Ed Johnson

PCB File

HOW SHEER LUCK MAY HAVE SAVED THE WORLD FROM MASSIVE KILLING OF ORGANISMS BY DDT

By Richard H. Gilluly
From Science News

INTO THE ABYSS



It is possible that DDT does not harm humans directly in the quantities that exist in the environment. Recently there have come forward defenders of DDT ranging from Nobel laureate Norman E. Borlaug to a Los Angeles couple who swallowed large quantities of the insecticide and said they were not harmed. DDT has been important in reducing disease and increasing food production in underdeveloped countries. On the other hand, second- and third-order effects may cancel the apparent gains.

But the view that if DDT in environmental amounts cannot be proven to be harmful to humans it is therefore safe, cannot be sustained. There is no doubt whatever that it harms other organisms and thus "poses an imminent threat to human welfare in terms of maintaining healthy, desirable flora and fauna in man's environment," in the words of an advisory report to the Environmental Protection Agency.

Biological scientists are constantly producing new evidence of the widespread dissemination of DDT and its metabolites in various ecosystems and of its harm to organisms in these systems. Scientists at Woods Hole Oceanographic Institution recently released new evidence regarding the occurrence of DDT, as well as of the ubiquitous industrial compounds polychlorinated biphenyls (PCBs), in marine organisms, and the results are no cause for optimism. "PCB," say the scientists, "is readily demonstrable in all, and DDT in most, of a series of organisms collected from the North Atlantic Ocean."

The scientists are George R. Harvey, Vaughan T. Bowen, Richard H. Backus and George D. Grice. They collected a variety of marine organisms on cruises in the Atlantic. "It was our intention," they say, "to look for gradients of [PCB and DDT] concentrations in reference to a few major features, such as river-borne supplies to the Hudson and Savannah estuaries, the southward transport in the Canary Current of European petroleum [DDT and PCB are highly soluble in fats and oils], tradewind transport to the North Equatorial Current, the gyral circulation of the Sargasso Sea and the large currents of the South Atlantic."

To understand the significance of the work, it is necessary to have some understanding of the immensely complicated, and often not yet fully explained, pathways of transmittal of DDT in the environment. DDT's danger to living organisms comes from its near insolubility in water and its relatively high solubility in fats and oils, and from its persistence. "The physical and chemical characteristics of DDT might lead one to assume that the biosphere should behave as a giant separatory funnel, gradually partitioning the lipid-soluble residues into the lipid-rich biota," explains an article in *Science* written by George M. Woodwell, Paul P. Craig and Horton A. Johnson of Brookhaven National Laboratory.

Fortunately, the partitioning of DDT in the fatty tissues of organisms has not occurred to the degree that would be expected on a worldwide basis, and thus there have not been the massive extinctions of organisms that might likewise have been expected. The difficulties in measuring effects, however, are so great that it is likely that long-term chronic effects have been overlooked.

But there is no doubt that DDT has posed large dangers to organisms in local situations, particularly warm-blooded, small-bodied carnivores. Ospreys, pelicans and other birds have experienced severe disturbances in reproduction, and their numbers have declined. But the declines can be arrested or reversed relatively quickly when DDT use is halted in the affected area. This fairly simple relationship between amounts of DDT in a local environment and its levels in and effects on organisms is not difficult to understand, but the problem grows far more complicated when DDT is con-

MONS 069052

sidered on a worldwide basis.

It is increasingly obvious that DDT transport into oceans via rivers is less significant than earlier thought. Evidence now indicates that much of the DDT sprayed on crops never reaches the land surface but instead enters the atmosphere. And DDT that does reach the land surface often vaporizes and is carried away in the atmosphere. The pathway for DDT appears to be "from the land, through the atmosphere into the oceans and [ultimately] into the oceanic abyss." Biologically, the pathway appears to be from simpler organisms up the food chain to more complex organisms.

Both the physical and biological mechanisms are highly complicated and do not always follow the general patterns. Further, new work indicates that the PCBs, although chemically similar to DDT, may often take different physical and biological routes from DDT. Finally, the Woods Hole work throws some new light on the question of why DDT levels in the environment are high enough to cause large-scale extinctions but do not, in fact, do so.

The Woods Hole researchers say that a possible speedup of both DDT and PCB disposal to the abyssal "sink," where biological effects are minimal, may occur biologically. "A group of fish and crustacea that feed near the sea surface at night but migrate to considerable depths during the day show DDT and PCB concentrations not greatly different from those of predaceous organisms whose lives are spent mostly in the upper layers," they say. "We believe this shows that biological removal processes may help to control chlorinated hydrocarbon concentrations in the open ocean." In short, there may be biological mechanisms that rather quickly take DDT and PCBs from the air-water interface or from oily slicks on the surface to great depths—thus preventing magnification to a point where extinctions would occur in the more biologically active upper levels of oceans. The Woods Hole researchers now plan analysis of sediment cores "to estimate how effective the biological process is in removing toxic materials from the whole water column."

There are apparently no consistent lateral gradients of DDT or PCB distribution in the Atlantic Ocean, which indicates that large amounts are not coming from estuaries. And there seems to be no indication of a systematic pattern of DDT and PCB ratios conforming to relative amounts released from Europe and North America. The apparent explanation for these findings is the airborne transport of both substances and a general mixing.

While there is a general pattern of both DDT and PCB concentration up food chains, there are exceptions to this, as well as differences in pathways for the two kinds of compounds. For instance, certain phytoplankton samples showed higher DDT than PCB concentrations in areas of petroleum residues, indicating that these residues may be intermediating in the uptake of DDT but not of PCBs. A tendency to high PCB and low DDT in some zooplankton samples may not be related to the diets of the organisms but rather to surface/volume ratios of the animals. Thus, for some reason the zooplankton may absorb and/or retain PCBs directly from the water but may reject DDT by this route or not retain it. A related hypothesis is that the zooplankton samples, collected at night, may have been heavily weighted with vertically migrating organisms. These organisms may have absorbed ambient PCBs through surface uptake when they came to upper layers for nighttime feeding but had not yet had time to ingest high levels of DDT.

Those are just a few of the complexities and unanswered questions revealed by the Woods Hole scientists, and analysis of these data is still going on. Concentration of chlorinated hydrocarbons up the food chains of land animals is relatively straightforward, because the food pathway is the most significant one in these organisms. But for aquatic creatures the non-food-drink pathway is more significant. That is, the environment-organism interface is far more blurred for the aquatic creatures.

Some scientists believe food-chain amplification of the toxic material is relatively insignificant in aquatic organisms. For instance, levels may be related simply to size and life-span of the organism. A large, long-lived fish may have more DDT and PCBs in its body than a smaller, short-lived one.

Aquatic food chains are more often "short-circuited" than dry-land ones. "Tuna, sometimes when they just seem to be feeling good, will fill their stomachs with medium-size grazing plankton instead of with larger predaceous fish."

Probably the most important need is for toxicological work. Marine creatures are notoriously difficult to maintain in the laboratory. "A variety of organisms we collected," says Dr. Bowen, "had levels of DDT and PCBs in the range that has been established to be toxic to freshwater organisms. Desperately needed is a study of physiological, genetic and cytomorphological effects in marine organisms."

And PCBs are far less understood than DDT. Little is known of their metabolism, and their persistence in nature is expected to be longer than that of DDT, which scientists generally agree has a half-life of ten years.

The implications are serious. A model constructed by the Brookhaven group indicates that DDT levels worldwide will soon be in a decline if there is decreasing use through 1974, with levels back to the pre-1950 level by the year 2000. Sheer luck saved the world from massive organism extinctions due to DDT. The reason for this luck is not yet explained, although the fairly rapid biological transport to abyssal sediments may be at least part of the explanation. Although the use of DDT in the United States has been steadily declining since 1960, high levels of use in foreign countries could continue; if so, levels in the mixed layers of the oceans, the troposphere and the biota will continue to rise. Luck may not hold.

There are significant differences between PCBs and DDT in their respective physical and biological pathways and probably also in metabolism and persistence. So little is known that the outcome of PCB dissemination is difficult to predict. Once again, luck may not hold.

PCBs are far less understood than DDT, but they are expected to persist in nature even longer.

There are several things that must be done. One is to quickly adopt international inventory, monitoring and control systems for toxic chemicals. Another is to evolve mechanisms whereby developed nations help underdeveloped nations to cope with their pest problems with more expensive techniques than persistent, broad-spectrum chemicals, thus eliminating objections to the halting of DDT use. Finally, far more research and development must be done so that man can learn what he has already done to the biosphere with the persistent chemicals, how he can halt or reverse the undesirable changes and what he can do to handle pest problems in less damaging ways.

Richard H. Gilluly is environmental sciences editor of *Science News*.

Reprinted with permission from Science News, the weekly news magazine of science and the application of science, copyright © 1972 by Science Service, Inc.

MONS 069053