Red Tides Rising

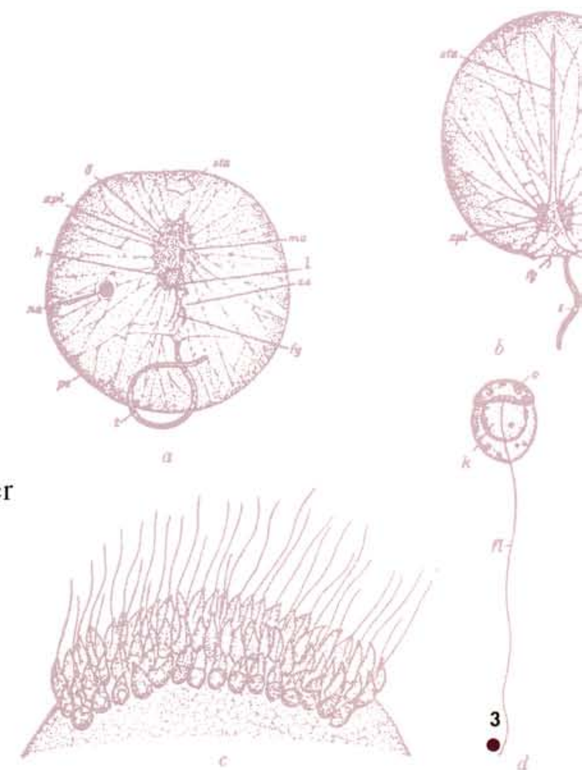
LOCAL PLANKTON BLOOM POSSIBLE SIGN OF GROWING GLOBAL THREAT

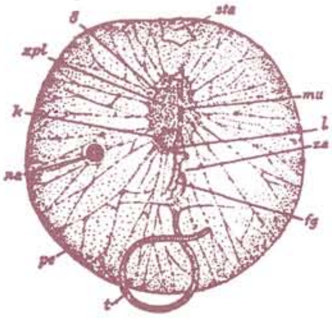
BY JANET HOWARD

PEERING FROM THE WINDOW of a hovering helicopter, Peter Franks can barely control his excitement as he marvels at the miles of neon-orange colored ocean that stretch beneath him.

"I've never seen anything like this–it's huge," he shouts over the whir of helicopter blades churning overhead. "Certainly we've had *Noctiluca* blooms in other countries and even this area before, but this one is just so dense and widespread–it is really unusual."

A Scripps biological oceanographer, Franks has been studying a





Red tides are by no means a recent phenomenon. The Old Testament, for example, makes reference to waters turning a blood red, which is most likely how the Red Sea got its name.

phenomenon called red tide for more than eight years. But he never anticipated finding such a spectacular bloom of microscopic algae in his own backyard.

Franks thinks the colorful event was triggered in January 1995 when San Diego experienced unusually heavy rainfall that caused area rivers to dump large amounts of nutrient-rich runoff into coastal waters.

The accompanying calm, warm weather provided perfect conditions for a massive bloom of single-celled algae called dinoflagellates that colored the water brown by day and turned breaking waves luminescent blue by night.

According to Franks, the event marked the largest red tide reported off the coast of southern California in the last 90 years. The massive plankton bloom extended from off the coast of Santa Barbara to south of the Mexican border.

What happened a few weeks later, however, sent Franks scrambling into the helicopter of a local news station to get a better look. What he discovered was a spectacular pattern of brilliant orange stripes spread across the ocean surface. One stripe was only about 300 feet wide but extended some 20 miles along the coastline. This "orange tide" was created when a larger dinoflagellate called *Noctiluca* (above left) began feeding on the phytoplankton produced during the original red tide.

"This is just an amazing phenomenon," said Franks. "It is an incredible manifestation of the sorts of things that we study in biological oceanography."

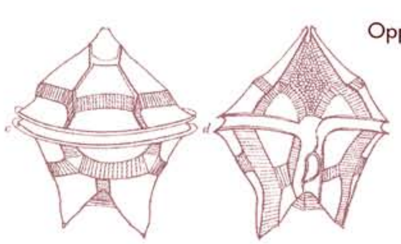
Some dinoflagellates are toxic. Luckily, the organisms involved in both events were harmless to most marine life and humans. Other areas of North America have not been so fortunate in recent years. In 1987, three people died and more than 100 became ill in Canada after eating mussels from Prince Edward Island containing a toxin, domoic acid, from a massive bloom of a golden-brown alga called a diatom. Several victims lost their short-term memory as a result of the illness, known as amnesic shellfish poisoning.

Meanwhile, more than a dozen humpback whales died mysteriously in Cape Cod Bay, Massachusetts, after feasting on mackerel that had been exposed to saxitoxin, a dinoflagellate toxin that blocks nerve transmission. Also in 1987, a dinoflagellate that had caused recurrent red tides along the Gulf Coast of Florida spread north along the coast of North Carolina for the first time. The algal bloom resulted in a $25 million loss to the shellfish industry, which was shut down when plankton in the area became contaminated with a neurotoxin called brevetoxin.

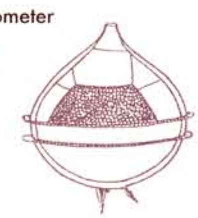
In 1991, pelicans in the Monterey Bay area died of domoic acid poisoning after eating anchovies that had been contaminated from a bloom of diatoms.

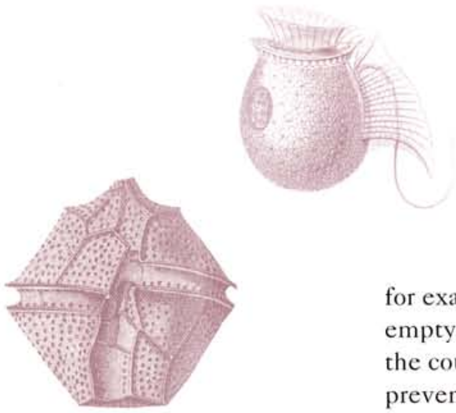
Red tides are by no means a recent phenomenon. The Old Testament, for example, makes reference to waters turning a blood red, which is most likely how the Red Sea got its name. The recent rash of outbreaks of red tides, however, has led some scientists to question whether the phenomenon is occurring more frequently around the globe–and becoming potentially more threatening.

Franks said he believes it is too early to tell whether red tides are truly on the increase or if the sys-



Opposite page, Peter Franks with his CTD/fluorometer/transmissometer package. This instrument array enables accurate sampling of hydrographic and biological variables. *Gonyaulax polyedra*, the organism responsible for the March red tide, is pictured at the bottom, along with other dinoflagellate species.





tem for reporting them has simply improved.

"One of the big problems is that we don't have enough long-term monitoring to put any of these incidents into context," he said. "You have to do monitoring if you are going to understand how variability fits into the larger picture."

One issue that remains unresolved is whether urbanization and an increase in agricultural runoff is selectively supporting the growth of toxic algae. Sewage, for example, usually contains high levels of nitrogen and phosphorus and minimal levels of silicon. Such a mixture of nutrients would support the growth of dinoflagellates–some species of which are toxic–better than the usually harmless diatoms, which have silicon dioxide shells and rely heavily on silicon for reproduction.

Scientists believe the various types of single-celled algae are spread from one coastal region to another during severe storms and across oceans in the ballast water of ships. The Australian government, for example, now prohibits the emptying of ship ballast tanks in the country's ports in an effort to prevent new species of algae and other organisms from being introduced into the coastal waters.

One problem posed by many dinoflagellate species is that they are capable of forming cysts that can survive for years on the seafloor or in ballast water. The thick-walled cells remain dormant until conditions turn favorable, whereupon they can germinate and spawn new red tides. Consequently, once a toxic alga is introduced into an area, it can be extremely difficult to eradicate.

The last reported toxic bloom along the coast of southern California occurred in 1901. It was documented by Harry Beal Torrey, a University of California scientist who observed large numbers of dead fish washing up on area beaches.

In the past, most of the problems with toxic red tides in the United States have occurred along the northwestern and northeastern coasts as well as along the coast of the Gulf of Mexico. Over the past eight years, Franks has been investigating a recurrent toxic bloom of phytoplankton in the Gulf of Maine. Blooms of a toxic dinoflagellate have been appearing beginning in April or May in the region every year since 1972, forcing the closure of shellfish beds along the coasts of southern Maine, New Hampshire, and Massachu-

Pictured at left above, Tippi Hedren from Hitchcock's classic *The Birds* attempts to fight off the attack of a seagull. Both seagulls and pelicans as well as other shore birds are affected by *Pseudonitzschia australis*, a microscopic alga. This marine phytoplankton produces toxins poisonous to the birds, which can cause erratic behavior.

HITCHCOCK HORROR BASED ON FACT

A team of biologists may have discovered what caused birds to madly attack residents in California's Monterey Bay area in 1961. The incident–reported to have inspired Alfred Hitchcock's thriller movie *The Birds*–apparently was triggered after the birds consumed a natural poison produced by marine phytoplankton during a red tide.

David Garrison, an associate research biologist at UC Santa Cruz's Marine Sciences Institute, began to suspect that domoic acid was responsible in the 1961 case after pelicans and cormorants began exhibiting similar behavior in the same vicinity in 1991. The birds acted drunk, swam in circles, and squawked pitifully. More than 100 seabird carcasses washed ashore near Santa Cruz in the following few weeks.

Now, Garrison and colleagues report that *Pseudonitzschia australis*, the alga producing the toxin, is frequently present in Monterey Bay. Domoic acid appears to be capable of spreading throughout the food chain, to zooplankton, fish, mussels, clams, and anchovies. The impact of the poison appears to depend on both the size and timing of the algal bloom.

Analysis of preserved seawater samples from the area dating back to 1977 indicates domoic acid was present during at least 12 of the last 17 years. The researchers suspect that domoic acid has been present in the bay for decades and probably was responsible for several incidents in which birds acted strangely, including the 1961 case in which they smashed into things and pecked eight people.

Scripps researchers Carina Lange, Freda Reid, and Maria Vernet have shown *P. australis* to be a regular and sometimes abundant component of the phytoplankton off Scripps Pier, especially during the spring and early summer. Intact materials were retrieved from samples collected off the pier more than 60 years ago. These samples also frequently contained *P. australis*. Yet, there has not been a major outbreak of domoic acid in the Southern California Bight.

At right, this lava-colored bloom of *Noctiluca scintillans* occurred during April 1995, about 2 miles off the coast of Scripps. This stripe, shown here near the demise of the red tide, stretched for twenty miles parallel to the coastline. As *N. scintillans* dies off due to starvation, it floats to the surface and interacts with water flow to form dense accumulations. The small boat leaving the bloom is towing a line with five floats, each 22 yards apart.

setts. People who eat shellfish contaminated with a neurotoxin produced by the alga risk suffering from paralytic shellfish poisoning.

After conducting three years of field study and analyzing 11 years of historical data, Franks determined that the toxic algae originated around an estuary to the north. The cells were being transported down the coast in a plume of fresh water being dumped into the coastal zone from the Androscoggin and Kennebec rivers.

Although Franks and scientists at the Woods Hole Oceanographic Institution continue to work on developing models for how the cells are being transported, they already can predict when shellfish in the region risk becoming toxic.

A native of Kingston, Ontario, Franks said he sort of stumbled into becoming a biological oceanographer.

"I started out wanting to be a physicist, but I decided after about a week that physics was really dry," said the 36-year-old assistant professor in the Scripps Marine Life Research Group, his boyish face breaking into a grin. "So I decided to go into biology instead."

After receiving a bachelor of science degree in biology from Queen's University in Kingston, Ontario, Franks was at a loss as to what to do next.

"I had heard about biological oceanography while working at a biology station north of Kingston. I thought marine biologists were pretty much a dime a dozen and that there would be too much competition," he said. "But I thought oceanography sounded really cool."

Despite knowing little about the field, Franks applied to the master's program in oceanography at Dalhousie University in Halifax, Nova Scotia, and was accepted. He knew almost immediately that he had found his niche in the world.

"In oceanography, I could combine physics, math, and biology. It brought together all the subjects that had been separated all through undergraduate school," he said.

Franks was first introduced to the study of red tides at Woods Hole while pursuing a doctoral degree in oceanography under the guidance of Don Anderson, a renowned expert in the field.

An outgoing person, Franks enjoys everything from making furniture to kayaking. But his first love appears to be food–both cooking it and eating it. Name a city, and Franks will be sure to tell you where you can get the best wood-fired pizza or stuffed Copper River salmon. Stop in at one of the many local restaurants that Franks frequents with his wife, Sharon, and the owner will likely know the couple by name.

While Franks said he sometimes misses the harsh Canadian climate he grew up in, he does not try to hide his obvious jubilation at landing a faculty position at Scripps.

"Getting your dream so early in life seems almost unfair," he said. "I just couldn't imagine having a better job than this."

Franks said he plans to pursue many avenues of research during his tenure at Scripps, including studying the toxic red tides he believes will one day begin striking southern California.

"I think we were just lucky that we didn't have a toxic bloom here this spring, but it is only a matter of time before some toxic species does take hold here and we start to have recurrent toxicity problems," he said. "I think toxic blooms are going to be happening all along the coasts of every country in the world that has oceanic coastline."

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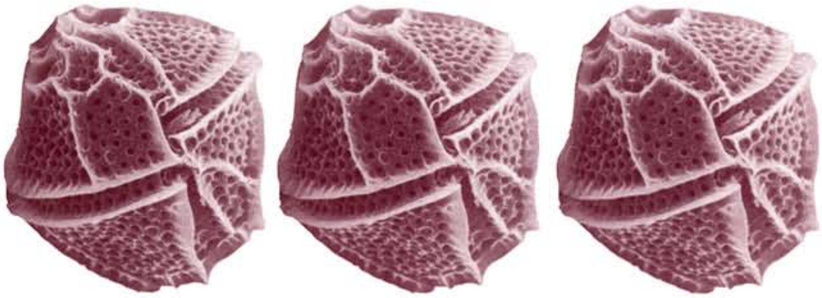


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