



Mollusks such as oysters and these mussels are sessile and tend to accumulate concentrations of chlorinated-hydrocarbon pesticides, thus serving as indicators of pollution levels in local marine waters. They would be among organisms sampled in suggested monitoring programs for checking pesticide levels in the world's oceans.

PCB-DDT Chlorinated- hydrocarbon Pesticides

Amass in the World's Oceans

SLOWLY, many residues of the world's chlorinated-hydrocarbon pesticides are draining into the oceans. Washing from the land, pouring from sewage outfalls, falling from the atmosphere, these persistent chemicals continue to accumulate in marine waters with "demonstrable" impact on the fish, crabs, shrimp, birds, and other creatures of the sea.

Already 550,000 tons of DDT—25 percent of the world's total production—may have entered the oceans. The remaining 75 percent—1,650,000 tons—eventually may be deposited in that "ultimate repository," the ocean, a National Research Council report warns.

The report, *Chlorinated Hydrocarbons in the Marine Environment* (see "New Publications," p. 12), results from studies by the Panel on Monitoring Persistent Pesticides in the Marine Environment, established in the spring of 1970 by the NRC Committee on Oceanography, now the Ocean Affairs Board.

The panel participated in the one-month Study of Critical Environmental Problems (SCEP), arranged at Williams College last summer by the Massachusetts Institute of Technology, and some SCEP participants contributed substantially to the panel's report.

With this report on the production and distribution of persistent pesticides and their effects on the marine environment, the panel—chaired by Edward D. Goldberg of the Scripps Institution of Oceanography—says it hopes to "alert the community of marine scientists to one of the most serious problems arising from the dispersal of man's materials to his surroundings."

How Long to Decay?

The world may now be producing some 110,000 tons of chlorinated hydrocarbons a year—including DDT, aldrin, chlordane, dieldrin, endrin, heptachlor, toxaphene, and the polychlorinated biphenyls. The rate at which these substances degrade to harmless products is unknown, according to the panel. The half-lives of some of the more persistent materials may be of the order of years, and perhaps even of decades or centuries. If most of the remaining chlorinated hydrocarbons now in land reservoirs are transferred to the sea, "we may expect an increased level of these substances in marine organisms, despite future improvements of manufacturing practices." And if these compounds degrade with half-lives of decades or longer, "there will be no opportunity to redress the consequences."

The warnings are not new. As the NRC panel notes, Clarence Cottam and Elmer Higgins of the U.S. Fish and Wildlife Service declared in 1946:

"From the beginning of its wartime use as an insecticide the potency of DDT has been the cause of both enthusiasm and grave concern. Some have come to consider it a cure-all for insect pests; others are alarmed because of its potential harm. The experienced control worker realizes that DDT, like every other effective insecticide or rodenticide, is really a two-edged sword: the more potent the poison, the more damage it is capable of

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doing," Drs. Cottam and Higgins point out that the "advantage of control of undesirable species [by poisons] would be more than offset by the detriment to desirable and beneficial forms." An effective poison such as DDT "will certainly destroy beneficial insects, fishes, and wildlife."

Evidence of that prophecy's fulfillment has been noticed. In the marine environment, "populations of fish-eating birds have experienced reproductive failure and decline," the NRC report states. Other marine species, too, are affected in deleterious ways by pesticides.

Although data on the pollution of the ocean environment is inadequate as yet, the panel considered its findings serious enough to call for a "massive national effort" immediately "to effect a drastic reduction of the escape of persistent toxicants into the environment."

The panel called also for examination and perhaps revision of laws relating to the registration of industry's production figures of chemicals. A legal structure "that allows manufacturers of a given material, where there are no more than two producers, the right to hold their production figures as privileged information" serves to prevent scientists from gaining full information on chlorinated-hydrocarbon production. Although the panel recognizes the "economic rationale" behind such a law, it believes that "there are times when it is not in the public interest for government to maintain as privileged data that are necessary for research into the state of our environment and for an assessment of its condition." The panel says "the protection afforded manufacturers by government is an artificial obstacle to effective environmental management, particularly with reference to the polychlorinated hydrocarbons." It adds: "In view of other impediments—technological, methodological, and financial—such protection is clearly inappropriate."

The panel recommended initiation of programs to determine the rates of entry of each pollutant into the oceans and to determine the distribution of the pollutants throughout this environment.

Data on world production and use of chlorinated hydrocarbons are difficult to assimilate because of lack of available information. Although some figures can be obtained for certain countries, comprehensive data for the major producers have not yet been compiled, hampering "mass-balance calculations for dispersion of these materials around the earth and making an understanding of their behavior in nature difficult."

Many Routes to the Sea

The residues of the various chlorinated hydrocarbons wend their way to the sea by various routes, principally through the rivers, through sewage pumped or hauled into the oceans, and through the atmosphere. By using the figure of maximum concentration of 100 parts of DDT per trillion of water, found in a survey of rivers of the western United States, the panel extrapolated that if all rivers of the world contained this maximum, approximately 4,000 tons of DDT residue (approximately 3 percent of estimated annual production of the world) would be transported through streams to the ocean. Most DDT residues may be transported through the atmosphere. DDT residues enter the air by drift when pesticides are

applied and when they vaporize from water surfaces or from plants and soil. Once in the atmosphere they may travel great distances before they eventually fall into the sea, washed out by rain or precipitated as dry particles. From limited data, the panel calculates that about 26,000 tons of DDT residues may be transported annually—about 25 percent of the estimated total amount produced each year. "It is at least plausible that the atmosphere is the major route for transfer of DDT residues into the oceans," the panel concluded.

Throughout the report, the panel emphasizes figures on DDT because these chemicals have been the most studied to date.

DDT in Marine Organisms

More than 1,000 tons of DDT probably have entered the systems of marine organisms. In laboratory testing, the panel reports, varying amounts of toxic chemicals have been shown to affect growth, reproduction, and mortality of marine animals. They have been known to inhibit photosynthesis in single-celled marine plants and inhibit growth in plankton, bases of the food chain in the ocean. In the laboratory, commercial species of shrimp and crabs were killed in concentrations of chlorinated hydrocarbons of parts per billion. For instance, shrimp died within 28 days in concentrations of 0.2 parts per billion. Concentrations of this magnitude have been detected in Texas river waters flowing into commercially important shrimp-nursery areas, the report points out.

Ocean fish are widely contaminated with chlorinated-hydrocarbon residues. DDT residues in ripe eggs of speckled sea trout on the south Texas coast are about 8 parts per million. This level may be compared with the residue of 5 parts per million, in freshwater trout, that causes 100-percent failure in the development of sac fry or young fish. "The evidence is presumptive for similar reproductive failure in the sea trout," the report states.

Chlorinated-hydrocarbon residues have seriously affected adult birds as well as their reproduction, the panel reports. Deaths of bald eagles, common loons, and peregrine falcons have been correlated with lethal amounts of these pesticides in body tissues. Studies of museum eggs indicate that eggshell thinning has occurred since the mid-1940s in a wide range of species of fish-eating birds and birds of prey. Samples of eggshell thinning of marine birds such as black ducks, kestrels, brown pelicans, and egrets have been detected in various parts of the United States. Where this eggshell thinning has occurred, the populations have usually declined. Eggshell thinning and consequent population decline have been linked to chlorinated-hydrocarbon residues found in eggs and in the body tissues of birds. "Continued buildup of chlorinated hydrocarbons in this ecosystem and in other marine ecosystems around the world will cause reproductive failures in these and other marine species."

The panel says it sees "clearly that the observations and predictions of Cottam and Higgins have been confirmed by subsequent events." Man's knowledge of the fate and behavior of the chlorinated hydrocarbons in the marine environment is inadequate, says the NRC panel, with a plea that further investigations and actions be taken in this field.

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