for several weeks in January and hung over northern Europe from London to Moscow. "It's somewhat disconcerting to see [chlorine monoxide] in such large quantities over such extensive areas," said UARS principal investigator Joe Waters of JPL.

All that's needed now for some serious ozone destruction at northern latitudes is more sunlight, which turns on the catalytic destruction of ozone by chlorine monoxide. The Airborne Expedition team estimates that the chlorine monoxide present in the vortex at the end of January could destroy ozone at a rate of 1% to 2% per day when the spring sun hits it—more than twice as fast as the rate of springtime ozone destruction calculated during a 1989 study of the Arctic stratosphere. The total ozone loss depends on how long the polar vortex—which normally breaks up in March or April—confines the brew of chemically altered air. "If the vortex persists," says Anderson, "we can expect large ozone losses," on the order of 30% to 40%. Losses in the Antarctic hole exceed 50%, but it does not get pushed off the pole and over large population centers, the way the Arctic vortex does.

If things look bad now, researchers say, just wait a few years. Pinatubo's extra contribution to ozone destruction will fade away during the next couple of years, but the atmospheric concentrations of manmade chlorine are increasing apace. The abundance of stratospheric chlorine is now about 3.4 ppb, according to a United Nations analysis, but chlorine will peak at the turn of the century at about 4.1 ppb even if all nations adhere to the Montreal Protocol by eliminating CFCs by 2000.

All that chlorine, the latest findings suggest, will do more damage than was assumed only a few months ago. Just last October, a study sponsored by the United Nations and the World Meteorological Organization had concluded that "the additional ozone losses during the 1990s are expected to be comparable to those already observed for the 1980s." But Michael Kurylo, NASA's upper atmosphere program manager, now thinks that assessment "is probably an underestimate because the atmosphere's ability to keep ozone losses in check is less than we thought."

This realization is adding to the momentum, even within the heretofore reluctant Bush Administration, for another acceleration of the CFC withdrawal schedule and stiffer controls on other dangerous compounds. But even an accelerated phase-out would reduce peak chlorine concentrations by only a few tenths of a part per billion. That would mean, notes Kurylo, that ozone loss will be "our legacy for much of the next century." ■ RICHARD A. KERR

Swimming Against The PCB Tide

A group of marine biologists and toxicologists is out to rejuvenate the bad reputation of organohalogens

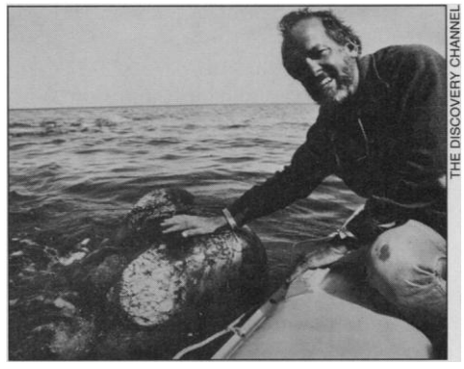
ONCE CONSIDERED SO DANGEROUS THAT Congress banned their manufacture in 1976, the family of chemicals known as the polychlorinated biphenyls (PCBs) has come in for some revisionist thinking in recent years. Many of the toxicity problems attributed to the PCBs can instead be traced to other chemicals with which PCBs were contaminated, this thinking goes. But now, PCB revisionism may itself need some revising, if a group of marine biologists and toxicologists—call them the counterrevisionists—is right.

Although no PCBs have been manufactured in the United States and other industrialized countries for years, the chemicals are still very much with us: Like DDT, they are extremely long-lived. They are still found today, for example, in older electrical transformers, where they are used as coolants. And only about 1% of the total PCBs produced have reached the oceans so far, estimates marine biologist Peter J.H. Reijnders of the Research Institute for Nature Management in The Netherlands. It's the PCBs' longevity and the lingering threat of more PCBs being released into the environment that worries the counterrevisionists.

They maintain that the PCBs and related organohalogens that have entered the oceans are making their way through the food chain into marine animals. As a result, they claim, the animals are becoming more prone to a variety of ailments, including reproductive abnormalities and immune suppression that makes them more susceptible to disease. "The oceans may be suffering from a condition similar to AIDS," is the eye-catching way that marine biologist Roger Payne, president of the Whale and Dolphin Conservation Society, puts it. Unless something is done to prevent further contamination by organohalogens such as PCB, many species of ocean mammals might become extinct and some species of fish inedible, he predicts.

Earlier this week, Payne and several colleagues officially launched a campaign to solicit funds for a 3-year research project aimed at determining just how serious PCB and other organohalogen problems are in the oceans. The idea is to look for correlations between organohalogen exposures and illness in two populations of animals in the Northern Hemisphere: beluga whales and albatross. "We want to wake up the world to the fact that these chemicals have pervaded ecosystems globally," says zoologist Theo Colborn, a senior fellow at the W. Alton Jones Foundation, a nonprofit organization that funds environmental policy research.

Payne's group has started to approach foundations and federal agencies for funding for their study, which they say could begin as early as this summer. And they've already had some success: The Dutch government tentatively has agreed to participate in some of the immunological work, Colborn says.



PCB danger? *Marine biologist Payne says yea, but others say nay.*

But some of the researchers who are most familiar with PCBs' track record are giving Payne's proposal a chilly reception. "I think the [PCB] problem is under control," says Stephen Safe, a Texas A&M toxicologist who has been studying the chemicals for 20 years. And another leading PCB researcher, Alf Fischbein of the Mount Sinai School of Medicine in New York City, says: "It's a situation where we don't have evidence of health risk. One has to raise the question about whether this concern is warranted."

Floating in the gulf that separates the two schools of thinking is a hot issue in toxicology generally: how to pin down the risks posed by low-level exposures to toxic substances such as PCBs, especially when exposures are rarely limited to just one potentially toxic chemical. Indeed, risk assessment related to low-level exposure of toxic chemicals will be a major topic at this year's meeting of the Society of Toxicologists,

which will be held in Seattle on 23 to 27 February. The meeting will also feature special sessions on the organohalogens' mechanism of action and on the responses of aquatic animals to environmental toxicants.

Twenty years ago, there seemed to be no doubt that PCBs deserved a nasty reputation. Two mass poisonings, one of which occurred in Japan in 1968 and the other in Taiwan in 1979, were attributed to the consumption of rice oil contaminated with the chemicals. In the two incidents, a total of about 3500 people came down with a variety of symptoms that included a skin rash called chloracne that is one of the classic signs of PCB toxicity, as well as weakness, vomiting, and persistent learning difficulties. What's more, studies in rats performed in several labs showed that some commercial PCB preparations are potent promoters of liver cancer, prompting the Environmental Protection Agency (EPA) to classify them as suspected human carcinogens.

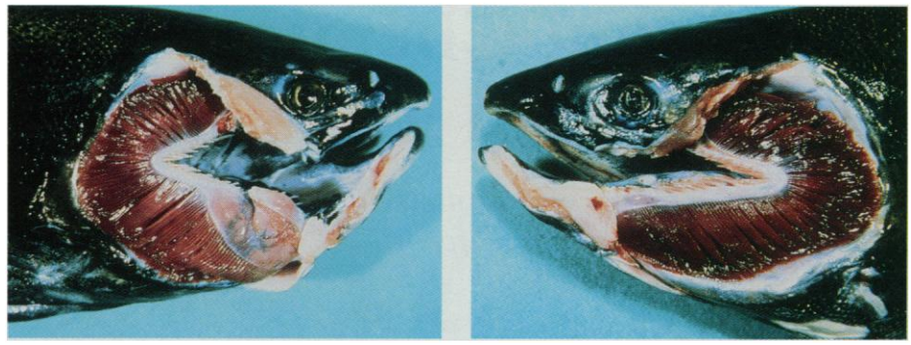
But in the late 1970s, the first revisionist wave started breaking when toxicologists began acquiring evidence that the PCBs were far less sinister than they had been portrayed. Fischbein, for example, conducted epidemiological studies of workers in capacitor manufacturing plants who were exposed to PCBs on the job. The result: Despite comparable levels of serum PCB, the workers' symptoms weren't as severe as those seen in the Asian poisoning victims. The workers did show signs of PCB poisoning, including chloracne, enlarged livers, and increased blood serum lipids. But all their toxic symptoms disappeared soon after exposure to PCBs ended.

So why were the Asian incidents more devastating? To Fischbein, the evidence points to other suspects—highly toxic polychlorinated dibenzofurans that were also found in the rice oil along with the PCBs. In short, says Fischbein, "that's how we've come to revise the effects of PCBs."

The link between PCBs and cancer also has grown more tenuous over the years, partly because of epidemiological studies on workers who were exposed to high levels of PCBs in capacitor and paint manufacturing plants, as well as on the Asian poisoning victims. The results suggest, Safe says, "that the adult human population most highly exposed to PCBs doesn't show any consistent increase in mortality or specific cancers."

Even Payne and his counterrevisionist associates concede that environmental levels of PCBs don't cause acute toxicity or cancer in humans. Instead, they are focusing on a more subtle array of problems that have been cropping up in seabirds and marine animals.

In the August 1991 issue of the *Journal of Toxicology and Environmental Health*, for example, a research team led by biologist Michael Gilbertson of the Ontario-based International Joint Commission describes a syndrome called GLEMEDS for "Great Lakes embryo mortality, edema, and deformities syndrome" in herring gulls, terns, and other Great Lakes marine birds that the researchers think is associated with the organohalogens. "There was a time when bird eggs wouldn't hatch in the Great Lakes. The shells were too thin because of DDT," says wildlife biologist James Ludwig of the Ann Arbor-based Ecological Research Services, Inc., who co-authored the GLEMED paper and will head the albatross component of Payne's project. "But egg hatchability didn't return to what it should have been, and lo and behold, the problems that crop up are associated with PCBs and dioxins," he says.



Toxic effect? *Coho Salmon* (left) *with enlarged thyroid. Is it PCB pollution?*

Other researchers are blaming organohalogens for mass die-offs of dolphins, seals, whales, and other marine mammals. When more than 700 bottlenose dolphins washed up on the U.S. Atlantic coast during the winter of 1987-88, EPA researchers found elevated levels of PCBs and DDE, a breakdown product of DDT, in several of the dolphins tested. While marine biologists blamed the die-off on brevitoxin, a neurotoxin produced by the Florida red tide organism, some speculated that PCBs or other chemical contaminants might have suppressed the dolphins' immune systems and contributed to their deaths. In addition, researchers have correlated increasing exposure to PCBs to the declining populations of seals in the Baltic Sea and in the Dutch Waddenzee, possibly because the chemicals contribute to poor fertility and make the animals more susceptible to infections by canine distemper virus or other viruses.

Beluga whales in the St. Lawrence estuary, where water from the Great Lakes runs into the Atlantic, are suffering from a potpourri of health problems too. "Our whales have a lot of opportunistic infections," says marine biologist Pierre Beland, scientific director of the St. Lawrence National Institute of Ecotoxicology. Beland says he has found PCB concentrations ranging as high as 600 parts per million in the fat of beluga whales in the St. Lawrence estuary, compared with a background rate of less than 5 parts per million in Arctic whales. "We think [the infections] result from their weak immune systems, which we think result from the PCBs," he says. Beland also has found mammary gland lesions and gastric ulcers in the whales. However, he admits, PCBs may not be the only factor causing the abnormalities—the whales also store high levels of DDT, mercury, lead, and mirex, a pesticide.

PCBs are implicated in developmental effects in humans, too. In a recent study of babies born to women who ate moderate amounts of Lake Michigan fish—roughly two to three fish meals a month—and had moderate blood concentrations of PCBs, researchers at Wayne State University in Detroit and the Michigan Department of Public Health found reduced psychomotor function and visual recognition in the infants, and impaired verbal and memory abilities at age 4. A study of North Carolina children with only background levels of PCBs turned up similar deficiencies, although by the time those children were 3 years old, they were testing normal. "Still, it's spooky to me that you can find effects at background exposures," says epidemiologist Walter J. Rogan of the National Institute of Environmental Health Sciences, a co-author of the North Carolina study.

Despite evidence suggesting that PCBs may have subtle effects in mammals and children, revisionists are holding their ground, saying the evidence just isn't persuasive enough. "Despite the fact that there are effects on certain species of animals," says Fischbein, "we just don't have any evidence of chronic or acute health effects in community exposure." Besides, says Safe, "we have lots of other environmental problems to work on." Fischbein agrees, maintaining that the kind of attention and funding that Payne's PCB campaign is attracting could be better spent on more serious threats to human health—such as the effects of lead and passive smoking. ■ RICHARD STONE