generators are supported with vibration isolators. All other noise causing machines, equipment and components are also supported with sound isolators for the optimum quiet navigation.

The "YOKOSUKA" is now under construction by KHI, utilizing up-to-date

marine engineering technology and scheduled for delivery in April, 1990.

*Main specifications are Length (o.a.): approx. 105 meters, Length (b.p.): 95 meters, Breadth: 16 meters, Depth: 7.3 meters, Designed draft: 4.5 meters, Deadweight at designed draft: approx. 1,090 M.T., Gross tonnage: approx. 4,500 tons, Main engine: 2 x Diesel Engine, MCO: 2 x approx. 3,000 PS x 600 rpm, Service speed: approx. 16 knots, Classification: Nippon Kaiji Kyokai.*

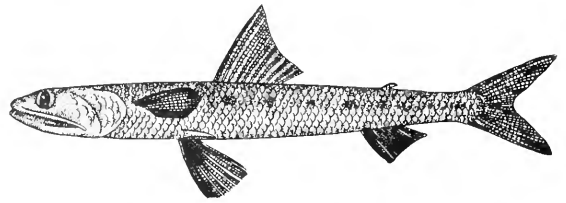
 **KAWASAKI**  
HEAVY INDUSTRIES, LTD.

World Trade Center Bldg., 4-1, Hamamatsu-cho 2-chome, Minato-ku, Tokyo, Japan  
Phone: 81-3-435-2111 Fax: 81-3-436-3038

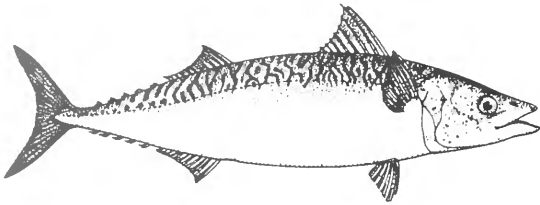
(continued from page 62)

ceiling on the number of fishing vessels allowed in the protection areas in a year—China may send only 624 vessels; Japan 444. A joint fisheries commission, with three members from each country, will examine the treaty periodically and recommend improvements.

There is little information on fisheries issues between China and North Korea. They signed a treaty in 1959 to “provide for the full and rational exploitation of marine resources in the Yellow Sea by both parties in a joint endeavor to develop



*Lizard fish, Saierida tumbil*



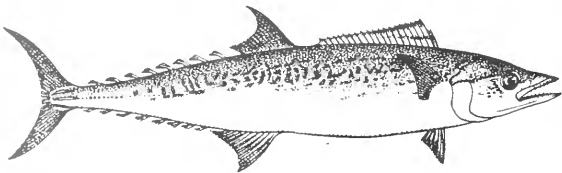
*Chub mackerel, Scomber japonicus*

fisheries projects,” but what progress has come from this treaty is unclear.

South Korea does not have diplomatic relations with China, and the two countries have no bilateral fisheries agreements for the Yellow and East China seas. (However, the Chinese government has sponsored 50-50 joint ventures with private South Korean companies in the South China Sea.) The South Koreans do not acknowledge the Sino-Japanese agreement, but they have regularly observed it to avoid stimulating a sensitive political situation, and to prevent a possible “fish war.” This stable situation is changing, however. On 13 April 1989, South Korea announced that they intend to extend their fishing activities, possibly into the protection areas set aside by the Sino-Japanese agreement. This new factor may create fisheries conflicts in the future.

### Multilateral Agreement Needed

Although the bilateral agreements by China with Japan and North Korea are steps in the right



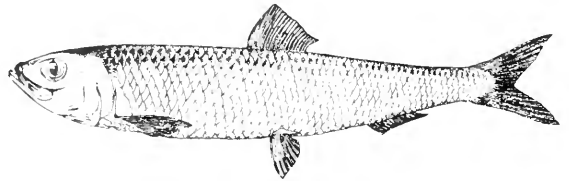
*Spanish mackerel, Scomberomorus niphonius*

direction, there has not been any overall coordination. Since fish migrate through the Yellow and East China seas, effective management plans must incorporate the whole area as a single ecosystem rather than a patchwork of various jurisdictions.

We need a regional fisheries agreement between all the bordering nations. Such a multilateral agreement will certainly be difficult to create, because of the complex political relations. However, I reiterate that without such an agreement there will almost certainly be further degradation of the precious fisheries.

To conserve fish stocks and fishing grounds, we need scientific data. There is little investigation of the resources in this region. Past oceanographic and marine investigations were limited to the offshore waters of individual countries, and exchange of information between the countries has been restricted for various reasons. Some countries have rarely published on fisheries catch or oceanographic research. Therefore, there is no systematic information on the whole region. Until they have data, scientists can hardly provide suggestions to governments.

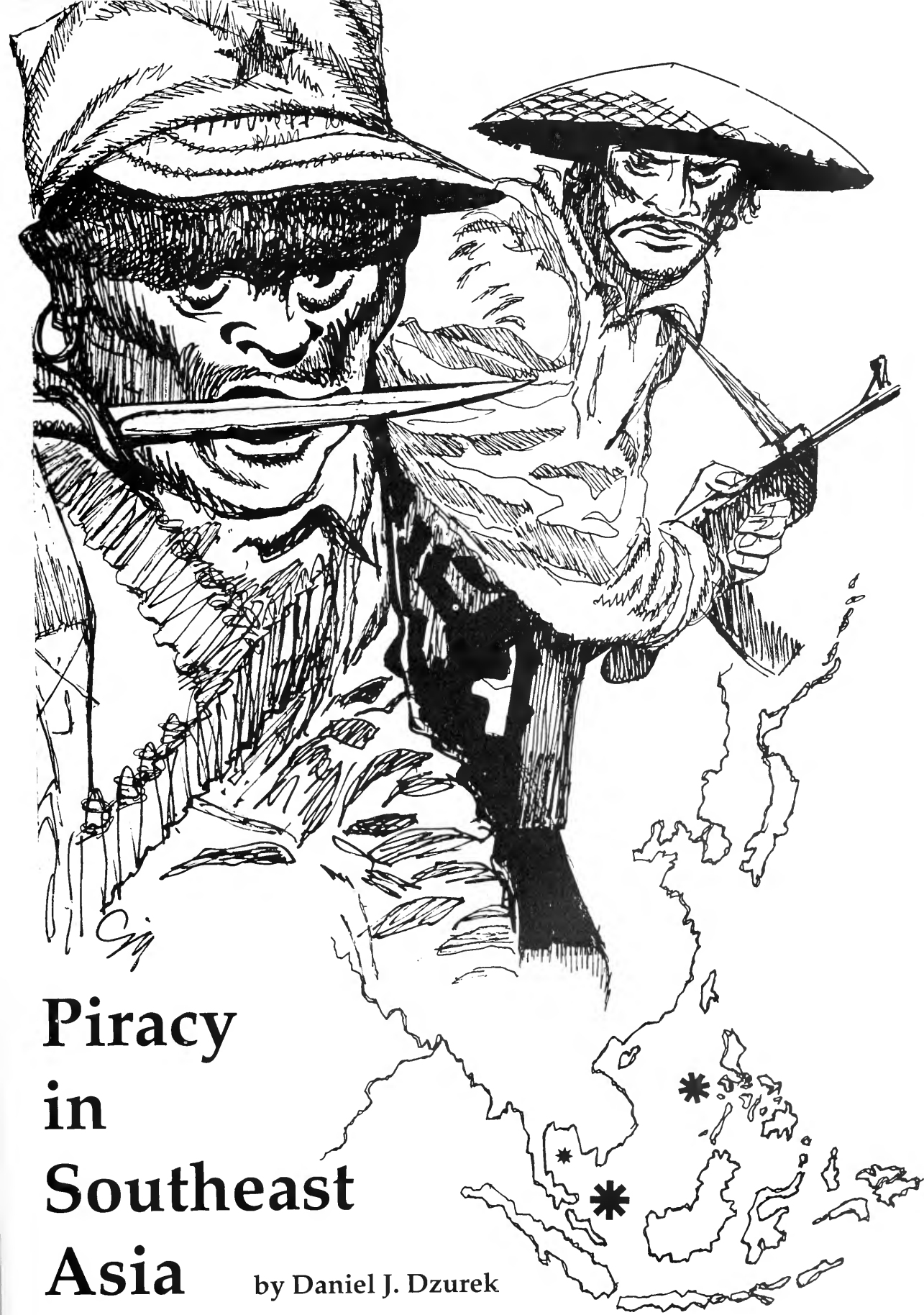
Each state should share both the benefits and the responsibility of conservation by doing three



*Japanese anchovy, Engraulis japonica*

things. First, limit the quantity of the catch and the number of fishing vessels; for if there is no limitation, each country's fishermen will overfish because they fear that others will take everything. Second, establish more protection areas to conserve spawning grounds and young fish. Third, restrict some types of gear, and set minimum sizes for net mesh and length of fish to be caught.

Neutral international agencies, such as the Food and Agriculture Organization, the International Oceanographic Commission, and their subregional agencies may be able to coordinate and ensure the conservation and development of fish stocks in this region. They could organize the exchange of oceanographic data and fishing statistics, and provide information and suggestions to the governments concerned. □



# Piracy in Southeast Asia

by Daniel J. Dzurek



Traders have been harassed by pirates in Southeast Asian waters for centuries, and the grim harvest that continues to be reaped by pirates from the Strait of Malacca to the Celebes Sea has perhaps never been richer than it is today. Desperation born of exhausted fishing stocks and political intolerance has combined with vast fleets of commercial ships and boats carrying refugees to bring about a wave of maritime terror.

American anxiety about piracy dates to the Founding Fathers—the U.S. Constitution explicitly empowers Congress “to define and punish Piracies and Felonies committed on the high Seas.” America’s first misadventure with Malay pirates occurred more than 150 years ago when the *Friendship* was attacked while anchored off Kuala Batu. Everyone on board was killed. A year later, in retaliation the frigate *Potomac* assaulted the nearby settlement, killing some 300 inhabitants.

Such gunboat “diplomacy” is no longer possible or desirable, but piracy still haunts American and other seafarers in Southeast Asia. In 1985,

---

Daniel J. Dzurek is a research associate in the Environment and Policy Institute of the East-West Center, Honolulu. He formerly served as chief of the Spatial, Environmental, and Boundary Analysis Division of the Office of The Geographer, U.S. Department of State.

the *Falcon Countess*, chartered by the U.S. Military Sealift Command to carry jet fuel from Bahrain in the Persian Gulf to Guam, was attacked by pirates. After passing through the risky waters near Singapore, the security crew left their posts at the high-powered water hoses at the stern. Only then did the pirates board the vessel and rob its safe of cash.

Most information about piracy is fragmentary and anecdotal, but the immediacy of the problem is clear. During the last week of June 1989, pirates seized the 2,700-tonne cargo ship *Isla Luzon* in the central Philippines. Most of the crew was found adrift in a life raft on June 27, according to an Associated Press report.

About five weeks later, a 51,000-tonne petroleum gas tanker en route from the Persian Gulf to Japan was attacked by sword-wielding pirates near Indonesia’s Anambas Islands. They robbed the crew of cash and valuables. The next day near the same islands, pirates robbed a 14,000-tonne tanker of cash. In both instances, the pirates approached in high-speed, wooden boats that were not detected by ships’ radar. And in the following two days, Greek and Norwegian vessels were also reportedly attacked by pirates, according to a Japanese news service.

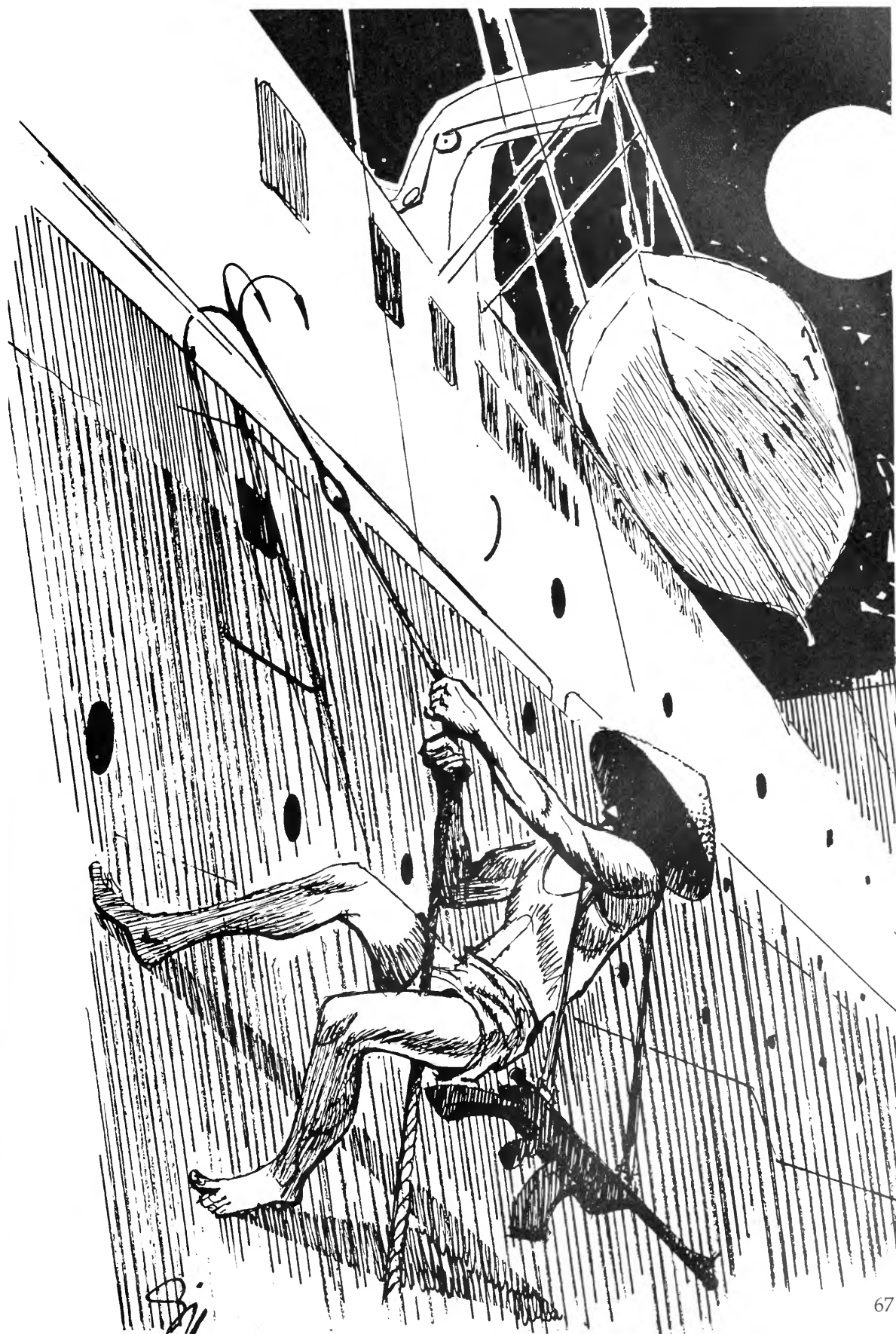
However frequent the attacks on commercial shipping, the plight of the “boat people” is better publicized. Despite public outcry against the atrocities perpetrated on these refugees, they continue to be victimized. The percentage of refugee boats arriving in southern Thailand that had been attacked has diminished from a 1981 high of 80 percent to 12 percent in 1987. Nevertheless, on March 26 of this year, 70 refugees fell victim in one attack in which 20 to 30 young women and children were abducted and most of the remaining passengers were robbed, clubbed to death, and thrown overboard. Only an old man and a boy lived to tell the tale.

In addition, Southeast Asian pirates frequently attack fishing and passenger vessels, which are usually unarmed. Excluding the hundreds of murdered Vietnamese boat people, more than 50 lives have been lost to pirate attacks in Southeast Asia in the last 15 years. At least a dozen attacks on commercial vessels occur each year in the Strait of Singapore according to some estimates.

### The Failure of the Law of the Sea

Perhaps the most disturbing aspect of modern piracy is the negative effect of recent developments in the Law of the Sea, which put piratical incidents and lairs beyond the reach of international law. This is because the very definition of piracy under international law is area-specific; the piracy must occur on the high seas and be for private ends. By this definition, most of the seaborne violence in Southeast Asia is not piracy under international law, since the attacks occur in jurisdictional waters of coastal states, which may or may not define such activities as piracy.

A more common-sense view is that piracy is an act of violence against persons or goods commit-



Bi

ted on the sea by a private vessel against another vessel, or by mutinous crew or passengers against their own vessel. In Southeast Asia, most piratical incidents occur within newly expanded internal waters, territorial seas, and recently recognized archipelagic waters of the coastal states. Most of these developing countries lack the resources to police their vast marine areas effectively.

Every state may seize pirate ships on the high seas; but the 1982 UN Convention on the Law of the Sea reduced the effective area subject to international police action when it expanded national jurisdiction seaward. Influenced by the 1982 convention, many countries now claim straight baselines\* along their coasts, within which the marine area becomes internal waters. Vietnam, for example, uses this practice to draw baselines that extend nearly 150 kilometers to an islet off its coast. These baselines enclose 93,000 square kilometers of newly claimed internal waters—about a third the size of its land area—most of which was previously high seas.

The majority of the coastal states of Southeast Asia claim such baselines. Two, Indonesia and the Philippines, claim extensive archipelagic waters that are bounded by baselines connecting their outermost islands. The 1982 convention recognizes their exclusive jurisdiction within these archipelagic waters, which together equal an area twice the size of Alaska. Piracy in these waters is subject only to the jurisdiction of the coastal state; the international community has no legal base to suppress piracy there.

Considering the density of maritime activity in Southeast Asia, only a minuscule fraction of the coastal population engages in maritime robbery, or worse; but, just as more technologically developed countries are unable to eradicate organized crime, these countries seem unable to suppress pirate activity completely.

### Raids on Commercial Shipping

Although pirates operate in the Gulf of Thailand and South China Sea, commercial piracy is most common in the Strait of Malacca and Strait of Singapore. Small groups of men in speedboats overtake slow-moving tankers and merchant ships negotiating the narrow, five-mile Phillips Channel—which is within the Indonesian territorial sea in the Strait of Malacca. Usually attacking at night, the pirates fling grappling hooks over the ships and haul themselves aboard. Armed with knives or guns, the pirates raid captains' cabins for valuables

and cash, then disappear over the side. Some 6,000 ships pass through the area each month.

Although reports are fragmentary, a vice-president of the Singapore National Shipping Association reported 16 incidents of piracy in the first half of 1987, compared to a total of 15 for all of 1986. The same report gave unofficial Singapore government figures citing 61 incidents in the first half of 1987.

Attacks against commercial targets in the strait present several issues of concern. Pirates who apparently are based on Indonesian islands in the strait attack Singapore-bound commercial vessels, which irritates relations among Singapore, Indonesia, and Malaysia. Perhaps a more serious concern than either the thefts of valuables or the possibility of personal injury is the likelihood of incapacitating the crew of a tanker or merchantman, with a resultant wreck that might block the world's busiest strait. A pitched battle aboard a tanker could also result in a catastrophic fire or oil spill.

Increased incidents of piracy against commercial vessels since 1980 have prompted action by the International Shipping Federations, the International Maritime Bureau of the International Chamber of Commerce, and the International Maritime Organization (IMO) of the United Nations. The Federations and the Bureau have begun collecting and reporting information about circumstances of attacks and shipboard security measures.

### Victimizing Refugees

The frequency of piratical attacks against Vietnamese boat people has fluctuated with both the numbers of refugees attempting to flee and with the strength of suppression efforts (see right-hand figure, page 70). A report of an incident implies, of course, at least one survivor of the ordeal. According to the UN High Commissioner for Refugees (UNHCR), of the 81 attacks in the Gulf of Thailand reported in 1986, 25 percent occurred in Vietnamese waters, 22 percent in Thai waters, 14 percent in Malaysian waters, and 39 percent in disputed waters. In 1987, pirates attacked 154 of the 1,322 refugee vessels arriving in southern Thailand and Malaysia.

A recent upsurge in the numbers of boat people has been attributed to this year's announcement of cutoff dates after which first-asylum countries will introduce screening to determine eligibility for refugee status. In 1989, there have been several heart-rending stories of government forces pushing boats away after they had nearly reached land.

Only a tiny fraction of the tens of thousands of Thai fishing vessels in the gulf carry pirates who prey on refugees. Seventy-five percent of arriving boat people report receiving aid from Thai fishermen, but it is the acts of barbarism that make the headlines. Endemic overfishing in the Gulf of Thailand and high levels of poverty foster piracy. Ethnic and religious antagonism also contribute to the problem. There also are recurring reports of attacks on Thai fishermen by pirates.

\* The normal baseline is the low-water line along a country's coast. However, where a coastline is deeply indented or fringed with islands, a coastal state may claim straight baselines connecting appropriate points. If they meet certain criteria, archipelagic states may claim archipelagic baselines joining the outermost points of the outermost islands and drying reefs. The marine area within these baselines is called "archipelagic waters." All maritime jurisdictional zones are measured from normal, straight, or archipelagic baselines.





*A small boat packed with Vietnamese refugees arrives in Hong Kong. The flood of boat people has overwhelmed refugee camps in the territory, forcing the government to detain arrivals without shelter or facilities on the barren Soko Islands outside Hong Kong. (Reuters/Bettmann Newsphotos)*

Although piratical attacks on refugees continue, Thailand, Malaysia, and the international community have made some headway with the problem. The UNHCR, with financial support from the United States (\$920,000 in 1988) and other developed countries, has an antipiracy program. It supports law enforcement activities by the government of Thailand and encourages humanitarian assistance to the boat people.

During 1986 and 1987, Thailand made 68 piracy arrests and concluded 14 piracy trials (with multiple defendants). The difficulty in apprehending pirates is a function of the vast area in which the highest frequency of piratical attacks occur. Indeed, most of the arrests result from police work on shore.

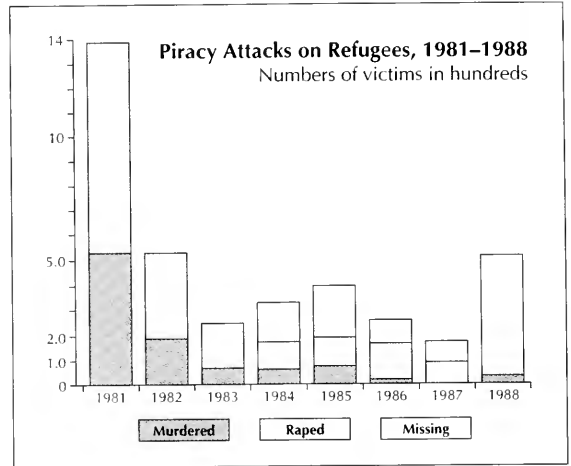
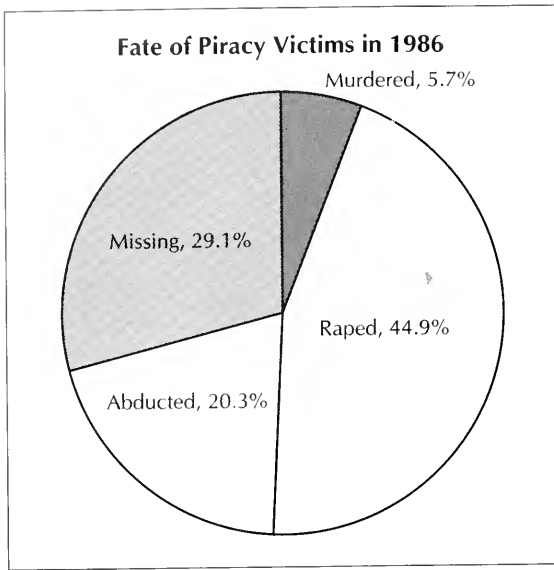
Parallel with the antipiracy program, UNHCR has a rescue-at-sea program that facilitates rescue of refugees by merchant vessels. Merchant vessel owners are reimbursed for some rescue costs, and local authorities are guaranteed prompt onward resettlement of refugees landed by the vessels. In 1987, more than 2,400 refugees were rescued at sea and resettled under this program.

### Politically Inspired Piracy

The Sulu and Celebes seas, between Malaysia and the Philippines, are frequently the scene of piratical attacks against coastal freighters, passenger ships, and fishermen. The apparent involvement of the Moro National Liberation Front (MNLF\*) has complicated suppression efforts and increased tensions between Malaysia and the Philippines. In one 1984 incident, the pirates murdered 33 people, wounded 4, and abducted 3 teenage girls during an attack on a boat carrying Moslems from eastern Malaysia to the southern Philippines.

Perhaps the most brazen incident—not technically a piratical attack because a vessel was not the target—occurred 23 September 1985, when MNLF marauders mounted a seaborne attack on the Malaysian town of Lahad Datu in northeastern Borneo. They robbed a bank and airlines office of \$82,000, killed 10, and injured 11. There are conflict-

\* A group seeking independence for the southern, predominantly Muslim, part of the Philippines.



ing reports of a reprisal by Malaysian forces against the Philippine island of Maldanas a week after the attack.

Although not all the attacks are mounted by insurgents, the inability of the central authorities to control the area permits a degree of lawlessness that breeds smugglers and pirates.

Concern about maritime terrorism grew rapidly in the wake of the *Achille Lauro* incident,\* and the newest anxiety is over possible attacks on offshore oil and gas platforms. In 1987, the IMO produced a "Draft Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation" and a "Draft Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf."

Most legal authorities distinguish between piracy, which is indiscriminate in its choice of targets and done for private ends, and terrorism that is politically motivated and selective in its victims. These drafts sidestep the definitional problem of piracy and appear to include terrorism, but they only address the legal issues of sanctuary, jurisdiction, and extradition. They do nothing to promote the capture of pirates, which is still the responsibility of the coastal state.

Efforts to subsume terrorism under the regime dealing with piracy would be leaning on an already weakened reed. Offshore platforms present targets of as yet unexploited opportunity for pirates or terrorists, who could hold such facilities and their crews for ransom. These initiatives of the international community address some of the issues relating to piracy, but they do little to suppress it at its source.

\* The incident in which an Islamic terrorist group captured the *Achille Lauro*, a Mediterranean cruise-liner. A handicapped American, Leon Klinghoffer, was killed during the attack.

### Regional Cooperation Necessary

The response within Southeast Asia to piracy, though still inadequate, is growing. The Federation of ASEAN Ship Owners' Associations has held several meetings on the issue and pressured regional governments to increase suppression efforts in their waters. In a continuing response to the plight of the boat people and other refugees in Southeast Asia, ASEAN representatives, donor countries, and the UNHCR met this July in Geneva. With each of the first-asylum countries, the UNHCR is discussing how to ensure that the procedures and criteria used to determine refugee status are consistent with internationally accepted standards. How to handle rejected cases remains to be settled, as does facilitating legal departure programs with the source countries.

Because modern pirates in Southeast Asia are land-based and not the rovers of ancient times, the coastal states must shoulder primary suppression responsibility. The tools of piracy are often the same as of smuggling, which is also a chronic regional problem. Most of the piratical attacks, like smuggling, occur along the maritime frontiers of Southeast Asian countries.

The law-enforcement resources of the states in the region are insufficient for the task. As a first step, the countries of the region should harmonize their domestic legislation relating to piracy, and provide for extradition of offenders. Second, an ASEAN-wide mechanism should evolve to suppress piracy. With material support from the maritime countries, this would offer the best chance for success in attacking both smugglers and pirates throughout Southeast Asia. □

Original drawings by Sig Purwin, a Cape Cod artist.

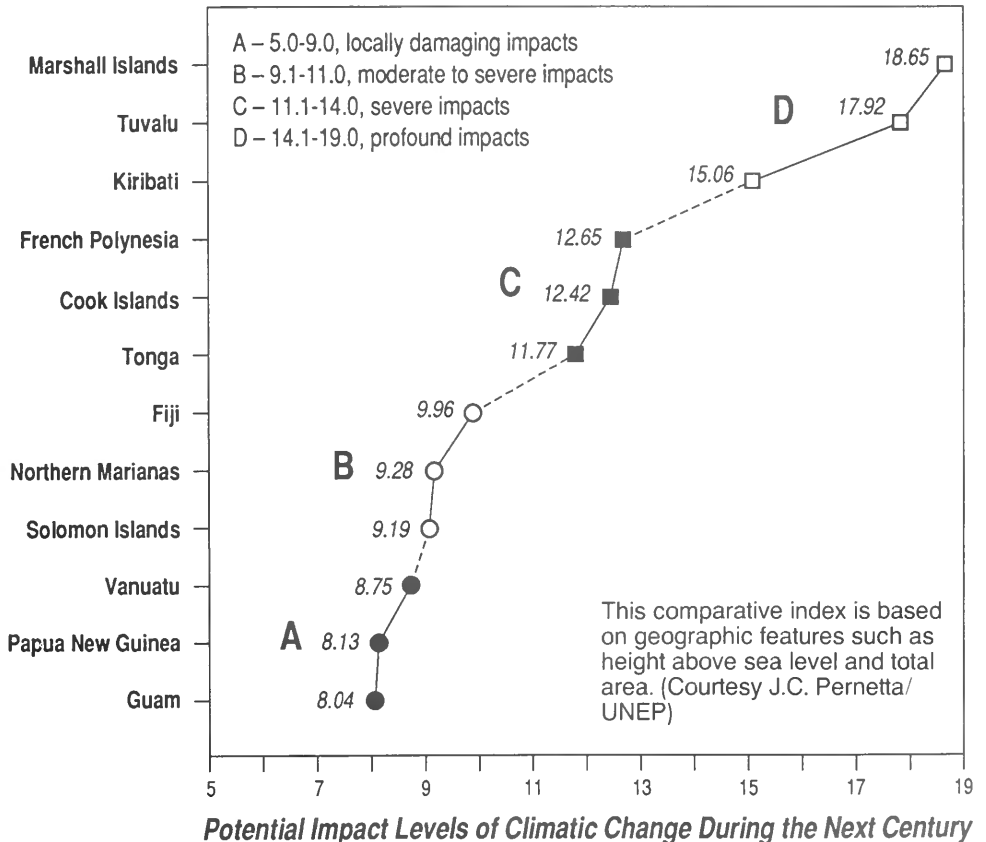
# Changing Climate and the Pacific

by Frank J. Gable and David G. Aubrey

The Pacific is particularly susceptible to changing climate and an associated acceleration of sea-level rise because within the region lie many low islands—some less than 4 meters above mean sea level. Consequently, rising sea levels and storm surges may render some islands uninhabitable.

For inhabited islands, the option to move inland to higher ground is limited. In addition, many Pacific archipelagoes—which contain a larger proportion of coastal zone to land than do

*Frank J. Gable is a geographer with the Coastal Research Center of the Woods Hole Oceanographic Institution. David G. Aubrey is Director of the center.*



most continental nations—recently became independent. These nations rely heavily on coastal and marine resources for both local consumption and export.

In the Pacific, sea-level measurements have the potential for improving predictions of El Niño, identifying global warming effects, and estimating heat transport by major ocean currents. In addition, the Pacific is particularly useful in measuring global oceanic changes, since it is the largest body of water on Earth. Eustatic change in sea level is the worldwide change in volume of ocean water, it is different from local oceanographic effects such as currents, and uplift or subsidence of the land by tectonic processes. In the Pacific Region, geologic processes such as tectonism that originate within the Earth cause the movement of crustal plates. These movements exert significant influence on tide-gauge records.

A study of sea-level data obtained from the Hawaii Sea Level Data Center has concluded that relative sea levels in the Pacific have been rising at a rate of 3.5 centimeters a decade since 1960. This compares with the estimated 10 to 15 centimeter rise experienced during the previous 80 to 100 years. The researchers also found that there has been an accompanying increase in sea-surface temperatures of about 0.6 degrees Celsius a decade. These conclusions have been corroborated by a 1989 satellite-derived sea-surface temperature study. Taken together, these studies suggest Pacific sea-level rise may be accelerating.

Should sea level increase at a very steep rate, the outcome might include the progressive drowning of coral reefs—the Pacific contains about 55 percent of the world's coral reefs, 335,000 square kilometers of them. This drowning in turn could lead to reduced spawning and feeding areas for commercial or traditional fisheries.

Any rise in sea level will almost certainly be aggravated by manmade pressures, such as increased waste discharges from shoreside development and increased use of natural resources for tourism. Other effects might include saltwater intrusion into water tables, especially in sand and limestone aquifers. This in turn would result in a significant decrease in the available freshwater supply for human, animal, and agricultural use.

Examples of where the loss of groundwater could render small atolls and limestone islands uninhabitable is Kavieng (population 4,600), on New Ireland, Papua New Guinea. This port town is close to sea level, and its source of freshwater is a limestone aquifer that is susceptible to increased intrusion of saltwater as a result of climate changes.

The Marshall Islands, composed of low-lying (less than 1.5 meters high) coral reef-derived sand cays, are susceptible to the destructive forces of catastrophic tropical storms variously known as cyclones, typhoons, or hurricanes.\* Other Pacific island nations composed entirely of atolls and raised coral islands are subject to large climate change impacts (see figure, page 71). These nations include Kiribati (formerly Gilbert Islands) and Tuvalu (formerly Ellice Islands).

Another region of the Pacific that may experience coastal flooding and/or permanent inundation according to projected climate changes is the Cook Islands. Here, if sea levels rise 1.5 meters, at least 17 percent of the intensively farmed, densely populated, and narrow coastal plain would be lost. Further, most of the islanders' staple food crops are grown in swampy areas that would be inundated.

Nuku'alofa, the capital of Tonga, is another area threatened by a rising sea level. Located on the northern side of low-lying Tongatapu island, a 1.5-meter sea-level rise on central Nuku'alofa would affect about 17.5 percent of the land area. The impact on the main port of Nuku'alofa alone would be about a 42-percent land loss with a 1.5-meter rise.

Moderate-to-severe impacts may occur on the Fiji Islands. Local effects of a relative sea-level rise of 1.5 meters indicate that more than 10 percent of Vatoa Island's land area would be inundated. Similarly on Vanua Levu, Fiji, almost 26 percent of the town of Labasa would be affected.

### Japan's Submergence Problems

At present, according to David G. Aubrey and K. O. Emery of the Woods Hole Oceanographic Institution, Japan is experiencing, on average, a relative sea-level rise of about 3.1 millimeters a year. This rate is attributed to tectonic and oceanographic influences, which include land motion, changing density of ocean water, and the effects of ocean currents. However, the eastern and southern coasts of Japan—those that face the Pacific Ocean—have relative sea-level rise rates approaching 20 millimeters a year.

Japan's southernmost point at present is an island consisting of two rocky outcrops about 70 centimeters above high tide. This island, called Okinotorishima, is a reef about 2 by 5 kilometers at low tide that Japan has had sovereignty over since 1968.

The island is a marine boundary control-point for Japan's archipelagic territorial baselines and its equally important 200-nautical mile fishery zone. Should the rocks be permanently submerged under the rising seas, Japan might lose both economic and sovereign rights over an area of about 400,000 square kilometers. Lost would be exclusive rights to the sea and potentially\*\* the seabed: fishing rights to commercial species such as tuna and bonito, and rights to the cobalt-rich crusts and similar nonliving resources on the seabed.

Last year, the Japanese government decided to spend about \$240 million during a 3-year period to maintain the integrity of the atoll from the rising seas. They hope to prop up the island from the clutches of wave erosion by laying iron tetrapods around the two remaining rocks, in effect forming a circular wall 50 meters in diameter, that will then be

---

\* In the western Pacific, a hurricane is generally called a "typhoon," while in the central Pacific and Indian Ocean, this same type of storm is referred to as a "cyclone." In any event, the terms hurricane, typhoon, and cyclone are interchangeable.

reinforced with concrete. Work on this endeavor began in the spring of 1988.

This action is a policy response not only to the present danger to the reef and the territorial integrity of coastal Japan, but possibly to the implied problem of global sea-level rise and the known rate of submergence of southern Japan. For the Japanese government, the problem was immediate; it could not sit back and adopt a wait-and-see approach. However, few other Pacific archipelagoes can implement a policy decision similar to Japan's because they lack technical and financial resources.

For many archipelagoes around the Pacific, the loss of outlying islands or islets to submergence may result in a substantial reduction in the size of their Exclusive Economic Zones (EEZs) (see *Oceanus*, Vol. 27, No. 4). The importance of the EEZ to these nations is illustrated in the potential for exploitation of marine fishery and seabed resources.

### The Storms of Changing Climate

Another effect accompanying climate change is the possible alteration of the magnitude and duration of storms. Storm patterns are responsive to changes in weather and climate, in the short and long term. As climate warms, atmospheric and oceanic temperatures will increase. The ocean/atmosphere interactions that give rise to storms may change the intensities and tracks of those storms, and some areas could experience an increased number of severe storms.

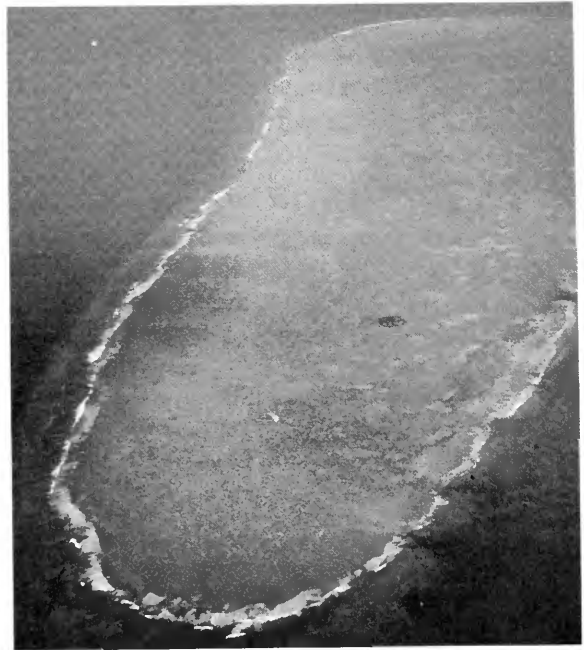
Areas within the Pacific are likely to be affected. The western Pacific Ocean on average, presently accounts for more than 50 percent of the yearly global total of tropical storms, including hurricanes.

The most intense typhoon ever recorded occurred in the Philippines near Luzon in 1979. The lowest pressure recorded for this storm was 25.69 inches of mercury (869.86 millibars), a remarkably low reading. Another violent typhoon (Ruby) hit Luzon in October 1988, causing an estimated \$40 million in damage to the rice crop alone, and left more than 100,000 people homeless.

Probably the most severe storm recorded for southern Tonga since the turn of the century occurred in March 1982, where there was coastal flooding up to 6 meters above normal high tide.

### Observing the Vast Pacific

In response to concern expressed by Pacific nations about the implications of potential man-induced climatic changes in the marine and coastal environment, the UN Environment Programme (UNEP) has inaugurated studies around the Pacific (and elsewhere) to review the coastal environment. Some of the objectives of the studies include analyzing, on a regional basis, the potential effects of sea-level changes on the coastal ecosystems, including



*Japan is spending \$240 million to prevent Okinotorishima from disappearing beneath the waves. (Courtesy of Asahi Shimbun Photo service, Tokyo, and Islands magazine, USA)*

beaches, coastal river flood plains, lagoons, mangroves, and reefs.

UNEP held a conference, in association with several South Pacific organizations, at Majuro, Marshall Islands in July of 1989 to assess the ramifications of global climate warming on low-lying Pacific island nations, the severity and timing of the anticipated changes, and the options that governments have in contingency planning.

Because of the vastness of the Pacific, any observation system must have widespread coverage. Measurements from space, which are essential to view the entire Pacific, and in situ measurements are necessary for local and regional studies, as is subsurface sampling and confirmation of space remote sensing data. Some aspects of the long-term monitoring of climate change in the Pacific however, may best be handled by satellites. To address this need, the U.S. National Aeronautics and Space Administration has several satellite-projects that will provide data to the region's governments on global change. □

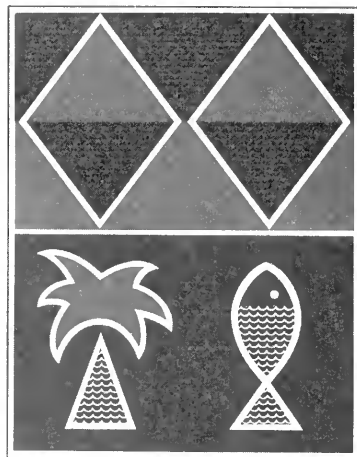
### Acknowledgments

This research was supported by the Richard King Mellon Foundation through the Coastal Research Center of Woods Hole Oceanographic Institution. Thanks to Zorah Krueger of *Islands* magazine (Santa Barbara, CA).

\*\* Japan has not yet officially declared an Exclusive Economic Zone, though international law allows them to do so.

# Greenpeace's Pacific Campaign

by Sebia A. Hawkins



**G**reenpeace has long-term campaigns under way in the Pacific Region against nuclear weapons testing and high-seas driftnet fisheries; but during the last two years, another serious environmental issue has exploded on the world scene—trade in hazardous waste.

Industrialized countries have recently adopted increasingly strict and costly regulations for the disposal of hazardous wastes. Therefore, waste producers are looking for cheaper and easier methods to get waste off their hands. One dangerously popular method is to ship it to developing countries, and dump it there either covertly or in a previously purchased dump site.

The international trade in waste has soared in recent years. Greenpeace estimates that between 1986 and 1988, more than 2.8 million tonnes of garbage were shipped from industrialized to developing countries. With the public eye currently on Africa, where a number of illegal and deadly waste-trade schemes were uncovered in the summer of 1988, waste traders have identified a new target—the Southwest Pacific.

*Sebia A. Hawkins is a Coordinator of the Greenpeace Pacific Campaign in Washington, DC.*

## Poison or Poverty?

Already, waste brokers from industrialized countries have offered large cash payments to a number of South Pacific countries. The payments for accepting foreign waste are often large enough to tempt South Pacific nations to mortgage their public health and environmental integrity in exchange for much-needed currency (see box, page 76). Business deals like these force developing nations to make the unfair choice between poison and poverty.

Waste trade threatens the public health and environment of the receiving country and contributes nothing to solving the waste disposal problem. All waste disposal facilities, including high-temperature incinerators, landfills, and "detoxification" plants will release contaminants into the environment sooner or later.

The only real solution to the waste problem lies at the point of production.

The people of the Pacific should not be made to suffer the consequences of unhealthy and unsustainable production processes used elsewhere. Karol M. Kisokau, Secretary of Environment and Conservation in Papua New Guinea, summed up the current crisis of the global waste

trade by stating: "It seems to be difficult to convey to people from other countries the abhorrence and disgust caused by attempts of others to dump industrial wastes on developing countries."

American Samoa, the Marshall Islands, Papua New Guinea, the Philippines, the Solomon Islands, Tonga, and Western Samoa have received requests to dispose of vast quantities of waste from other countries. All but the Philippines and the Marshall Islands have rejected these schemes.

## The Admiralty Pacific Scheme

In 1988, the Marshall Islands were approached by the U.S. firm, Admiralty Pacific, with a proposal to use U.S. garbage as landfill on the islands. Although the Marshallese have not given final approval to Admiralty Pacific's waste export scheme, the company has attempted to enter into contracts with U.S. waste handlers and begin shipment to the Marshalls by June 1990. The scheme calls for up to 10 percent of the garbage from the U.S. West Coast to be shipped to the Marshalls.

Under the proposal, 23 million tonnes of waste would be dumped by the fifth year. The company's estimated profits during the first year would exceed

\$27 million. Admiralty Pacific claims that increasing the height of the atoll will protect the Marshalls from the sea-level rise predicted in some global warming scenarios (see article, page 71). Additionally, the Marshalls would supposedly earn up to \$56 million by the fifth year of operation.

Officials from Admiralty Pacific insist the garbage would be nontoxic municipal waste, but it must be understood that U.S. household waste contains many dangerous components such as cleaners, solvents, pesticides, and batteries. According to the U.S. Environmental Protection Agency, approximately 0.38 percent of municipal waste is hazardous. While this may seem a low percentage, it means there would be almost 90,000 tonnes of hazardous waste deposited on the Marshall Islands during the first five years of the scheme.

Admiralty Pacific's plan is presently on hold because they have run into significant obstacles. Notably, the consulting firm they wanted to do the environmental impact assessment, Radian Corporation, has refused their offer. Also, many waste handlers are unable to enter into such a contract because of regulations that prohibit shipments of waste across municipal, state, and national boundaries. Finally, many local political leaders in the Marshall Islands are questioning the desirability of such a proposal.

The only solution to the waste problem in the Pacific—and worldwide—begins with a global ban on the export and import of hazardous waste. It is not satisfactory to “control” the trade in waste; this only legitimizes the practice and misleads people into believing that safe methods of waste disposal already exist.

Fortunately, some countries in the Pacific followed the lead of at least 40 developing nations that have banned the trade of hazardous and other wastes. On 30 October 1989, 66 African, Pacific, and Caribbean nations—including Fiji, Kiribati, Papua New Guinea, Solomon



*The Pacific is known for its idyllic natural settings. An international effort to ship waste to these islands has soared in recent years. (Top, courtesy of Greenpeace/Pereira; bottom, Greenpeace/Vallette)*

Islands, Tonga, Tuvalu, Western Samoa, and Vanuatu—reached an agreement with the European Economic Community to prohibit the export of toxic and nuclear waste from the community to the developing nations.

To support this growing opposition in the Pacific, Greenpeace advocates banning waste disposal regionally, nationally, and internationally, and halting the production of waste at its source.

### Waste Trade in the South Pacific

Company	Target	Date	Status
Recycled Energy Inc.	The Philippines	1984	proposed
Admiralty Pacific	The Marshall Islands	1988-89	under discussion
Global Telesis Corporation	Papua New Guinea	1988	rejected
Global Telesis Corporation	The Solomon Islands	1988	rejected
Omega Recovery Services	Tonga	1988	rejected
LPT Development	American Samoa	1987	rejected
LPT Development	Western Samoa	1986	rejected
Boeing	Entire Pacific Region	1980	unclear

Indonesia, the Philippines, the Solomon Islands, Tonga, Vanuatu, and Western Samoa presently ban waste imports.

SOURCE: Greenpeace.

## Dumping for Dollars

**A** California-based firm, Global Telesis Corporation, proposed a disposal facility for U.S. hazardous waste in Papua New Guinea's Oro Province. The plan called for more than 600,000 tonnes of toxic waste to be imported from the West Coast of the United States each month for "treatment" in the proposed \$38-million plant.

Newman Mongagi, premier of the province, supported the plan because it would have brought \$45 a tonne in revenue to his provincial government and \$15 a tonne to the national government. The fees to dispose of toxic waste in the United States range from \$220 to \$2,200 a tonne.

Church leaders and environmentalists expressed concern about the environmental threats posed by the wastes. Dr. Chalapan, chemistry professor at the University of Papua New Guinea, stated that "no government in its right mind would allow toxic wastes to be shipped through international waters and dumped here. Why can't the Americans dump their own waste in their own backyard?"

—SAH

### Nuclear Testing in the Pacific

Greenpeace was born in 1971 in the Pacific, when it challenged U.S. nuclear-weapons testing on Amchitka Island, Alaska. The test site was abandoned and developed into a bird sanctuary.

This encouraged then-activist and now-Chairman of Greenpeace International, David McTaggart, to sail to Mururoa, French Polynesia in 1972 and 1973 to protest the French nuclear-testing program that began there in 1966. People throughout the Pacific strongly opposed the French testing; only three years earlier there had been hope for a nuclear-free

region when the United States, Britain, and the Soviet Union halted their Pacific testing programs under the Partial Test Ban Treaty of 1963.

In 1974, Australia and New Zealand won a World Court ruling against France on the basis that the French tests polluted their national territories. France ended its atmospheric testing program a year later, and moved the program underground.

Greenpeace's present campaign against French testing in the Pacific is part of a worldwide campaign to end all weapons testing by the five-member nuclear "club"—France, the United States, Britain, the Soviet

Union, and China. Greenpeace also has challenged U.S. nuclear testing activities, and has worked with the people of the Marshall Islands who suffer from the effects of 66 atmospheric nuclear weapons tests carried out between 1946 and 1958.

In 1985, the first major campaign of the original *Rainbow Warrior* was to relocate 308 people from the highly radioactive island of Rongelap, in the northern Marshall Islands, to an uncontaminated atoll further south (see page 48). Greenpeace supports the people of Rongelap in their efforts to obtain an independent environmental and health survey of their home atoll.

### Riddled With Holes

But the campaign against the French has a particular urgency because of the very serious environmental damage that is occurring at Mururoa. Greenpeace argues that atolls cannot be relied on to contain the radioactivity produced by underground nuclear tests.

For underground testing, warheads are detonated in shafts 800 to 1,000 meters deep that are sealed off with cement to prevent atmospheric contamination. The explosions create huge cavities that then fill with molten rock and radioactive debris.

After more than 100 underground explosions, Mururoa is now so riddled with holes that it has been likened to a piece of Swiss cheese. The layers of coral, dolomite, and basalt that make up atolls are bound to fracture over long periods of time. Pressures from waves, winds, and currents, compounded by shock waves



from the tests themselves, are continuous stresses.

The French have not permitted any independent scientific team to undertake a thorough study of Mururoa. Three brief investigations, including a trip by Jacques-Yves Cousteau in 1987, visited only places allowed by the French authorities. All three expeditions revealed serious geological problems with the atoll—deep cracks and fissures, evidence of submarine slides, and subsidence. In addition, there seem to be periodic and frequent ventings and leaks into the lagoon test area and the open ocean, which have unknown consequences.

Construction work at the atoll connected to the testing program may also contribute to other environmental problems, particularly the increasing incidence of ciguatera, a form of food poisoning. This devastating illness comes from eating fish containing toxins from a coral reef dinoflagellate (as does paralytic shellfish poisoning, the well-known sickness caused by red tides off North America). Ciguatera outbreaks are brought on by disturbances in the reef ecology.

Tilman A. Ruff of the Department of Social and Preventive Medicine of the Alfred Hospital in Prahran, Australia, has documented ciguatera reports in the Pacific islands. He found that wherever the French military has built bases or test sites, outbreaks of the disease have followed. From 1973 to 1987, French Polynesia reported three times the regional average.

In early 1988, the Commander of the French Navy in the Pacific and the Pacific Test Center, Vice-Admiral Edouard Pierre Thireaut, announced that to prevent further serious damage to Mururoa, the more powerful blasts would be conducted at Fangataufa, 37 kilometers away. Fangataufa is a smaller coral atoll, already heavily contaminated by the atmospheric tests of 1968—so much so that it was declared off-limits for six years.

Relocating nuclear testing to an equally vulnerable atoll a



*At top, an aerial view of Mururoa in French Polynesia, where (middle) the French prepare a site for nuclear-weapons testing. At bottom, drilling rigs in the lagoon bore holes as much as 1,000 meters deep for nuclear tests. (Top, photo by Jean Gaumy/Magnum; middle, Robine/Agence France-Presse; bottom, Herrmann/Sipa Press)*

few kilometers away is extremely irresponsible. By 1963, the United States and Britain had already assessed that atolls permeated with water are not suitable for subterranean explosions, and the U.S. and British tests were moved to Nevada.

### The Pacific Pays the Price

Greenpeace objects to the Pacific paying the environmental price for the weapons tested there by France, weapons tested against the wishes of the local people, and against the political will of the region. The weapons are for the French stockpile and will be carried aboard French naval vessels. Under the 1958 Euratom Treaty the Commission of the European Community has the responsibility for monitoring health and safety procedures for "particularly dangerous experiments" undertaken by member states, which include France. Greenpeace argues that this covers French nuclear testing in the Pacific and that the European Community so far has not shouldered this legal obligation.

The South Pacific Regional Environmental Program (SPREP) treaty, signed by 15 countries, including France, was designed in 1986 to protect the Pacific from all sources of pollution, including nuclear testing. It obligates the signatories to notify others in the region in the event of accidents or "pollution emergencies."

The treaty has not yet entered into force because only six out of a required ten countries have ratified it. In the meantime, as with any treaty, all signatories should comply with the spirit of the SPREP until it becomes official. Therefore, France's planned move to Fangataufa and continued testing at Mururoa should be challenged by both their European and Pacific treaty partners.

Few people argue that the area most affected by nuclear weapons testing is the Pacific Region, whether the programs are conducted by France, the United States, or Britain. Pacific countries long have championed the idea of the region becoming a nuclear-free zone, and in 1985

adopted the South Pacific Nuclear Free Zone Treaty.

This 1985 treaty is the culmination of a series of regional nuclear-free zone proposals since the early 1960s. Its main objective is to ensure that the region is free of nuclear weapons. It has been signed and officially ratified by Australia, the Cook Islands, Fiji, Kiribati, Nauru, New Zealand, Niue, Tuvalu, and Western Samoa.

Despite such regional protests, France conducted at least 44 atmospheric tests in the Pacific—39 over Mururoa and 5 over Fangataufa. And since 1975 they have tested at least 117 weapons underground—112 at Mururoa and 5 at Fangataufa.

Two goals of the Greenpeace Nuclear Testing and Pacific Campaigns are 1) the Pacific Test Site should be closed down, and there should be no relocation of nuclear testing from Mururoa to Fangataufa; and 2) a comprehensive test-ban treaty should be enacted and adhered to by all nuclear countries, including France and China who have not yet signed the Partial Test Ban Treaty of 1963.

Greenpeace also advocates that an independent international scientific team, including medical and geophysical specialists, should investigate the health and environmental effects of nuclear testing in Polynesia, with unrestricted rights to visit, interview, and take samples as they deem necessary. Also, as inherent parts of the marine environment, all low-lying coral atolls in the Pacific should be declared specially protected areas, and thereby protected from such hazardous activities as nuclear-weapons testing.

Greenpeace believes that nuclear-weapons testing is part of nuclear weapons production and proliferation. This point must be underscored on the eve of the Fourth Review Conference on the Treaty for the Non-Proliferation of Nuclear Weapons. This treaty, ratified by 96 countries since 1968, aims to stop the arms race among the five nuclear-weapons states, and to prevent nuclear material and

technology from spreading to other countries. The treaty may expire in 1995 unless plans to extend it are initiated at this next review conference in autumn 1990.

### High-Seas Driftnets

Another damaging factor in the Pacific are the high-seas driftnet fisheries. These nets ravage both the northern and southwestern Pacific, and threaten the high seas with ecological disaster on a par with the effects of ozone depletion and the "greenhouse effect." Japan, Taiwan, and South Korea operate driftnet fisheries in the region.

High-seas driftnets are large gillnets\*—more than two kilometers long—deployed in international waters. A single driftnet vessel can put out 74 kilometers of driftnet to a depth of 14 meters in a single setting.

High-seas driftnetting is an indiscriminate fishing method; it catches and kills virtually all creatures that swim into it, from entire schools of tuna and salmon, to dolphins and small whales. The net is so sheer that it cannot be seen by diving birds or detected by dolphin sonar.

Marine creatures, in search of food and lured by fish already caught in the net, swim or dive into the plastic web where they become entangled. Hundreds of thousands of seabirds and tens of thousands of marine mammals drown in driftnets annually (see box, page 79).

Driftnetting also is highly wasteful. As much as 40 percent of the catch in the South Pacific tuna fishery falls out of the net while it is being hauled back into the boat. Many of these lost fish eventually die from their injuries, or are caught later by longline and troll fisheries. Many are badly net-scarred and therefore less marketable.

Driftnets make sound ecological management of fisheries resources impossible. These fisheries are rapidly depleting the fish stocks, such as albacore tuna,

\* Standard gillnets are panels of strong plastic webbing suspended vertically in the water by floats attached to the top and weights attached to the bottom.

that the fragile economies of South Pacific island nations depend on for survival.

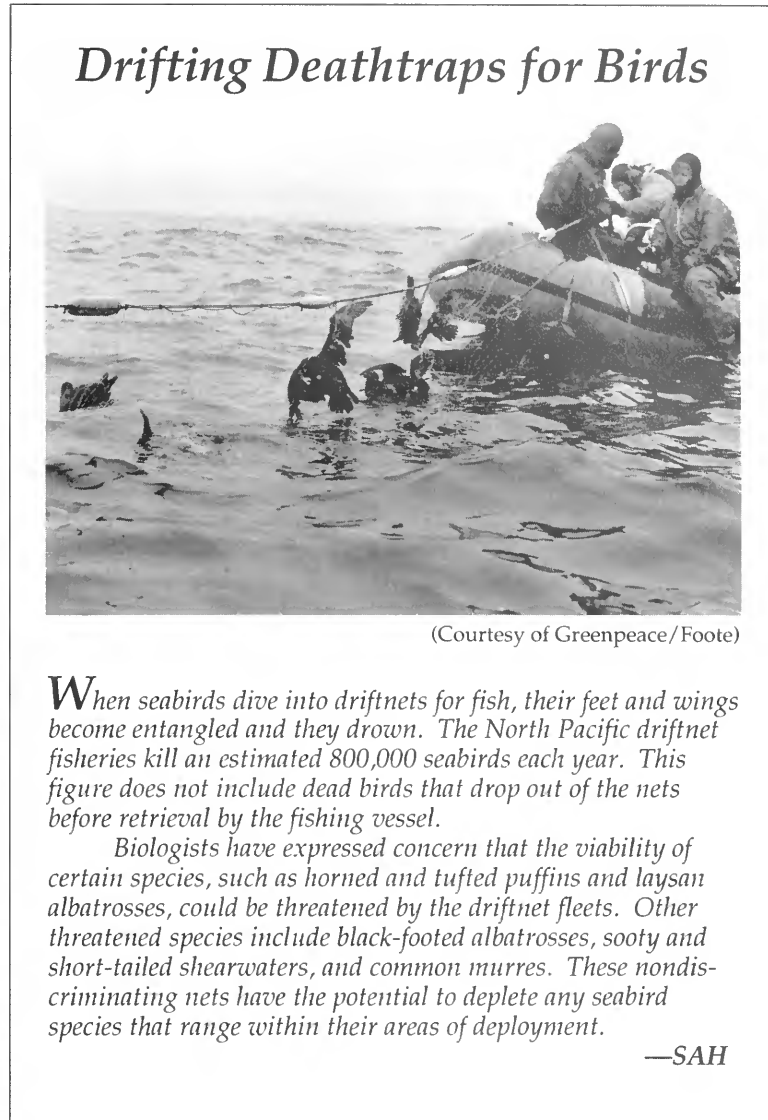
During the fishing season in the North Pacific, the 1,400-vessel Asian fleet sets more than 37,000 kilometers of net each night. In the South Pacific, where driftnetting is just beginning, in 1988 and '89 a 190-vessel fleet set more than 11,000 kilometers of net each night.

The North Pacific salmon driftnet fishery is the only one regulated by an international fisheries convention. During the last week of September 1989, the United States and the Soviet Union concluded an unofficial agreement concerning driftnets in the North Pacific. Discussions included collaboration on scientific research, monitoring the fleets, and possible sanctions.

The remaining North Pacific fisheries for squid, tuna, and billfish, as well as the tuna driftnet fishery in the South Pacific, are totally unregulated. Japan, however, agreed in September 1989 to reduce the size of its southwestern Pacific fleet. However, the Japanese have reduced neither the size nor the total nightly deployment of their nets. It is possible that the ships removed from the southwestern Pacific fleet will simply join the North Pacific fleet. Japan, Taiwan, and South Korea have rejected requests to start up objective international regulatory programs, probably because they fear a global ban on driftnetting.

Declining stocks of North American salmon can be linked to driftnet fisheries. American and Canadian fisheries scientists have shown that Japan's salmon driftnet vessels are catching salmon on the high seas that would normally return to North American waters and be taken by U.S. or Canadian fisheries, or return to their streams of origin to spawn. The squid driftnet fleets of Taiwan, Japan, and South Korea all operate in areas inhabited by North American salmon and steelhead.

Concerns about the decline of salmon stocks led the fishing industries of the United States and Canada to demand a rapid phase-out of high-seas driftnet



(Courtesy of Greenpeace/Foote)

## Drifting Deathtraps for Birds

*When seabirds dive into driftnets for fish, their feet and wings become entangled and they drown. The North Pacific driftnet fisheries kill an estimated 800,000 seabirds each year. This figure does not include dead birds that drop out of the nets before retrieval by the fishing vessel.*

*Biologists have expressed concern that the viability of certain species, such as horned and tufted puffins and Laysan albatrosses, could be threatened by the driftnet fleets. Other threatened species include black-footed albatrosses, sooty and short-tailed shearwaters, and common murre. These nondiscriminating nets have the potential to deplete any seabird species that range within their areas of deployment.*

—SAH

fishing. In addition, the Soviet Union has formally notified Japan that it intends to curtail and eventually phase out all Japanese allocations of high-seas Soviet-origin salmon.

### Threatened Economies

The recent movement of driftnet fleets into the South Pacific threatens the southern albacore tuna stock, but also the economies of island nations such as Tuvalu, Kiribati, and Western Samoa. These island nations have little to sell apart from the right to fish in their 200-nautical mile Exclusive Economic Zones (EEZs).

Even larger Pacific states, such as New Zealand, Papua New Guinea, and Fiji, rely on fishing as a major part of their economic development plans. During their first commercial season, the Asian driftnetters worked international waters on both coasts of New Zealand, and took roughly 45,000 tonnes of albacore—five times the amount ever taken before. Scientists predict the collapse of the surface albacore fishery within two to five years if driftnet operations continue.

Ironically, driftnetting also has a serious impact on the Asian fishing industries themselves. Since most of the tuna taken by driftnetters are juveniles, driftnet

fleets deny the long-line boats of Japan, Taiwan, and South Korea (as well as New Zealand and other island states) the opportunity to catch adult fish after spawning.

Long-liners generally operate in territorial economic zones and pay island governments for the right to do so, providing a valuable source of revenue to each party. Meanwhile driftnetters operate in international waters and pay nothing.

Despite the threats driftnetting poses for Pacific economies, driftnet fishing is spreading rapidly to other oceans around the world. Unless an international ban is negotiated soon, this technology will become more entrenched, which would have devastating consequences for coastal fishermen and fish stocks.

The South Pacific states have opposed driftnetting with considerable solidarity. All 15 South Pacific Forum\* countries have banned driftnet fishing and vessels from their EEZs. Shipments of driftnet-caught tuna are prohibited within these zones as well. No driftnet vessel is welcome in any South Pacific port for maintenance, refueling, or supplies. New Zealand has threatened any driftnet boat found in its EEZ with arrest, confiscation of the vessel, and fines against the skipper and crew.

\*The South Pacific Forum is a self-governing regional body to discuss local military and economic issues. Recently, it has begun to address environmental problems. The 15-member countries are Australia, the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Nauru, New Zealand, Niue, Papua New Guinea, the Solomon Islands, Tonga, Tuvalu, Vanuatu, and Western Samoa.

## Pacific Sea Turtles Threatened



**B**y now just about everyone has heard about the plight of Atlantic sea turtles: leatherbacks stranding on New England beaches, Gulf of Mexico loggerheads drowning in shrimp nets, Kemp's ridley turtles with hurricane-ravaged nesting beaches, and Cayman Island green turtles being ranched for European gourmet turtle soup. But we rarely hear about the sea turtles of the Pacific, which are also in dire straits.

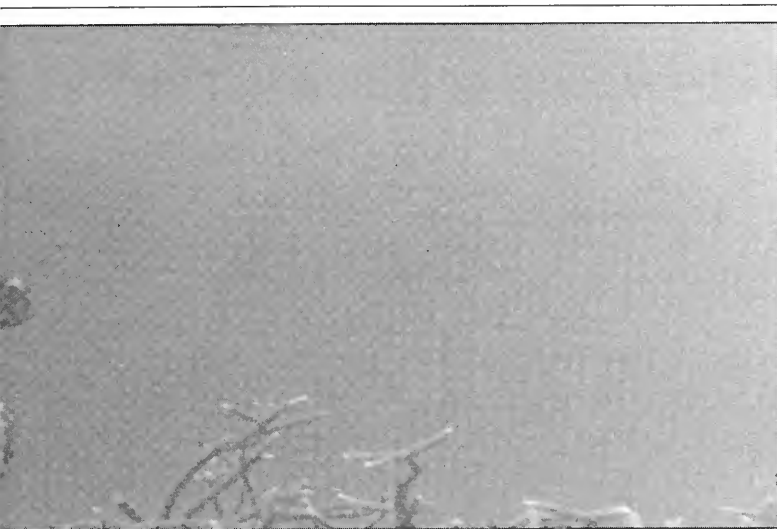
There are seven sea turtle species throughout the Pacific, namely the green turtle, *Chelonia mydas*; Pacific green turtle, *Chelonia agassizi*; hawksbill, *Eretmochelys imbricata*; leatherbacks, *Dermochelys coriacea*; loggerhead, *Caretta caretta*; olive ridley, *Lepidochelys olivacea*; and Australian flatback turtle, formerly *Chelonia depressa*, now *Natator depressus*.

Historical records from the Pacific coast of Central America, associated offshore islands, and areas of the western Pacific including Malaysia and Indonesia, have shown dramatic decreases in the populations of virtually all of these species. International conservation organizations have determined that these sea turtles are close to extinction and all seven species are now protected under international law by the Convention on the International Trade in Endangered Species.

People collect the eggs from the nesting beaches for local consumption. (Many tropical cultures believe the eggs are aphrodisiacs.) Harvesters catch the turtles for meat, shell, calipee (a locally-consumed delicacy made from the protective underbody of the turtle shell), oil, and skin. Centuries ago the great sailing ships would stop over in the Galápagos Islands, not to marvel at Darwin's finches, but to load up on live green turtles, which would stay alive unattended in the ship's hold for several months.

Harvest for skins, calipee, and oil is artisanal and low-level, but harvest for shells supports a highly lucrative international trade that has not diminished even in light of strict laws protecting these endangered species. Most of the shells go to Japan to supply the high-fashion industry with eyeglass frames, hair combs, bracelets, and the like. Japan annually imports some 27 tonnes of tortoiseshell, much of it coming from the beautiful hawksbill turtle.

Sea turtles of the Pacific are also falling prey to other perils. Coastal pollution in many tropical and subtropical areas threatens



(Courtesy of Aaron Tinker)

*critical habitats of most sea turtles. And high levels of coastal development, particularly near white sandy beaches, destroy the turtles' nesting habitats.*

*Offshore pollution is another threat to sea turtles. Hatchlings instinctively swim for two to three days from the nesting site to the open ocean, then drift and feed along ocean currents. These offshore currents merge to form driftlines, and all the materials they are carrying—hatchling turtles as well as toxins such as oils—become concentrated. The late Archie Carr, a turtle researcher, found dead and moribund animals along these polluted driftlines.*

*The few turtles that survive these onslaughts may later have to contend with entanglement and incidental capture in fishing gear, buoy lines, miles upon miles of driftnets, seines, and the like. Additionally, the dumping of plastics into the sea annually leads to the death of hundreds of adult turtles and countless hatchlings, which mistake bits of plastic for food and die of intestinal blockage.*

*Recently there have been attempts to protect Pacific turtles. Local residents in many countries are beginning to see that living turtles can generate more profit in the form of ecotourist dollars than can dead ones. Rather than standing by watching their turtle resources being depleted (most often by people from outside the local area), coastal residents are trying to preserve them and have started turtle-watching cruises. The money generated from these boosts local economies.*

*Locals have set up progressive beach patrolling projects in Central America, Australia, Malaysia, and Sri Lanka to ensure that at least some nests are successful. They aim to ward off "egggers" who rob nests for profit. They also have established hatcheries where clutches of eggs can incubate undisturbed. In addition, coastal countries in the Pacific Region are setting aside more marine parks to protect vitally important foraging habitats. In recognizing the importance of sea turtles as living resources, local people may become the turtles' only salvation.*

**—Tundi Agardy  
Marine Policy Center  
Woods Hole Oceanographic Institution**

The South Pacific Forum countries are presently developing a treaty for a regional management regime to conserve their living marine resources and exclude driftnet fishing from the region. The U.S. Congress passed a resolution in early November 1989, endorsing the ban on driftnet fishing in the South Pacific. In addition, both New Zealand and the United States have launched initiatives at the UN General Assembly.

The UN resolution, introduced by the United States on 2 November, calls for a worldwide ban on driftnet fishing, beginning 1992. Greenpeace hopes for a quick political remedy to this stripmining of the seas as well as to the waste trade and nuclear testing that are damaging the Pacific environment. □

#### **Acknowledgments**

Thanks to Bunny McDiarmid, Pacific Campaign Coordinator, as well as Rebecca Johnson, Alan Reichman, Mike Hagler, Ann Leonard, Lafcadio Cortesi, Lesley Stone, Jeanne Kirby, Kathleen Bryan, and Paula McKay for their invaluable help with this article.

*"The best toys teach subliminally...  
...while you are having fun"*

— Dr. Athelstan Spilhaus

**K**ids...what are you gonna do with them?

It's so important to teach them the right things these days. With the many social concerns about America's youth, how can we train them about the world around them. Sure, you can teach them to drive a car or use a typewriter...but you need to train their minds also.

Dr. Athelstan Spilhaus, world-renowned oceanographer, meteorologist,

sculptor, and author of books, monographs and a comic strip, is taking a step in the right direction through the creation of a series of toys designed to teach our children about the world around them. A collection of maps, puzzles and other toys are used to teach children geography and science while they're having fun.

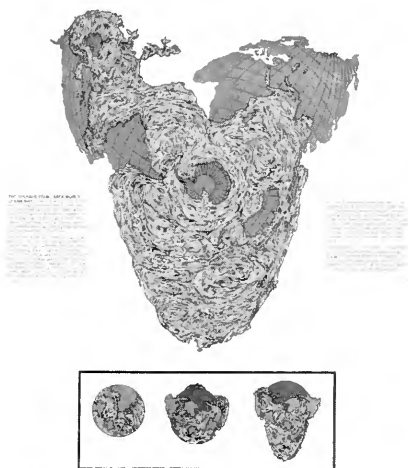
...and that's the best way to teach a child.

### World Ocean Map

The Spilhaus Projection shows continents and oceans uncut by map edges. Text provides fascinating facts about our planet which is 72% water! This 24" x 36" creation is a beauty and suitable for framing. Laminated.

Just one of the many  
GeoLearning products.

### WORLD OCEAN MAP (SPILHAUS PROJECTION)



For more information and sales, contact:

**GeoLearning Corporation**  
P.O. Box 2042  
Sheridan, WY 82801  
(307) 674-6436

**WHERE WE WERE**  
...  
**WHERE WE ARE**  
...  
**WHERE WE'RE GOING**  
...

LEARNING

# Are Dolphins Being Deafened in the Pacific?

by Kathy Glass

Oil spills, driftnets, the tuna purse-seine fleet—publicity waxes and wanes but the problems continue for marine mammals. A long-running and little-known abuse, however, is the deployment of explosives on dolphin schools. The U.S. Secretary of Commerce will make a decision in April 1990 on the legality of this fishing practice common in the Pacific, the effects of which are now under study by the Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA Fisheries).

Explosives are a key part of the fishing technique known as "setting on dolphins" favored by the tuna purse-seine fishery in the eastern tropical Pacific (*Oceanus*, Vol. 21, No. 2, pp. 31–37). In this region, large yellowfin tuna form mixed schools with dolphins, providing fishermen with a convenient way to net tuna: simply locate and herd the dolphins on the surface. The explosives of choice are devices known as "seal bombs," originally designed to discourage seals from interfering with fishing operations on the Pacific Coast.

During a tuna chase, the bombs are thrown from helicopters and speedboats to slow down and confuse dolphins, which react by forming protective schools. Once the dolphins are gathered into a school, the fishermen encircle them with a mile-long net. As the net is being set, more bombs are exploded at its open side to keep

the dolphins and tuna from escaping until the two ends of the net meet and the purse seine is complete.

The U.S. tuna fleet represents only about 20 percent of the international tuna fleet from southern California to Chile. The U.S. fleet estimates that they bomb and encircle approximately 17 million dolphins a year; and since the total dolphin population in the eastern tropical Pacific is roughly estimated at 7 million; many of these dolphins probably are set upon repeatedly. In a single set, dozens, even hundreds, of seal-bombs may be detonated.

Many dolphins die from drowning, fatigue, or injuries sustained in the nets. In the general chaos of encirclement, it is impossible to distinguish the effects of explosives from that of the purse-seine maneuver alone. Yet temporary or permanent hearing loss resulting from the close-range detonation of seal bombs could well be lethal to dolphins, which depend on their highly specialized hearing to forage, communicate, and navigate. But like the animals that are tossed severely injured but not yet dead from the fishing vessels' decks, dolphins with fatal hearing damage will never enter the mortality statistics.

## Catch 22 Hinders Research

The U.S. Congress considered the explosives issue during Marine Mammal Protection Act

(MMPA, *Oceanus*, Vol. 32, No. 1, pp. 21–25) reauthorization hearings in 1988. At that time, the environmental community proposed an immediate ban on the use of explosives in the tuna fishery, while the NOAA Fisheries countered that explosives are not detrimental to dolphins. The outcome was an amendment to the MMPA limiting the use of explosives to "Class C" devices, in which the component producing the audible effect may not legally contain more than 2.59 grams of explosive material.

Congress also ordered the Secretary of Commerce (overseer of NOAA) to study whether explosives contribute to "physical impairment or increased mortality" of dolphins, and decide by April 1990 whether to prohibit or restrict their use. The burden of proof falls on NOAA Fisheries to show that dolphins are *not* harmed by Class C explosives. It's a heavy burden, as the actual effects on dolphins are difficult to determine with certainty.

It is generally agreed, however, that dolphins' dual sense of hearing and echolocation is their most well-developed and important sense, and that they rely upon sound more than any other mammal, with the possible exception of bats. Their extreme sensitivity to sound implies a greater potential for damage, but one can only make logical assumptions without actually measuring hearing loss due to seal bomb blasts in controlled tests. The irony of the situation is that what is allowed every day at sea is too



When dolphins and tuna school together, fishermen herd the dolphins on the surface using seal bombs. The dolphins and tuna are then encircled in a large purse-seine net. (Courtesy of Earth Island)

inhumane to stage as an experiment—or at least would require extensive permit paperwork under the MMPA. Such a study would be “invasive and potentially cruel,” according to NOAA Fisheries.

In its studies, NOAA Fisheries has been open to suggestions for less-invasive experiments, and is reporting its progress in a series of “status summary” memos that are circulated to scientists, the fishing industry, seal-bomb manufacturers, and members of the conservation community prior to a workshop on the issue in late November 1989.

There are many uncertainties, but considering the explosive power of seal bombs—190 decibels at source—and the frequency with which dolphins in the eastern tropical Pacific undergo this “acoustic harassment” (to use the fishing industry’s own term), it’s not far-fetched to assume that use of explosives to frighten and herd dolphins is detrimental to the animals’ well-being, and contrary to the letter and spirit of the MMPA.

### The Potential for Injury

While there are no data on dolphins’ susceptibility to hearing loss caused by nearby

explosions, the immediate effects can be imagined by anyone who has ever been temporarily deafened by a loud and unexpected noise. It is frightening, disorienting, and painful. In the case of dolphins, this comes on top of the stress and exhaustion of a chase. Dolphins are likely to lose their orientation to other sounds, such as the skiff and purse-seine motors and distress calls from other dolphins. Bubbles from the underwater explosions create a barrier that further hinders sound perception. Panic rises, and the danger of entanglement increases.

According to Ken Norris of the Long Marine Laboratory in Santa Cruz, California, explosives may contribute to the “stress syndrome” observed with encircled spinner dolphins, *Stenella longirostris*, which often stop swimming, and then sink and drown. This theory suggests that important spatial relationships within a dolphin school are disturbed by being corralled in a tuna net, and temporary deafness contributes to the disorientation. It’s also possible that inner-ear damage resulting from the concussion of seal bombs upsets equilibrium and surface-orientation, a distressing predicament as anyone who has suffered from “swimmer’s ear” or other ear

problems knows only too well.

In addition to temporary deafness, dolphins may sustain some permanent hearing loss. Laboratory studies on various other mammals show that partial hearing loss results from repeated shots of a .22-caliber pistol, which has a sound-wave form similar to that of a seal bomb, although with less explosive power (approximately 150 decibels at source).

This high-impulse noise\* may be even more damaging to fetuses than adult animals. In chicks exposed to such noise while still in the shell, the initial damage is eventually extended to reception at higher frequencies as the ear’s basilar membrane develops over time, and frequency-reception positions shift along the Organ of Corti (in the cochlea). Whether dolphins are similarly affected is unknown but certainly possible.

The effects of any hearing loss can be far-reaching. Because dolphins rely on echolocation and hearing to maintain communication and spatial relationships in a school, temporary deafness or permanent partial hearing loss could adversely affect social structure and the working efficiency of a dolphin school. Whether this is indeed the case, we may never determine. NOAA Fisheries observers, however, have documented that:

- Dolphin mother-calf pairs are sometimes broken up by encirclement;
- Dolphin schools often are scattered on release; and
- Shark attacks in the vicinity of tuna sets on dolphins are common.

To what degree these adverse effects are caused or exacerbated by the use of explosives is not clear. However, there can be little doubt that it contributes to the problems. The fate of dolphins that survive encirclement but possibly sustain hearing

\* A high-impulse noise is one of relatively high sound pressure distributed over relatively little time.



damage is another unknown, although many scientists agree that a deaf dolphin or a dolphin without a school is a dead dolphin.

### Seal Bombs Save Dolphins?

The tuna industry claims one more use for explosives in its fishing operations. Perhaps in response to public pressure, tuna industry spokespeople indicated before the U.S. Congress in 1988 that seal bombs are used to save dolphin lives. The bombs are sometimes tossed into nets to drive dolphins over the trailing edge during the "backdown" procedure, to give dolphins an opportunity to swim free before the net is hoisted. But since panic is a main cause of dolphin deaths under these circumstances, detonating more bombs in the immediate vicinity would seem to compound the problem.

It will be interesting to see what arguments the tuna industry, and perhaps NOAA Fisheries, will marshal in coming months to support claims that explosives don't harm dolphins. Tests that approximate actual conditions are virtually impossible to devise.

NOAA Fisheries is now studying dolphin cochleas that may have been exposed to seal-bomb blasts, instructing observers on tuna vessels to remove and fix in preservative the cochleas of dolphins that die in the nets. These are to be examined later by scientists for evidence of damage. A major problem with this study, however, is that energy of the explosions that the dead dolphins were exposed to is unknown. A July 1989 NOAA Fisheries memo admits "the implications of any conclusions that could be made from such an examination [of cochleas] will be questionable."

Whether or not the results look "questionable," NOAA Fisheries has a history of siding with the tuna industry rather than the dolphins (see *Oceanus* Vol. 32, No. 1, pp 103-108) and is unlikely to prohibit all use of

explosives. And since current restrictions on seal bombs are routinely violated and poorly enforced, anything short of a complete ban will accomplish little.

Of course, the entire debate might seem peripheral to some, when tens of thousands of dolphins are killed outright each year in tuna nets. But recognition of the possible increase in dolphin mortality due to hearing loss gives a more complete picture of the problem. Statistical proof may be nearly impossible to obtain, but to assume that the explosives are harmless—as the tuna industry and its regulatory agencies have done for years—seems a careless conclusion indeed. □

### Acknowledgments

Background for this article came largely from David Phillips of Earth Island Institute, NOAA Fisheries research summaries, and the resources of the International Marine Mammal Project.

### Letters Policy

*Oceanus* invites your comments on our articles and issues concerning the marine scientific community. The publisher disclaims all responsibility to return unsolicited editorial matter, and all rights in portions published thereof remain the sole property of *Oceanus* magazine. Letters to *Oceanus* or its editors become the property of the magazine, and are assumed to be intended for publication and republication in whole or in part, and may therefore be used for such purposes.

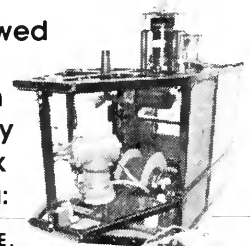
## Oops!

On pages 4 and 5 of Vol. 32, No. 1, because of editing errors, the International Whaling Commission's 1982 moratorium on commercial whaling was said to be ending in 1991. In fact, the moratorium will be reviewed by 1991, and it will end only if a three-quarters majority votes to end it. Given the largely conservationist composition of the commission, this is highly unlikely.

On page 40 of Vol. 32, No. 3, there were editing errors in the two tables. In Table 2, the units should be millions of long tons, not thousands, and in Table 3, the dollar values should be billions rather than millions.

## SHIPWRECK OR SUBMERGED TARGET

The Towed Survey System is ready to work for you:



LOCATE,

IDENTIFY,

AND SURVEY

- Proven Worldwide Performance  
Arctic to South Pacific
- Complete Services  
Side-scan sonar, long-range scanning sonar (C.T.F.M) towed survey sled with tethered ROV system.
- Our Customers Include:  
Insurance, salvage, military, scientific, motion picture and commercial organizations.



P.O. Box 622, Falmouth, MA 02541  
Tel. 508-540-6732 FAX 508-457-9680

## The 1st International Submarine Races

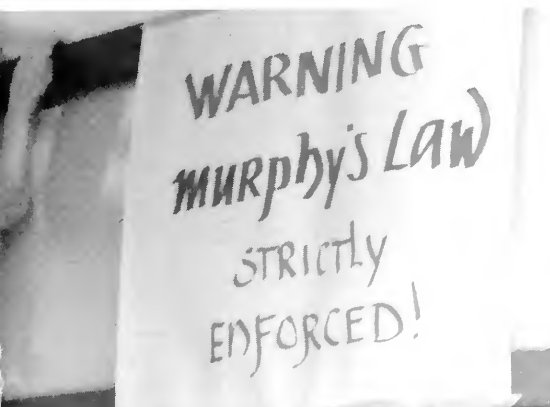
# Sub Humans Sink



Above, Hap Perry relaxes with the crew of Squid from the U.S. Naval Academy, winners of the "Overall Performance" prize. Left, Cal Poly's crew and Subversion were awarded best "Overall Performance by an Academic Institution." (Courtesy of the H. A. Perry Foundation)

# to New Heights

by Sylvia A. Earle



*Murphy's Law was not violated, despite conspiracies by engineering wizards Al Vine, Athelstan Spilhaus, and Cliff Gowdy—lower photo, left to right. (Upper photo by Sylvia Earle; bottom by Peter Britton)*

Muscle power propelled Matthew Biandi on the surface of the water at a record-breaking 3.96 knots in the 1986 Olympics; some dolphins and whales travel through the sea at speeds in excess of 35 knots; and certain species of tuna can move even faster. But how fast can humans—using muscle power—propel themselves underwater in small submersibles? In June 1989, there was a chance to find out.

The H. A. Perry Foundation of Bethesda, Maryland, and Florida Atlantic University's Department of Engineering issued a challenge that proved to be irresistible to 17 groups of would-be submariners: "To design, build, and then race a two-person, human-powered submersible through an underwater course."

According to founder Henry A. Perry, the rationale for the First International Submarine Race was very straightforward. Competitive races have inspired human creativity and ingenuity to solve the technical problems of moving through the air and over the ground—why not through Neptune's realm as well?

Perry recognized that there are profound lessons to be learned about propulsion, hydrodynamics, and life-support from building and operating small subs, and hoped to attract and inspire students of various engineering disciplines to look at the opportunities for problem-solving beneath the waves. As incentives, the foundation promised awards for cost-effectiveness, innovation, speed, and overall performance, with a Grand Prize of \$5,000 for the highest total score.

The prize money was a nice dividend, but as the teams assembled in West Palm Beach, Florida, in mid-June 1989, it was clear that there was much more at stake. No one even talked about the money; but everyone talked about clever solutions, elegant shapes, exquisite finishes, brilliant propulsion ideas, outrageous color schemes—and all-around excellence.

The response delighted on-lookers. Seasoned engineers mixed happily with aspiring students and a great assortment of ocean-loving people for several long days (and nights) of final preparation, trials, earnest discussions, tinkering, and, of course, time underwater with ingenious variations on the theme of human-powered subs.

---

*Sylvia A. Earle is a Research Biologist at the California Academy of Sciences, and President of Deep Ocean Engineering, Inc. of San Liandro, California.*



Many subs received last-minute attention. In this case, Cal Poly's crew tinkers with Speedstick, one of their three entries. (Photo by Sylvia Earle)

Strolling around, I caught a glimpse of Al Vine (see profile, *Oceanus*, Vol. 31, No. 4, pp. 61-66), sharing engineering insights and a few sea stories with some of his admirers. Al helped design the Woods Hole Oceanographic Institution's famous three-person submersible *Alvin*, which is officially named after him. A cluster of students surrounded hydrodynamics wizard Cal Gongwer, quizzing him about the design philosophy behind his spherical sub, *Knuckleball*, and the Gongwer propulsion system used on another vehicle, *HPS Gossamer Albacore*.

Smiling contently at the whole scene was John Perry, a renowned pioneer in underwater design, who expressed great satisfaction with the event that his son had helped to generate. So did a student who remarked (shaking his head in consternation after being pushed around underwater by an unexpected current): "I've learned more about

ocean engineering in the past few days than in 3 years of college." (He didn't say which college.)

Such unexpected currents and inclement weather interfered with the Race Committee's well-laid plans, and caused several alterations in the 0.33-kilometer race course. Rain, of course, was no problem for a submarine race, but the accompanying brisk wind and high waves endangered the safety of those underwater as well as those monitoring from above. Modified guidelines were used to evaluate winners, based on runs made during the time available. The judges, headed by J. Bradford Mooney, Jr., Director of Harbor Branch Oceanographic Institution of Fort Pierce, Florida, and former Chief of Naval Research and Oceanographer of the Navy, decided on the following awards.

**Cost Effectiveness:** *Humpsub* of the Applied Physics Laboratory, University of Washington.



The crew of Sub-Human, from Sub-Human Projects, remained incognito next to their cool, sleek design. (Photo by Sylvia Earle)



FAU's crew proudly displays their creation, FAUtilus, winner of the "Flair and Flamboyance" award. (Courtesy of H. A. Perry Foundation)

**Innovation:** *HPS Gossamer Albacore* of Lockheed Advanced Marine Systems, Los Angeles, California.

**Speed:** *Subversion* of Cal Poly, San Luis Obispo, California.

**Overall Performance,** and winner of the \$5,000 first prize: *Squid* of the U.S. Naval Academy, Annapolis, Maryland.

Some special awards were also declared. The E. I. DuPont de Nemours Company of Wilmington,

Delaware, sponsored an award for the "Best Use of Composite Materials," won by the U.S. Naval Academy's *Squid*. The Naval Coastal Systems Center of Panama City, Florida, provided awards for "Overall Performance by an Academic Institution," with Cal Poly taking first by virtue of the performance of its multiple entries, particularly *Subversion*; the U. S. Naval Academy placed second; and Florida Institute of Technology (FIT) came in third.

The magazine *Subnotes* of Spring Valley, California, offered an award for "Most Flair and



The flawless finish on Humpsbub reflects a beaming crew from the University of Washington. Their low-cost design, superb craftsmanship, and good speed shone through the races and earned them the "Cost Effectiveness" award. (Courtesy of H. A. Perry Foundation)



Minus a few threads, Innerspace Corporation pitched an unpredictable Knuckleball. Their strategy was speed, provided by a unique arm-driven propeller. Late-breaking damages caused them to withdraw, but they still scored with the "Sportsmanship and Intestinal Fortitude" award. (Courtesy of Benthos, Inc.)

Flamboyance," which was handily won by the sub *FAUtilus*, and its supporting team from Florida Atlantic University. The American Society for Engineering Education's award for the "Most Innovative Student Design" went to the team from the Massachusetts Institute of Technology for their sub, *Icarus*.

The award for "Sportsmanship and Intestinal Fortitude," offered by the Roy Marokus Professional Corporation of Edmonton, Alberta, went to the *Knuckleball* team from Innerspace Corporation of San Diego, California. The team was notable for their stiff upper lips in the face of fatal damage to their craft early in the race trials. And finally, the judges gave a special "Judges Prize" to *Spuds*, from the University of New Hampshire.

### A Roster of Radical Designs

Some of the rationale behind these decisions was offered in a commentary by Ralph Osterhout, member of the panel of judges, and Chairman and Founder of TEKNA, Inc., of Redwood City, California. Ralph also held the unique job of Underwater Start Judge.

### Nicole's Nickel

Tennessee Tech's entry was the most ambitious from an innovation standpoint, as this vehicle had no external control surfaces. Control was effected by varying the pitch of the propeller's individual blades. The propeller design, in conjunction with a clean, laminar-flow body, should have made for a slick boat. Unfortunately, linkage problems with the craft's propeller-steering arrangement caused the sub to drop out of the competition at the last moment. This sub also broke in half for entry and exiting, which was quite novel.

### Spuds

The University of New Hampshire's large, homely submarine looked like a *Popular Mechanics* home hobbyist's dream—but it worked! It was a simple design made of modest materials, including a totally transparent hull of thin Lexan sheets. The result was fabulous visibility on a low-visibility course, which helped them in their navigation. This improbable craft was well trimmed, always worked, and was far faster than it looked. Great attitude by the crew, low cost, and performance gave them the "Judges' Prize."

### HPS Gossamer Albacore

Lockheed Advanced Marine Systems' craft was highly innovative, with a chain-drive opposed "tuna-fin" thruster. This creative mechanical emulation of a fish's tail fin allowed the vehicle to accelerate faster than any other off the starting line. The hull, external control surfaces, visibility ports, and instrumentation were all well planned. This entry clearly deserved the "Innovation" prize for that marvelous thruster design.

### Sub-Human

Sub-Human Projects of Concord, California, came up with a creation that was characterized by a sleek hull, nicely executed fore-and-aft control surfaces, and a counter-rotating propeller. Mechanical problems prevented this fast-looking boat from finishing.

### Subasaurus

Benthos, Inc., of Falmouth, Massachusetts, came up with a compendium of simple, clever ideas, all packed into a compact boat. The clear nose gave the navigator good visibility. Large vertical and horizontal surfaces were neatly integrated and made for quite a maneuverable vehicle. The peddler was held in place by a nicely contoured semireclining seat that had integral shoulder restraint pads. In practice, this craft was quick and maneuverable—helped as it was by an efficient, large-diameter composite propeller. Unfortunately, a defective shear-pin fractured when the vehicle maneuvered into race position, eliminating it from the race. Bad luck for a well-designed vehicle.

### *Knuckleball*

Innerspace Corporation's entry was designed by Calvin Gongwer, arguably the most prolific and talented hydrodynamicist in the field of underwater propulsion. This vehicle captured the hearts of all who saw it, as did the unquenchable enthusiasm of its designer. No one expected this clear ball of plastic to fly, but it did, and it could turn on a dime! Its strange actuator-disk propeller, driven by arm power, allowed the vehicle to go much faster than the safety divers could swim. Waves caused the craft to suffer minor damage when it was pulled through the reef out to race, and it was forced out of the running. The crew maintained their graciousness throughout and was awarded the "Sportsmanship and Intestinal Fortitude Award."

### *Squid*

"The U.S. Naval Academy's vehicle was so well designed and meticulously executed that it would make a skeptic a believer in the U.S. Navy," according to Osterhout. The hull was oval, allowing for a face-down, stacked placement of two operators. This in turn allowed *Squid's* submariners to expend less energy on breathing, and more on peddling and steering. The Kort nozzle,\* in conjunction with counterrotating propellers, produced maximum thrust at the craft's design speed. Rugged control surfaces gave good maneuverability, and the innovative fiberglass foam-laminate hull construction allowed near-perfect trim. The vehicle did exactly what it was designed to do—very reliably—and walked away with second place in the speed competition. It won "Overall Performance" and "Best Use of Composites." All this success earned the cadets second place for "Overall Performance by an Academic Institution."

### *Icarus*

Massachusetts Institute of Technology's craft looked fast from any angle. Its smooth, very low-drag hull had clean control surfaces with good internal control design, and it probably had the best propeller design of all. So many things were so neatly done that it won the "Most Innovative Student Design" award. Navigation problems owing to its faulty compass probably cost them the race.

### *Sea Panther*

Florida Institute of Technology came in fourth in the speed competition with their submarine. This vehicle was compact, robust, and worked well by using a low-risk design. Perhaps its most innovative aspect was its clever pontoon-tow, dry-dock launcher. FIT thus avoided surf and launch

damage. *Sea Panther's* success carried FIT to third place in the "Overall Performance by an Academic Institution" competition.

### *Centipede*

Sea Scapes Saltwater Aquarium of Riviera Beach, Florida, arrived with a creation that clearly was constructed using very little money and in a very short time. Made of plastic pipe, fiberglass, and anything that was not nailed down, its small diameter made for nearly impossible entry and exit, and required bravery for its operation.

### *Turtle*

The David Taylor Research Center of Annapolis, Maryland, came up with a craft built around a hull form that was an outgrowth of U.S. Navy drag studies. It had unusual, v-shaped rear control surfaces that were reminiscent of those on a Beechcraft Bonanza aircraft. Trim problems and low thrust were its biggest detriments.

### *Humpsb*

The University of Washington's entry had a beautiful laminar-flow hull that was flawlessly finished. Its aft section swept into an efficient composite propeller/control-surface combination. Its canopy detached just past the starting line, and the attendant drag slowed it down. Low cost, wonderful craftsmanship, and still-good speed earned it the "Cost Effectiveness" award.

### *FAUtilus*

Florida Atlantic University arrived with a rational design—featuring well-made instruments—powered by a terrific crew. Good human factors and high forward visibility helped their runs. This crew also did the best job of low-visibility instrument navigation, as they always flew straight as an arrow. FAU captured first place in "Flair And Flamboyance."

### *Honeysub*

The University of California, Santa Barbara, had a

## Special Student Rate

We remind you that students at all levels can enter or renew subscriptions at the rate of \$20 for one year, a savings of \$5. This special rate is available through application to: **Oceanus**, Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

\* The Kort nozzle is a funnel that encircles propellers, and is often seen on tugs and minisubs. All good diver-propulsion devices use this feature because, at low speed, it can enhance thrust by as much as 30 percent.



*Sublime moments were found, even on dry runs. (Photo by Sylvia Earle)*

vehicle made from an aircraft wing tank, and that looked more like a World War II-vintage fighter aircraft than a sub—an effect enhanced by its huge acrylic canopy. Bad luck with mechanical problems put them out of the race.

### *Superfluke*

Cal Poly, San Luis Obispo, came with three submarines. This one had an interesting oscillating rear fin. The hull shape was configured to allow a high-visibility, wraparound flow-shield. This craft could best be characterized as a mechanical dolphin.

### **A Note to Teachers**

We offer a 25% discount on bulk orders of five or more copies of each current issue. A discount also applies to one-year subscriptions for class adoption (\$20 per subscription). Teachers' orders should be sent to **Oceanus Magazine**, Woods Hole Oceanographic Institution, Woods Hole, MA 02543

Mechanical problems unfortunately caused this interesting sub to drop out.

### *Subversion*

Cal Poly's second entry, at first glance, looked like a mechanical, blunt-nosed Great White Shark. It was the last boat to qualify, the last to race—in near darkness—and clearly the fastest! The vehicle had large, sharklike control surfaces (fins) that coupled to direct, rugged control linkages, allowing superb control at all speeds. Its clear dome nose permitted great visibility. The synthesis of a clean hull, good prop, and excellent controls was the winning combination. This fine craft won first place in the speed competition, and helped Cal Poly to achieve best "Overall Performance by an Academic Institution."

### *Speedstick*

Cal Poly's other design owed its heritage to the 1950s and Aerojet General's peddle-powered tubular swimmer propulsion vehicle with counterrotating propellers. Made of PVC pipe, this open-hull design was actually only fifth fastest.

### **No One Loses at the Submarine Races**

Not all of the subs won prizes, but there truly were no losers. Winners included the spectators, who were treated to a far more direct involvement than is possible in most sports events, and they helped make history. Everyone shared in the satisfaction that they had been a part of something extraordinary.

Dr. Stanley Dunn, FAU's Acting Dean of the College of Engineering, and Chairman of its Department of Ocean Engineering, remarked: "When the idea was first broached about organizing a competition of this type, few of us imagined what proportions the program would assume. . . . Those of us who have seen the process unfold. . . are pleased beyond our wildest expectations."

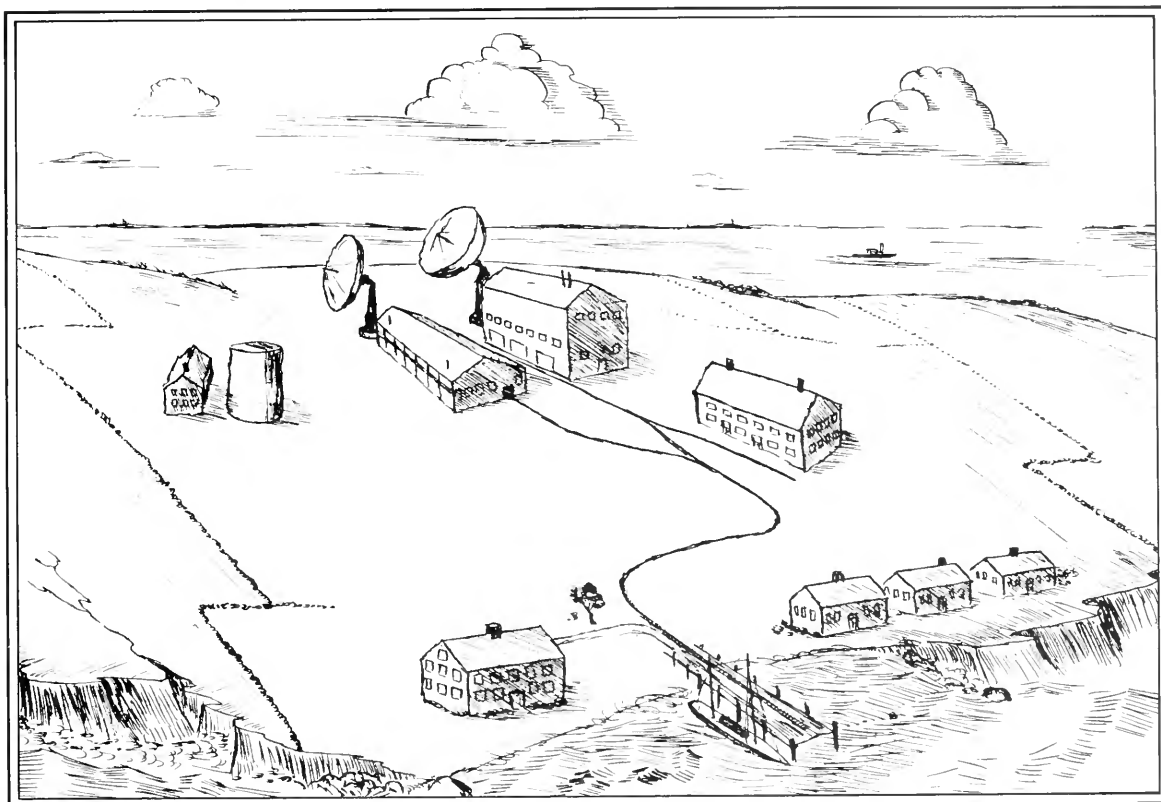
Henry "Hap" Perry, who worried whether anyone would take "submarine races" seriously, noted: "We set off an explosion! . . . We came to find new technology, to increase interest in the field of subsea engineering, to create the opportunity for individuals to excel. In the end, we found incredible imagination and the pioneering spirit; we found eagerness, dedication, and commitment; we found far more than we were looking for. We found people at their best."

June 1989 marked the First International Submarine Race, but no one expects it to be the last. As champagne glasses were raised and a crowd of 400 cheered, plans for a 1991 race were announced.

Can the record speed of 2.76 knots by Cal Poly's *Subversion* ever be exceeded? Will the secrets of underwater propulsion, endurance, and drag reduction—perfected over millennia by dolphins, whales, and tuna—be unraveled and applied by some clever engineers? The Second International Submarine Races should prove to be at least as challenging, rewarding, and irresistible to creative engineers as the first. □



# The Slocum Mission



Drawing by Henry M. Stommel

by Henry M. Stommel

*EDITOR'S NOTE: In the following article, Henry Stommel takes us to the year 2021, and presents his vision of the future of physical oceanography. Stommel, a Senior Scientist at Woods Hole Oceanographic Institution, was awarded the 1989 National Medal of Science by President George Bush in a White House Ceremony on October 18. His profile appears in Oceanus Vol. 27, No. 1, pp. 55-59.*

It is difficult to realize that 25 years have passed since I first came to the Slocum Mission Control Center on Nonamesset Island, one of Massachusetts' Elizabeth Islands, in 1996. I was a post-doc in physical oceanography, and the Department of the Environment had just acquired the island from the descendants of a sea captain prominent in the China trade of the early-19th century.

The government acquired Nonamesset to establish the World Ocean Observing System (WOOS), a facility capable of monitoring the global ocean using a fleet of small, neutrally buoyant floats called "Slocums," which draw their power from the temperature stratification of the ocean. Nonamesset

Island was chosen partly because it is isolated from the mainland of Cape Cod, but mostly because it is close to the Woods Hole Oceanographic Institution, the Marine Biological Laboratory, and a thriving scientific community.

Nestling low in the hills is the Mission Control Center itself, with its satellite antennas. Along the beach, facing Buzzards Bay, there are a few houses for a small permanent staff. Most of the scientific staff commute from their homes in the Upper Cape area, reaching Nonamesset by ferry. There is a large dock at the cove, but the one that the ferry uses is at Sheep-Pen Harbor on the Hole. There are no automobiles on the island. The buildings are

connected by footpaths and there is a narrow-gauge railroad for moving supplies from the docks to the facilities. For the most part the island has been left undisturbed. It is in a pristine state of beauty, tranquil beyond the experience of those who swarm about on the mainland.

The Slocum float is named after Joshua Slocum, the Yankee skipper who first went around the world single-handed in a small sailing vessel. There were Slocums on the Elizabeth Islands before, ever since Peleg Slocum of Dartmouth purchased Cuttyhunk, Nashawena, and Penikese Islands in 1693. Whether Joshua was related to them, I never have discovered. But my relationship with the Slocums has a different genealogy—a scientific and technical one. Perhaps I should begin by saying what Slocums do.

---

An intricate, cotillion-like “Dance of the Sentinel Slocums” is sometimes staged, in which patrols are interchanged over the course of a year, to obtain a complete intercalibration of all the Slocums on the section.

---

They migrate vertically through the ocean by changing ballast, and they can be steered horizontally by gliding on wings at about a 325-degree angle. They generally broach the surface six times a day to contact Mission Control via satellite. During brief moments at the surface, they transmit their accumulated data and receive instructions telling them how to steer through the ocean while submerged. Their speed is generally about half a knot. There are military applications for them, but our work in WOOS is unclassified.

We have a fairly large fleet of Slocums, about 1,000. Half are devoted to a program of routine hydrographic observation, much like the meteorologists’ upper-air network. The rest make soundings of temperature, salinity, oxygen, nutrients, and those geochemically important tracers that the geochemists have been clever enough to find automatic measuring devices and sensors for. The other half of the Slocum fleet is devoted to purely scientific purposes: special research programs carried out under the instructions of academic scientists, by contract. Slocums were originally designed with a five-year lifetime, but many have been in continuous service at sea for more than 10 years. They are widely dispersed throughout the world’s oceans.

Our WOOS center and the Slocum Mission had their start because of the growing concern with monitoring the environment: Is the ocean heating up? Where are the pollutants going? Can we construct theoretical models of the ocean circulation that are useful in predicting the direction of climate change? With a necessarily small fleet of research

ships, how could numerous, widely dispersed measurements throughout all depths of the ocean be obtained on a routine basis?

In 1995, much of the oceanographic community had been involved for 15 years in the World Ocean Circulation Experiment (WOCE), exploring the general circulation of the ocean but still using the technology of the 1980s. For example, one of the keystones of WOCE was the World Hydrographic Program (WHP), which used a single ship per year over a period of 12 years to survey 48 long hydrographic sections, with some repeats. Only six stations could be occupied each day, giving a very low rate of data acquisition compared to what the meteorologists were getting from their upper-air network.

A really new method was needed, one that would provide subsurface data on a scale and at a frequency that matched what remote-sensing by satellite provided for the sea surface. Multiplying the number of ships by a factor of 100 was economically out of the question. But a pioneering ocean engineer had a different vision of how to garner a harvest of data on a deep-ocean, global basis; and this led, after a few vicissitudes, to the Department of the Environment’s determination to support the Slocum Mission and the present deployment of Slocums throughout the world. It has been my career.

So here I am on a lovely October day sitting in the library of Mission Control overlooking Vineyard Sound. On the grass bank outside the window there is a flock of sheep grazing. I have the daily logbooks of those first deployments and experiments made in the early days of Mission Control before me on the table. The assembled staff has asked me to describe the excitement of those early days on a personal level, so that is what I am going to try to do.

**A**s most of you know, the backbone of our climate-monitoring capability is our permanent fleet of 480 Sentinel series of Slocums. These are able to occupy, on a monthly basis, all the 48 hydrographic sections that once took the WHP 12 years to do. We acquire data from this widely dispersed network via satellite telemetry.

It is something of a wonder to follow the intricate patrol pattern of the Slocums assigned to the various sections. For example, there are 10 assigned to patrol a section along 24 degrees North in the Atlantic. Each patrols a 6-degree segment of longitude. Pairs meet once a month to do an intercalibration.

Sometimes we schedule an intricate, cotillion-like “Dance of the Sentinel Slocums” in which they interchange patrols, thus obtaining, over the course of a year, a complete intercalibration of all the Slocums on the section. We also have special Calibration Standard Slocums that wander randomly about the patrol lines, like the inspectors on a subway system, calibrating all Slocums that they encounter.

Each Slocum reports into Mission Control via

satellite about six times a day. At each report, conductivity, temperature, and depth (CTD) data are transmitted, along with auxiliary tracer data. The satellite also reports the Slocum's position, which informs us how much the float has been set by the ocean currents it encounters and permits its automatic pilot to be reset according to a course-correction algorithm. During the day, the casts terminate at different depths, and sometimes the floats dwell for a period at the bottom of the cast, so it is possible to recover information about the vertical modal structure of the currents.

Thus we have a basic set of Sentinels routinely patrolling the ocean between 50 degrees South and 50 degrees North, equivalent to a fleet of 48 full-time hydrographic survey ships, making no port stops, using no fuel, and by international law exempt from the restrictions on passage through territorial waters exacted of manned vessels. Each day we get about 300 CTD profiles from our Sentinel fleet.

The prototype Sentinel was launched in 1994, before the Mission Control Center was built, and the little group of originators was still working in the attic of the Bigelow building at WHOI. I can only imagine what the sense of excitement must have been in the attic control center when they started to control the navigation of Sentinel 1 after its launch off Bermuda.

According to the logbook, it was decided not to confront the Gulf Stream at the start. The plan was to steer the Slocum as nearly eastward along 32 degrees North as could be done, making a highly detailed hydrographic section along the way. With some delays due to interrupted communication, this section took 198 days. It ended off Ifni on the northwest coast of Africa, where the *RRS Discovery* had ended her 1957 section long before. The ship managed to obtain 25 casts. Sentinel 1 obtained 3,820 casts.

On this leg, the prototype successfully demonstrated that effective hydrographic station work of a routine nature could be done remotely by an unmanned and un fueled instrument package, directed by controllers far away. The atmosphere in the attic must have been ecstatic—rather like that in the spacecraft control room when *Voyager 2* rendezvoused with the moon of Neptune in August 1989. That first Slocum spawned the whole fleet of monitoring Sentinels that we have in the ocean today.

**B**ut Sentinel 1 had further successes. On a return westward section the following year, it encountered a Mediterranean salt-lens eddy. According to the logbook, the eddy was first detected in the velocity structure. It was decided to go eddy chasing. Soon the high salt at 1,200-meters depth became evident. Sentinel 1 became trapped by the eddy, but after three revolutions it was shaken loose, and the controllers were now faced with an interesting problem—how to relocate the eddy and implant the instrument package in it again.

In those days there was very little information about the nature of the variability of the background

current field, and it was difficult to find the eddy. Help was proffered by some numerical modelers, who had set up a dynamical model on the basis of the data obtained during the first three revolutions before the eddy was lost. Their model suggested a general amplitude of pulsation and a direction of drift.

As it turned out, the search was successful, and for a further six years, the eddy was tracked, measured, and studied as no eddy had ever been before. On the basis of this study, the Mediterranean Water Experiment during the years 2003–2013 was designed and conducted with spectacular success—revealing an unexpected physical process of tracer dispersal, and a bizarre mathematical way of parameterizing it in general circulation models.

One of the naïve early experiments with Slocums—before the Department of the Environ-

---

The popular three-Slocum race proved that there is nothing like the need to make decisions to lay bare areas of ignorance that are papered-over in textbooks.

---

ment assumed responsibility for them and built the Nonamesset facility—was the international 'round-the-world race of three Slocums. At the time, the whole idea of participating in a race sounded a little disreputable to the rest of the scientific community; but a sense of adventure, reinforced by a lack of alternative funding, drove the Slocum advocates to accept the invitation of the New York Yacht Club—and the Australian and French equivalents—to build three Slocums for the purpose. They were controlled from the attic office, but according to instructions received from the three race committees.

The U.S. committee had originally suggested that the race be from Bermuda to Bermuda, but it was finally decided to begin and end at Hawaii, since it was suspected to be more difficult to choose good north-south courses in the Pacific than in the Atlantic. Each committee was given the positions of all the Slocums. Because the Slocums did not have to carry CTD and tracer sensors, they cost less than \$100,000 each, and funds of \$200,000 a year for the attic control center were guaranteed for five years.

The race was a great popular success. Television programs carried news of the progress of the race on a weekly basis. Lay people became familiar with equatorial undercurrents, western boundary currents, and the Antarctic Circumpolar Current. Mesoscale eddies became a part of everyday language. The National Geographic Society made two television documentaries about the contest. Theoretical pundits offered their advice to all sides. National computer centers confidentially advised their national race committees. Cadets at Annapolis tried to organize a last-minute entry of their own. The French won with a spectacular score of 708 days.

The race showed that one could develop skill in programming the Slocums. Having to decide what heading to choose stimulated modelers and descriptive oceanographers to exercise their minds and their computers. As the results of decisions became obvious, knowledge grew, and as knowledge grew, performance improved. The challenge of the race inspired a marvelous exploration of geography, phenomenology, dynamical theory, computer programs, and technical development. There is nothing like the need to make decisions to lay bare areas of ignorance that are papered-over in textbooks. Suddenly one is faced with the practical problem of finding a western boundary current, riding internal Kelvin waves, or traversing an unknown oceanic region, learning about it as one goes.

**I**n later years, the early U.S.-Australian-French race paid handsome dividends. It evolved into our program of Explorer Slocums, today the predominant scientific program of the Mission Control Center. More than 300 Slocums are dedicated to several dozen scientific studies at any one time.

There are presently 40 devoted to studying the recirculation regions of both the Gulf Stream and Kuroshio. To date, these instruments have collected information for synoptic descriptions and mapping, and have gathered statistics about low-frequency variability for more than 15 years in each region. The result has been a remarkable improvement in physical understanding and numerical modeling in both these regions. Other groups of Slocums study equatorial dynamics, map overflows, and western boundary currents in remote oceanic regions, and increase the precision of local data bases, for example.

Some of these Explorer projects have gone on for a decade or more. One of the earliest was a study of the circulation in the equatorial Indian Ocean, suggested in 1988 by a few far-sighted oceanographers. Several Slocums were launched in the western Pacific near Mindanao. They were steered into various passages in the Indonesian Archipelago, such as the Banda Sea, and then held in position by gliding against the prevailing currents in such a fashion as to monitor the transport of water from the Pacific into the Indian Ocean through the archipelago. This part of the project lasted two years, until statistically good transport estimates had been obtained.

Then the Slocums explored the water-mass front near 10 degrees South latitude in the Indian Ocean, in particular that part of the circulation that passes toward the west, north of Cape Amber, Madagascar. It was found that most of the time this water flows northward across the equator to join the Somali Current. During later years, it was discovered that intermediate-waters escape from the Arabian Sea and manage to move southward across the equator.

The projects that I have always liked best are the ones conceived on the spur-of-the-moment by an inquisitive individual. We try to reserve 20 percent of our Slocums to pursue such sudden

inspirations. They are generally the most exciting; they evolve in unexpected ways and reveal new dimensions of the unknown about the ocean.

We used small numbers of Slocums to follow whale migrations, for example, and to decipher the language of whales. We explored regions where political unrest would hamper the conduct of conventional ship operations. And we always have delighted in being of service to scientists with unusual and new ideas that demand examination, even at the expense of the pressures to expand military obligations and more routine civilian monitoring programs. We found, over the years, that the payoff in increase of knowledge often is greater the more unconventional the idea, especially when it conflicts with collective wisdom.

When I first came to Nonamesset, the techniques of graphic displays of data were just emerging from the flat screen of the cathode-ray oscilloscope and liquid-crystal devices of the late-20th century. Now, of course, the controller is literally animated. It can be zoomed to any time or space scale, giving the observer the impression of swimming through the ocean, much like being aboard a fictional space-ship from one of the old popular television programs. Our control room is a highly versatile submarine.

We can observe the data in a vast variety of ways. We can switch from observations to predictions of the great numerical models running elsewhere; we can scan the history of our subject; we can project ourselves into the scenarios constructed by the paleo-oceanographers. In short, we can immerse ourselves in an infinite variety of ways of looking at the real ocean and our mathematical abstractions of it. This ability is the result of 25 years of accrued observation, skill, and understanding. We can call upon the most informed scientific opinion available anywhere in the world. And we have become so accustomed to facile manipulation of this mass of information, we can scarcely imagine the plodding ways of earlier days.

**Y**esterday I was shooting the breeze with a colleague who has a summer house on Cuttyhunk. The view from his house is spectacular—nearly 270 degrees of horizon—extending from the Bourne Bridge, all along the New Bedford shoreline to Point Judith, Rhode Island, and then offshore to Sow and Pigs. There is also a wide view of Vineyard Sound over Canapitset Channel. I guess his view beats what we see from Nonamesset, although I do think ours is rather grand too. But then I walk into our control room, with its panoply of views of the sea.

There are the updated global pictures from the remote sensors on satellites, there are the evolving maps of subsurface variables, there are the charts that show the position and status of all our Slocum scientific platforms, and I am satisfied that we are looking at the ocean more intensely and more deeply than anyone anywhere else. □

---

*This article is reprinted courtesy of The Oceanography Society, Inc. © 1989.*

# letters

To the Editor:

[Regarding your "The Bismarck Saga and Ports & Harbors" issue] What a superb job you guys always do—and always faster than we can do it.

**William Graves**  
Senior Assistant Editor, Expeditions  
National Geographic Magazine

To the Editor:

I enjoyed the article by T. M. Hawley on the Port of Rotterdam in your fall 1989 issue. I've sailed into that port many times in the past. However, I felt it read a little too much like a public relations piece for the city. When the computers are down on the central ship-tracking system and elsewhere, everything grinds to a Dutch halt, hardly a treat. Also, was the headline a mistake? What does "Quays to the Heart of Europe" mean?

Still, as a merchant seaman, it was good to see something in print about the problems of ports and harbors. The article by Mr. Ryan on Japan was interesting. Why isn't the United States doing more to create artificial islands to solve some of our waste and storage problems? In fact, we could build some artificial islands and sell them to the Japanese to reduce our deficit and take the pressure off their buying property elsewhere.

I like the magazine. Keep up the good work!

**Captain John Bean**  
The SS *Tristar*  
Bethel, Maine

EDITOR'S REPLY:

According to the *American Heritage Dictionary of the English Language*, "quay" and "key" are homonyms. The headline was a play on words.

To the Editor:

I was born and raised in Rotterdam, and enjoyed reading the article about the Port of Rotterdam in your fall 1989 issue.

**Vera Kalmijn**  
Scripps Institution of Oceanography  
La Jolla, California

To the Editor:

Belatedly, but no less sincerely, congratulations on your outstanding Fall 1989 issue devoted to the *Bismarck* Saga and Ports & Harbors. You and your staff are to be commended for producing a marvelous document. As one of the issue's contributing authors, I am extremely pleased and honored to have been a part of it all.

**John M. Pisani**  
Director, Office of Port and Intermodal Development  
U.S. Maritime Administration

To the Editor:

As a recent arrival in the United States from New Zealand, I read with interest the article "Naval Bases, Base Rights,

and Port Access" by Joseph R. Morgan in the fall issue of *Oceanus* (Vol. 32, No. 3, pp. 85–88). The arguments advanced by Professor Morgan against New Zealand's restrictions on nuclear-powered or -armed ships have been well discussed in the popular media by politicians and military men. I suggest instead that 1) the U.S. Navy has very likely broken Japanese law in its visits to Japan with respect to nuclear weapons, and 2) twentieth-century history shows the danger and the irrelevance of military alliances.

The danger is exemplified by the snowball that led to the 1914–18 war in Europe. The irrelevance is exemplified by U.S. willingness to help whom it wants to (Britain before December 1941, and now the Contras in Nicaragua), and disregard for alliances it regards as inconvenient (Taiwan is the obvious example). I think that New Zealand is well served by its antinuclear policy.

**D. J. Hawke**  
Miami, Florida

To the Editor:

On page 13 of Volume 32, Number 1, the pre-exploitation estimate of minke whales is 140,000, while the present estimate is 725,000. Surely this is a mistake. It seems unlikely that minke whales have increased in numbers through exploitation. Maybe the "pre" figure should have been 1,400,000. I will be grateful if you will check the source of these data.

**Victor B. Scheffer**  
Bellevue, Washington

---

## NEW FROM CALIFORNIA

### The Pinnipeds

Seals, Sea Lions, and Walruses  
**MARIANNE RIEDMAN**

Riedman brings together a wealth of material on these fascinating marine mammals. She reviews the intriguing adaptations of pinnipeds to a great range of often harsh conditions and discusses mothering, nursing, and mating strategies. \$29.95

### A Systematic Revision of the Deep-Sea Subfamily Lipomerinae of the Isopod Crustacean Family Munnopsidae

**GEORGE D. F. WILSON**

The author provides descriptions and geographic distributions for one subfamily (Lipomerinae) in a larger group (Munnopsidae) that have secondarily evolved the ability to swim \$16.00 paper  
*Volume 27, Bulletin of the Scripps Institution of Oceanography*

---

At bookstores or order toll-free 1-800-822-6657.  
Visa & MasterCard only.

**University of California Press**  
Berkeley 94720

---

## EDITOR'S REPLY:

The above estimates came from the International Whaling Commission, and are indeed correct. However, the pre-exploitation estimate covers only the Northern Hemisphere, whereas the present estimate covers both hemispheres. The pre-exploitation minke population in the Southern Hemisphere is unknown. The estimate of the present minke population comprises 125,000 whales in the Northern Hemisphere and a well-established figure of 600,000 in the South.

To the Editor:

In composing a reply to the critics of my article on cetacean intelligence [see letters, *Oceanus* Vol. 32, No. 3, p. 92], I found myself referring to points in my original article (Vol. 32, No. 1, pp. 19–20). I therefore think the problem is that this form of article does not have references, and hence it is difficult for readers to see which parts are supported by published material and which parts are the opinions of the writer.

I might add that much new information on the "hardware deficiencies" in cetacean brains was given at

the symposium on Sensory Abilities of Cetaceans, held as part of the 5th International Theriological Congress, in Rome, 22–29 August 1989. The symposium papers are to be edited by J. A. Thomas and R. Kastelein (the organizers), and published by Plenum Press.

I very much enjoyed the "Whither the Whales?" edition of *Oceanus*, which covered so many topics in an original and interesting way. However I think the most important article was by Brownell, Ralls, and Perrin, pointing out in detail just how bad the outlook is for the vast majority of cetacean species. It is quite a thought that the entire IUCN Cetacean Action plan could have been carried out for about the same money that was spent in the attempt to save three gray whales last year! I know very well that it is not realistic to expect such diversion of resources, but is it not a scandal that even almost 2 years after publication of the plan most projects still have no financial support? When are we going to translate our love of dolphins into action to save them?

Margaret Klinowska  
Mammalian Ecology and Reproduction Group  
University of Cambridge, England

## book reviews

*The Compleat Crab and Lobster Book* by Christopher R. Reaske. 1989. Lyons & Burford, New York, NY. 150 pp. \$9.95.

Lobsters and crabs living along the North American Atlantic coast have enriched the life of the region in many ways. Reaske's book serves as a fine handbook, inviting novices to join in the pleasures of catching, preparing, and consuming blue crabs and clawed lobsters. The author wraps an aura of intrigue around the beasts by explaining where they live, how they make a living, and how knowledge of their prey may enhance your culinary experience.

The author shares his curiosity and enthusiasm for knowing more about dinner than what it tastes like. Even amid the pages of recipes, he interjects his fascination for the animal's cultural history. For example, he explains that "in the 19th century and earlier, lobsters were sometimes known as 'sea roaches' or 'water rats,'" and that lobsters were used as fertilizer by early American settlers.

As an appetizer, Reaske introduces crabs and lobsters by encapsulating their biology; natural history; and appearances in art, literature, and legend. Why does the word "crab" have such negative connotations, as in the terms "crabby," "crabbed handwriting," and "crab-apples?" How do crabs and lobsters get together with members of their species to make more crabs and lobsters? Although this book does not go into great detail answering questions like these, the author provides plentiful and well-chosen references to encourage further exploration.

For the main course, the book focuses on fishing and cooking. I remember the excitement of handling my own first blue crab off a dock in Florida. Handling—coaxing the prey into a net using a baited line—is just one of several crabbing techniques described in detail.

## • THE • COMPLEAT CRAB and LOBSTER BOOK

CHRISTOPHER R. REASKE



Recipes, Trapping Techniques, Natural History  
and more... from the author of *The Compleat Clammer*

Reaske also understands that catching crabs is only part of the experience. Crabbing is usually an interactive pastime. To facilitate interactions with fellow crabbers, the author provides translations of blue-crab terms such as

(continued on page 102)

For high-quality research on all aspects of the global climate system, reach for one journal

# Climate Dynamics

Observational, Theoretical and  
Computational Research on the Climate System

Executive Editors:

**W.L. Gates, H. Oeschger**

● The only journal focusing on the physical, chemical and biological interactions that effect the global climate system.

● An authoritative resource for original research on the structure and behavior of the atmosphere, oceans, cryosphere, biomass, and land surface as interacting components of global climate dynamics

● Brings you up to date reports on developments in observational, analytical, and computational methods.

● Integrates different approaches to provide stimulating ideas for your research.

● "It is clear that there is a need for a journal of this type, and that *Climate Dynamics* has the support of the most prominent members of the community. It promises to be an important addition to the list of climate and interdisciplinary research publications." — *Nature*

*Selected articles from Climate Dynamics*

Glacial meltwater cooling of the Gulf of Mexico: GCM implications for Holocene and present-day climates, *R.J. Oglesby et al.*

A GCM study of Antarctic glaciation, *R.J. Oglesby*

Lake levels and climatic change in eastern North America, *S.P. Harrison*

The dynamical range of global circulations II, *G.P. Williams*

Self-generated aperiodic behaviour in a simple climate model, *J.M. Salazar, C. Nicolis*

Put *Climate Dynamics* to work for you.  
Enter your subscription today, or send for  
a free sample issue.



**Springer-Verlag**

New York Berlin Heidelberg Vienna  
London Paris Tokyo Hong Kong

Order form

## Climate Dynamics

Title No. 382 ISSN 0930-7575

Return to Springer-Verlag New York, Inc.,  
Attn. E.Teatsorth, 175 Fifth Avenue, New York,  
NY 10010

**Order information:** Journal subscriptions must be prepaid. Subscriptions begin with the first issue of the volume and are filled as issues are published.

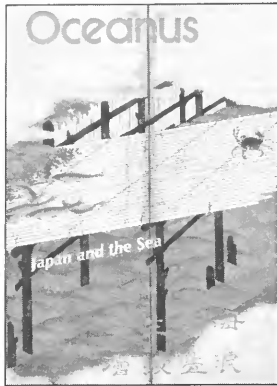
- Please enter my subscription to Vol. 5  
(4 issues) 1990: \$205.00  
 Please send me a free sample issue

**Payment**

- Check enclosed  
(made payable to **Springer-Verlag New York, Inc.**)  
 Charge my: Visa \_\_\_ Amex \_\_\_ Mastercard \_\_\_  
Card No. \_\_\_\_\_ Expires \_\_\_\_\_  
Signature \_\_\_\_\_  
Name \_\_\_\_\_  
Address \_\_\_\_\_  
City, State, Zip \_\_\_\_\_

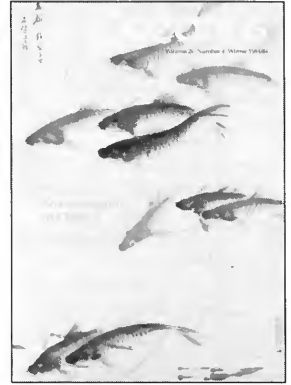
11/89 S385

# Additional Reading ... Back Issues of **Oceanus**<sup>®</sup>



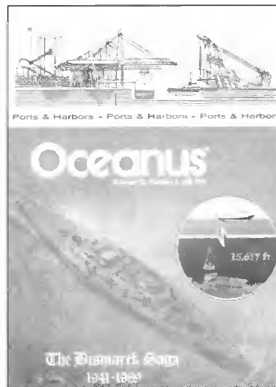
## Japan and the Sea

Vol. 30:1, Spring 1987 - The first comprehensive view of Japanese ocean science written primarily by Japanese authors. Describes how tradition and innovation combine to continue forging a strong link between Japan and the sea. Includes fishing, submersibles, SWATH vessels, recovery of uranium, ocean space, and much, much more.



## Oceanography in China

Vol. 26:4, Winter 1983/84 - Comprehensive overview of the history of marine studies in China, including present U.S.-China collaboration, tectonic evolution, aquaculture, pollution studies, seaweed-distribution analysis, the changing role of the Yangtze River, and the administrative structure of oceanographic programs.



## The Bismarck Saga and Ports & Harbors

Vol. 32:3, Fall 1989 - Highlights the little-known U.S. involvement in the heroic battle of 1941, and addresses the question of whether the *Bismarck* was sunk or scuttled. Japanese port innovations, Dutch successes, Third-World problems, and American plans are examined, as are the longshoremen's history and waterfront renovation.

## other available issues ...

### • The Oceans and Global Warming,

Vol. 32:2, Summer 1989 - Ocean/atmosphere interactions, El Niño, runaway greenhouse effect, Jason Project.

### • Whither the Whales?,

Vol. 32:1, Spring 1989 - Cetacean research, intelligence, research and tracking; whaling and dolphins.

### • DSV *Alvin* : 25 Years of Discovery,

Vol. 31:4, Winter 1988/89 - A review of the history and contributions of *DSV Alvin*.

### • Sea Grant Issue,

Vol. 31:3, Fall 1988 - Covers activities from biotechnology to estuary rehabilitation.

### • U.S. Marine Sanctuaries,

Vol. 31:1, Spring 1988 - Features all the operating, and various proposed, sites.

### • Caribbean Marine Science,

Vol. 30:4, Winter 1987/88 - Biology, geology, resources, and human impacts.

### • Galápagos Marine Resources Reserve,

Vol. 30:2, Summer 1987 - Legal, management, scientific, and historical aspects.

### • The Titanic Revisited,

Vol. 29:3, Fall 1986 - Radioactivity in the Irish Sea, ocean architecture, more.

### • The Great Barrier Reef: Science & Management,

Vol. 29:2, Summer 1986 - Describes the world's largest coral reef system.

### • Beaches, Bioluminescence, and Pollution,

Vol. 28:3, Fall 1985 - Science in Cuba, and Jacques Cousteau's turbosail vessel.

### • The Oceans and National Security,

Vol. 28:2, Summer 1985 - The oceans from the viewpoint of the modern navy, strategy, technology, weapons systems, and science.

### • The Exclusive Economic Zone,

Vol. 27:4, Winter 1984/85 - Options for the U.S. EEZ.

### • Deep-Sea Hot Springs and Cold Seeps,

Vol. 27:3, Fall 1984 - A full report on vent science.

### • Industry and the Oceans,

Vol. 27:1, Spring 1984 - The interaction of the oceans and industry.

### • Sharks,

Vol. 24:4, Winter 1981/82 - Behavior, physiology, repellants, & swimmer's advice.

Issues not listed here, including those published prior to 1977, are out of print. They are available on microfilm through University Microfilm International, 300 North Zeeb Road, Ann Arbor, MI 48106.

Back issues cost \$6.00 each (Reprinted Caribbean Marine Science issue, Vol. 30:4, is \$6.50). There is a discount of 25% on orders of 5 or more. Orders must be prepaid; make checks payable to W.H.O.I. Foreign orders must be accompanied by a check payable to *Oceanus* for £5.50 per issue (or equiv.)

send orders to:  
**Oceanus** Back Issues  
Subscriber Service Center  
P.O. Box 6419  
Syracuse, NY 13217-6419

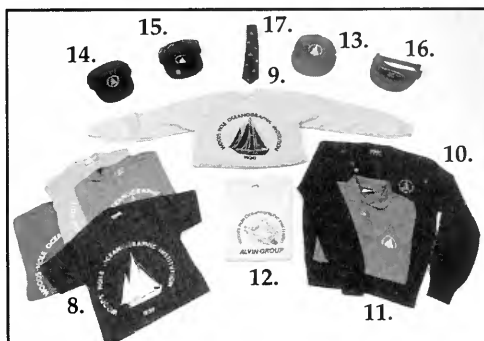




# Woods Hole Oceanographic Institution

## ... gifts for yourself or others

(proceeds help support our research)



ITEM	Price (Post/handling)
1. Fannie Pack	\$11.50 (2.00)*
2. Briefcase	\$34.60 (3.50)*
3. Canvas Tote Bag	\$30.40 (3.25)*
4. Duffle Bag	\$37.75 (3.75)*
5. Coffee Mug (White)	\$ 5.20 (1.25)*
6. Alvin Coffee Mug	\$ 6.25 (1.25)*
7. Coffee Mug (Blue)	\$ 8.35 (1.50)*
8. T-Shirt	Adult \$ 9.00 (1.25) Child \$ 7.00 (1.00)
	(S, M, L; Red, Blue, Green, Grey)
9. Sweatshirt	Adult \$17.00 (2.50) Child \$14.00 (2.00)
	(S,M,L,XL; Grey)
10. V-neck Pullover Sweater	\$25.00 (3.50)
	(S,M,L,XL; Blue)
11. Golf Shirts	\$17.00 (2.50)
	(S,M,L,XL; Red, Blue)
12. Alvin Group T-Shirt	Adult \$11.00 (1.25) Child \$10.00 (1.00)
	(S,M,L,XL; White)
13. Summer Cap	\$ 7.00 (1.00)
14. Winter Cap	\$10.00 (1.00)
15. Athletic Cap	\$10.00 (1.00)
16. Alvin Sun Visor	\$ 8.00 (1.00)
17. Necktie	\$11.00 (1.50)

To order, rush your check or money order for the price of the item(s), plus postage & handling to:

WHOI Gifts

### Oceanus®

Woods Hole Oceanographic Institution  
Woods Hole, MA  
02543

Please indicate size & color where necessary. Your order should include a daytime phone number and a street address for shipping.

\* Includes MA 5% sales tax.

Please allow 3-5 weeks for delivery.

W.H.O.I. claims no responsibility for typographical errors. Prices are subject to change without notice. All orders must be prepaid. We ship via UPS, so please provide a street address for prompt delivery.

(continued from page 98)

"Jimmy" and "Sook" (a male and female), "peeler" (a freshly molted crab), and "buck-and-rider" or "doubler" (mating pairs, which stay clasped together for several hours after the female has molted).

The most common method of catching lobsters is in traps, and this book pretty much leaves lobstering at that. The author neglects snorkeling, a simple method I often use for hand-catching both the local blue crabs and New England lobsters for my doctoral research. (But please check the legality of this technique in the area before trying it yourself!) Furthermore, he barely mentions the intriguing history of the lobster fishery. I can recommend *The Great Lobster Chase* by Mike Brown as a wonderful book full of lobster lore, one that gives a flavor for lobster fishing as a Down East tradition.

Reaske does, however, convey the message that it is wise to be polite and not get in the way of the professional lobstermen. For example, a convincing warning is aptly offered for any would-be lobster poachers. It seems that suspicious lobstermen have been known to lace their lines with razor blades so that any stranger hauling up a trap is liable to end up with bloody palms.

My research centers on the reproductive behavior of the American lobster and on the chemical signals that control when molting and mating take place. The fate of the Woods Hole lobsters I catch has been aquariums rather than pots, but Reaske's recipes tempt the latter fate. Our objectives at the end of the hunt may differ, but we share a respect for the animals and their environment. The author recommends that explorers and hunters consult local regulations, and he makes it easy to do so by providing a list of agencies' addresses. And for dessert, Reaske closes the book with a fun chapter on trivia about these not-so-trivial animals.

Diane F. Cowan  
Boston University Marine Program  
Marine Biological Laboratory  
Woods Hole, Massachusetts

*Antarctica: The Last Frontier* by Richard Laws. 1989. Boxtree Limited, London. 208 pp. £14.95.

This book is an informative, popular introduction to Antarctica. It was written to complement a series on the Antarctic produced in England by Anglia Television. Because of this cooperative relationship with Anglia, the publisher was able to illustrate the volume throughout with magnificent photographs of the continent, surrounding ocean, and animal life of the region. Many of the illustrations are quite striking, particularly those of tabular icebergs, and benthic flora and fauna.

The author, former Director of the British Antarctic Survey and a distinguished zoologist, has done an admirable job of crafting a nontechnical, highly readable text that will appeal to adults as well as younger readers. Six of the nine chapters review life on and around the frozen continent. Although Antarctica isn't a home for many land creatures, Laws points out that those that do thrive there have developed unusual strategies for survival. Several species of mites endure the harsh temperatures by producing antifreezes, such as glycerol. Antarctic fish also have evolved effective enzyme systems to survive the extremely cold waters. Many other interesting examples of metabolic adaptations are sprinkled throughout the text.

In the final chapter, Laws discusses humans and the Antarctic. He reviews the discovery of the hole in the ozone layer over Antarctica, the politics of claims in the region, and the Antarctic Treaty system. Although this section is introductory, it is a broad and concise overview of current Antarctic research and problems. The extraordinary photographs and excellent text make this book a valuable contribution to the general literature on the status and future role of the southern continent.

Lawson W. Brigham  
Marine Policy Fellow  
Woods Hole Oceanographic Institution

## Books Received

### Biology

*Advances in Marine Biology, Volume 25* edited by J. H. S. Blaxter and A. J. Southward. 1989. Harcourt, Brace, and Jovanovich, New York, NY. 274 pp. + x. \$35.00.

*Audubon Wildlife Report, 1989/1990* edited by William J. Chandler. 1989. Academic Press, San Diego, CA. 585 pp. + xx. \$39.95.

*Biology and Conservation of the River Dolphins* edited by W. F. Perrin, R. L. Brownell, Jr., Zhou Kaiya, and Liu Jiankang. 1989. IUCN, Cambridge, England. 173 pp. \$25.00.

*The Eyes of Fishes* by J. A. C. Nicol. 1989. Clarendon Press, Oxford University Press, New York, NY. 308 pp. + xx. \$90.00.

*Whales of the World* by Nigel Bonner. 1989. Facts on File, New York, NY. 191 pp. \$22.95.

### Fisheries

*Marine Invertebrate Fisheries: Their Assessment & Management* edited by John F. Caddy. 1989. John Wiley & Sons, New York, NY. 752 pp. + xvi. \$79.95.

*World Record Game Fishes, 1989* edited by Ray Crawford. 1989. The International Game Fish Association, Fort Lauderdale, FL. 320 pp. \$9.75.

### General Reading

*The Driving Force: Food, Evolution, and the Future* by Michael Crawford and David Marsh. 1989. Harper & Row, New York, NY. 298 pp. + xvi. \$25.00.

*Fishing Came First: A Memoir* by John Cole. 1989. Lyons & Burford, New York, NY. 216 pp. \$16.95.

**Mechanical Toys: How Old Toys Work** by Athelstan and Kathleen Spilhaus. 1989. Crown Publishers, New York, NY. 150 pp. + x. \$24.95.

**Rainbows, Curve Balls & Other Wonders of the Natural World Explained** by Ira Flatow. 1989. Harper & Row, New York, NY. 240 pp. \$7.95.

**Winter Watch** by James Ramsey. 1989. Alaska Northwest Books, Edmonds, WA. 144 pp. + vii. \$9.95.

## History

**Ben Franklin Stilled the Waves** by Charles Tanford. 1989. Duke University Press, Durham, NC. 227 pp. + viii. \$33.50.

**Bligh: A True Account of the Mutiny Aboard His Majesty's Ship *Bounty*** by Sam McKinney. 1989. International Marine Publishing, Camden, ME. 210 pp. + x. \$22.95.

**Captain Bligh: The Man and His Mutinies** by Gavin Kennedy. 1989. Sheridan House, Dobbs Ferry, NY. 321 pp. + xiv. \$34.95.

**No Woman Tenderfoot: Florence Merriam Bailey, Pioneer Naturalist** by Harriet Kofalk. 1989. Texas A&M University Press, College Station, TX. 225 pp. + xix. \$19.95.

## Oceanography

**Applications in Coastal Modeling** by V. C. Lakhan and A. S. Trenhaile. 1989. Elsevier, Amsterdam, The Netherlands. 388 pp. + xxvi. \$115.75.

**Coastal Oceanography of Washington and Oregon** edited by M. R. Landry and B. M. Hickey. 1989. Elsevier, New York, NY. 607 pp. + xvii. \$163.25.

**Coasts** by J. D. Hanson. 1989. Cambridge University Press, New York, NY. 96 pp. \$15.95.

**Hydrodynamics of Coastal Zones** by Stanislav R. Massel. 1989. Elsevier, Amsterdam, The Netherlands. 336 pp. + xii. \$105.25.

**Nearshore Sediment Transport** edited by Richard J. Seymour. 1989. Plenum, New York, NY. 418 pp. + x. \$85.00.

## The Pacific Region

**The Far East and Australasia 1989.** Europa Publications, London, England. Available in North America from Gale Research, Detroit, MI. 1,048 pp. + xxii. \$210.00.

**The Soviet Union and Northeast Asia** by Herbert J. Ellison. 1989. University Press of America, Lanham, MD. 64 pp. + x. \$6.50.

**The World of Thought in Ancient China** by Benjamin I. Schwartz. Paperback edition, 1989. Harvard University Press, Cambridge, MA. 490 pp. \$12.95.

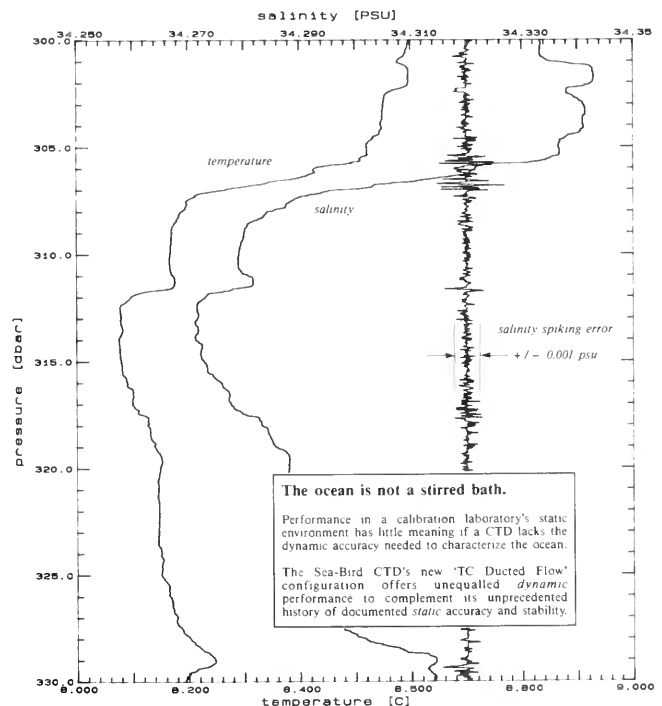
## Reference

**A Dictionary of Ethology** by Klaus Immelmann and Colin Beer. 1989. Harvard University Press, Cambridge, MA. 336 pp. + xiii. \$35.00.

**An Interdisciplinary Bibliography of Freshwater Crayfishes** by C. W. Hart, Jr. and Janice Clark. 1989.

**Encyclopedia of Environmental Control Technology, Volume 3: Wastewater Treatment Management** edited by Paul N. Cheremisinoff. 1989. Gulf Publishing, Houston, TX. 684 pp. + xii. \$135.00.

## THE FUNDAMENTALS OF CTD ACCURACY



Write or call for further information on the "TC Ducted Flow" feature which is available at modest cost as an option on new Sea-Bird CTD systems or as a field-retrofit to existing units.

**SBE** Sea-Bird Electronics, Inc. 1808-136th Place NE, Bellevue, Washington 98005, USA  
Telephone: (206) 643-9866 · Telex: 292915 SBEIUR · Telefax: (206) 643-9954

**Project Reef-Ed: Great Barrier Reef Educational Activities** edited by Jan Whelan and Jean Dartnall. 1989. Great Barrier Reef Marine Park Authority, Townsville, Australia. 400 pp. + appendix. \$16.00.

**Seas and Oceans** by Barbara Charton and John Tietjen. 1989. Collins, Glasgow, Scotland. 436 pp. + 6 appendices. £5.95.

**The Times Atlas and Encyclopaedia of the Sea** edited by Alastair Couper. 1989. Harper & Row, New York, NY. 272 pp. \$65.00.

## Ships and Sailing

**The Armed Transport *Bounty*** by John McKay. 1989. Naval Institute Press, Annapolis, MD. 120 pp. \$24.95

**Baja Journey: Reveries of a Sea-Kayaker** by Robin Carey. 1989. Texas A&M University Press, College Station, TX. 175 pp. \$12.95.

**Maritime Security** by Kenneth Gale Hawkins. 1989. Cornell Maritime

Press, Centreville, MD. 353 pp. + xiv. \$45.00.

**Mystic Built: Ships and Shipyards of the Mystic River, Connecticut** by William N. Peterson. 1989. Mystic Seaport Museum, Mystic, CT. 255 pp. + xvi. \$35.00.

**Naval Accidents, 1945–1988** by William M. Arkin and Joshua Handler. 1989. Greenpeace, Washington, DC. 84 pp. + ii. \$10.00.

## INDEX, VOLUME 32 (1989)

**Number 1, Spring, Whither the Whales?:** Frederic Golden, Introduction: *Facts & Fantasy*—Robert L. Brownell, Jr., Katherine Ralls, and William F. Perrin, *The Plight of the 'Forgotten' Whales*—Bruce R. Mate, *Watching Habits and Habitats from Earth Satellites*—Margaret Klinowska, *How Brainy Are Cetaceans?*—Robert J. Hofman, *The Marine Mammal Act: A First of Its Kind Anywhere*—Jóhann Sigurjónsson, *To Icelanders, Whaling Is a Godsend*—Steven K. Katona, *Getting to Know You*—Kathy Glass and Kirsten Englund, *Why the Japanese Are So Stubborn About Whaling*—Howard W. Braham, *Eskimos, Yankees, and Bowheads*—Tom Polacheck, *Harbor Porpoises and the Gillnet Fishery*—Bernd Würsig, Melany Würsig, and Frank Cipriano, *Dolphins in Different Worlds*—William Booth, *Unraveling the Dolphin Soap Opera*—Peter L. Tyack and Laela S. Sayigh, *Those Dolphins Aren't Just Whistling in the Dark*—Douglas W. Beach and Mason T. Weinrich, *Watching the Whales*—R. Natalie P. Goodall, *The Lost Whales of Tierra del Fuego*—Mark A. Fraker, *A Rescue That Moved the World*—Peter L. Tyack, Concerns: *Let's Have Less Public Relations and More Ecology*—Victor B. Scheffer, Concerns: *How Much Is a Whale's Life Worth, Anyway?*—T. M. Hawley, Essay: *The Whale, A Large Figure in the Collective Unconscious*—Victoria A. Kaharl, Profile: *Craig Emery Dorman: Flying High Cover*—Eric Best, *Voyages: An Odyssey of Self-Discovery*—Letters—Book Reviews.

**Number 2, Summer, Update: The Oceans and Global Warming:** Frederic Golden, Introduction: *The Role of the Seas in the Planetary Hothouse*—John H. Steele, *The Message from the Oceans*—D. James Baker, *The New Wave of Ocean Studies*—Arthur Fisher, *The Model Makers*—Taro Takahashi, *The Carbon Dioxide Puzzle*—Ants Leetmaa, *The Interplay of El Niño and La Niña*—Jodi L. Jacobson, *A Really Worst Case Scenario*—John D. Milliman, *Sea Levels: Past, Present, and Future*—Harry E. Schwarz and Lee A. Dillard, *The Impact on Water Supplies*—Diana Morgan, *The Historical View*—James F. Kasting, *How Venus Lost Its Oceans*—David Grinspoon, *The Venus Question Is Still Up in the Air*—Andrew R. Solow and James M. Broadus, *Climatic Catastrophe: On the Horizon or Not?*—Jerome Namais, Concerns: *The Greenhouse Effect as a Symptom of Our Collective Angst*—Thomas Levenson, Essay: *Tales of the Future*—Ronald K. Sorem, *Voyages: A Summer at Sea with the Soviets*—Diane Herbst, Expeditions: *In the Wake of a Modern Jason*—Book Reviews.

**Number 3, Fall, The Bismarck Saga and Ports & Harbors:** Paul R. Ryan, Introduction: *Sending "Sink the Bismarck!" to the Bottom*—Paul R. Ryan, Sara L. Ellis, and Jon Kohl, *The Bismarck Saga: 1941–1989—The Quest to Find the Bismarck: 1988/89*—John M. Pisani, *Port Development in the U.S.: Status and Outlook*—John Ricklefs, *Many Storms in a Port*—Mark Lincoln Chadwin, *From Wharf Rat to Lord of the Docks*—T. M. Hawley, *Rotterdam: Quays to the Heart of Europe*—Paul R. Ryan, *Japan: Rebirth of a Nation*—Amy Friedheim, *Puerto Quetzal, Guatemala: Container Cranes or Stevedores?*—James A. Fawcett, *A Tale of Two Ports With "2020" Vision*—Joseph R. Morgan, Concerns: *Naval Bases, Base Rights, and Port Access*—Marc J. Hershman, Concerns: *Port Concept Often Adrift in Waterfront Revitalization*—Letters—Book Reviews.

**Number 4, Winter, Pacific Century, Dead Ahead!:** Paul R. Ryan, Introduction: *Pacific Century, Dead Ahead!*—*The Soviet Far East*—*North and South Korea*—*China: Still a Bitter Sea*—*Japan: The Chrysanthemum Curtain*—*The Philippines*—*ASEAN*—*The Pacific Island States*—Joseph R. Morgan and Norton Ginsburg, *Notes from Nakhodka*—Michael V. Propp and Vitaly G. Tarasov, *Caldron in the Sea*—Yang Jinsen, *The Fisheries of the Yellow and East China Seas*—Daniel J. Dzurek, *Piracy in Southeast Asia*—Frank J. Gable and David G. Aubrey, *Changing Climate and the Pacific*—Sebia A. Hawkins, Concerns: *Greenpeace's Pacific Campaign*—Kathy Glass, Concerns: *Are Dolphins Being Deafened in the Pacific?*—Sylvia A. Earle, *Sub Humans Sink to New Heights*—Henry M. Stommel, *The Slocum Mission*—Letters—Book Reviews—Index.

# This Holiday Season

Give  
the  
Gift  
of the  
Sea



Or  
come  
aboard  
yourself  
now!

## Oceanus

*The International Magazine  
of Marine Science and Policy*

Published by Woods Hole  
Oceanographic Institution

### Foreign Subscription Order Form: Outside U.S. & Canada\*

Please make cheques payable to Cambridge University Press

- one year at £22.00  
Library or Institution:  
 one year at £40.00  
 payment enclosed.  
(we require prepayment)

Please send MY Subscription to:

Please send a GIFT Subscription to:

Name (please print)

Name (please print)

Street address

Street address

City State Zip

City State Zip

\*U.S. and Canadian subscribers please use form inserted at front of issue.

Donor's Name

Address

12/89

Act now... Only 250 available

To order this signed art, send your  
check or money order for \$200.00 (U.S.) to:

**Bismarck Art**  
**Oceanus** Magazine  
Woods Hole Oceanographic Institution  
Woods Hole, MA 02543

# HAS THE SUBSCRIPTION COUPON BEEN DETACHED?

If someone else has made use of the coupon attached to this card, you can still subscribe. Just send a cheque — £22 for one year (four issues) — to this address:

Please make checks payable to Woods Hole Oceanographic Institution



Cambridge University Press  
The Edinburgh Building  
Shaftesbury Road  
Cambridge CB2 2RU  
England

PLACE  
STAMP  
HERE

Cambridge University Press  
The Edinburgh Building  
Shaftesbury Road  
Cambridge CB2 2RU  
England

Ricklefs, *Many Storms in a Port*—Mark Lincoln Chadwin, *From Wharf Rat to Lord of the Docks*—I. M. Hawley, *Rotterdam: Quays to the Heart of Europe*—Paul R. Ryan, *Japan: Reberth of a Nation*—Amy Friedheim, *Puerto Quetzal, Guatemala: Container Cranes or Stevedores?*—James A. Fawcett, *A Tale of Two Ports With "2020" Vision*—Joseph R. Morgan, *Concerns: Naval Bases, Base Rights, and Port Access*—Marc J. Hershman, *Concerns: Port Concept Often Adrift in Waterfront Revitalization*—Letters—Book Reviews.

**Number 4, Winter, Pacific Century, Dead Ahead!** Paul R. Ryan, Introduction: *Pacific Century, Dead Ahead!*—*The Soviet Far East*—North and South Korea—China: *Still a Bitter Sea*—Japan: *The Chrysanthemum Curtain*—*The Philippines*—ASEAN—*The Pacific Island States*—Joseph R. Morgan and Norton Ginsburg, *Notes from Nakhodka*—Michael V. Propp and Vitaly G. Tarasov, *Caldron in the Sea*—Yang Jinsen, *The Fisheries of the Yellow and East China Seas*—Daniel J. Dzurek, *Piracy in Southeast Asia*—Frank J. Gable and David G. Aubrey, *Changing Climate and the Pacific*—Sebia A. Hawkins, *Concerns: Greenpeace's Pacific Campaign*—Kathy Glass, *Concerns: Are Dolphins Being Deafened in the Pacific?*—Sylvia A. Earle, *Sub Humans Sink to New Heights*—Henry M. Stommel, *The Slocum Mission*—Letters—Book Reviews—Index.

# The Bismarck ~1989



The Bismarck -1989

**Oceanus**<sup>®</sup> magazine is proud to offer this collector's item, a signed, limited edition, of Sig Purwin's recent work, "The *Bismarck*." This rendition of the *Bismarck*, lying on the bottom of the Atlantic as it was discovered this year by explorer Bob Ballard, originally appeared on the cover of our Fall 1989 issue. It is now available to you as a signed, framed (19" x 22"), expertly crafted work.

Act now . . . Only 250 available

To order this signed art, send your check or money order for \$200.00 (U.S.) to:

**Bismarck Art**  
**Oceanus**<sup>®</sup> Magazine  
Woods Hole Oceanographic Institution  
Woods Hole, MA 02543

# OCEANOGRAPHY

...by the sea  
...in Florida  
...what better place  
to study the oceans?

Florida Institute of Technology is located on the east coast of Florida, near the Kennedy Space Center, and only 1 hour from Orlando.

Opportunities abound for study and research along the Space Coast, in the Indian River Lagoon which is home for our research vessels, and at our nearby oceanside laboratory near Vero Beach. Cruises to the Gulf Stream and the Bahamas will complement your learning experiences. The Department of Oceanography and Ocean Engineering offers curricula leading to BS, MS, and PhD degrees in all basic areas of Oceanography and Ocean Engineering and an MS degree in Coastal Zone Management. Begin your oceanside career preparation now...



Please send me information about:

502

- Ocean Engineering, BS, MS, PhD
- Biological Oceanography, BS, MS, PhD
- Chemical Oceanography, BS, MS, PhD
- Coastal Resource Management, MS
- Geological Oceanography, BS, MS
- Physical Oceanography, BS, MS, PhD
- Undergraduate  Graduate

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

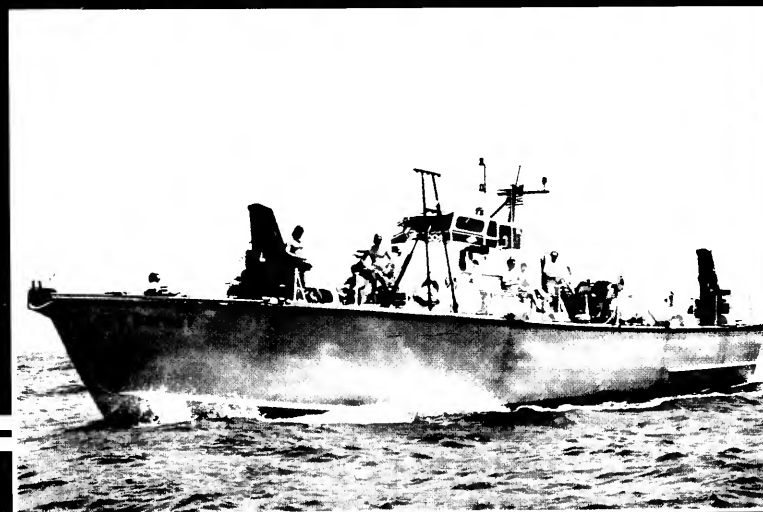
State \_\_\_\_\_ Zip \_\_\_\_\_

Phone (     ) \_\_\_\_\_

Possible Start Date \_\_\_\_\_

HS/College Grad. Date \_\_\_\_\_

HS/College Attended \_\_\_\_\_



## Florida Institute of Technology

150 West University Blvd., Melbourne, Florida 32901  
Toll Free 1-800-352-8324 • In Florida 1-800-348-4636