DDT IN BENTHIC FISH

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In 1973, we reported that the flesh of approximately 60 percent of the Dover sole trawled during 1971 72 between Redondo Canyon and the western entrance of Los Angeles Harbor exceeded the U.S. Food and Drug Administration's limit of 5 ppm (mg/wet kg) for DDT in seafood. A subsequent restandardization has raised that figure to 75 percent. The major source of this contamination had been the waste material generated during the manufacture of this pesticide and subsequently discharged to the marine environment via the Palos Verdes submarine outfalls. In 1970, the release of these wastes to the sewage collection system of the County Sanitation Districts of Los Angeles County was discontinued. Since then, marine inputs of DDT via these outfalls have decreased considerably.

To determine if excessive DDT concentrations still existed in flesh of fish collected from the region, we analyzed 1973 data provided by the Sanitation Districts. The principal fishes collected were the black perch (*Embiota jacksoni*) and the kelp bass (*Paralabrax clathratus*), both of which are highly specific to a given region and apparently feed on or near the bottom. In addition, a few Dover sole, green striped rockfish, and other benthic fishes were also collected and filleted for analysis of DDT concentrations.

An intercalibration experiment conducted in 1972 between the Districts' San Jose Creek Laboratory and that of Dr. Robert Risebrough, University of California at Berkeley, had resulted in agreement within about +10 percent on the DDT content of the mussel samples utilized. Monitoring data for 1973 from the Districts' laboratory are summarized in Table 1.

Only for the black perch and the kelp bass were enough flesh samples analyzed for the results to be statistically significant; on the average, the flesh of approximately half of these fish caught in the discharge region exceeded the Federal DDT limit. As shown in Table 1, the range of values for total DDT in fillets were 0.82 to 86.9 mg/wet kg for the black perch and 0.37 to 28.8 mg/wet kg for the kelp bass. In 1971 72, the reported ranges were 0.61 to 64.0 mg/wet kg in 32 black perch and 0.77 to 47.0 mg/wet kg in 29 kelp bass. Part of the explanation for the high percentage (65 percent) of black perch having excessive flesh concentrations of DDT may lie in the fact that this fish is viviparous (bears live young); thus body burdens of DDT in females are not reduced by the release of a large number of eggs during spawning.

These data indicate that a substantial percentage of the fish closely associated with the benthic food web on the Palos Verdes Shelf during 1973 still contained excessive concentrations of DDT compounds in their flesh, despite the fact that the annual discharge of this material from the outfalls decreased from 19 metric tons in 1971 to 3 metric tons in 1973. On the other hand, three Bonito (a surface-feeding predator) collected in 1972 had a median DDT concentration of 0.09 mg/wet kg (range: 0.05 to 0.11 mg/wet kg) in their muscle tissue. This concentration is from 15 to 500 times lower than the median concentrations found in the more localized near bottom feeders. The lower concentrations in the Bonito are probably due to the fact that this fish lives in the

water column and is a highly mobile organism. The enrichment of DDT concentrations in the resident fishes may well be due to the large reservoir (approximately 100 metric tons) of total DDT in the upper 12 cm of bottom sediments on the Palos Verdes Shelf. Much of this material is near enough to the sediment surface to be available to the benthic food web. Thus, it is possible that these contaminated sediments are an important (perhaps now the dominant) local source of DDT compounds to the ecosystem of the shelf. In light of the apparent ecological significance of this synthetic organic, and the degree of local contamination that has occurred, it is important that the persistence of this contamination in several different parts of the local marine ecosystem be followed through adequate monitoring programs. Several such programs are now being conducted by this project.

Our studies to date on chlorinated hydrocarbons in organisms generally have centered on concentrations in whole soft tissue or flesh, for which the several grams of tissue needed for analysis usually can be obtained from a single specimen. However, the literature indicates that, on a wet-weight basis, other tissues of marine species usually contain higher levels of these synthetic organisms than does the flesh. For example, Dr. John S. MacGregor of the National Marine Fisheries Service, La Jolla, found DDT compounds to be 4 to 49 (median = 10) times more concentrated in composite samples of liver than of flesh from five species of near bottom fish collected in Santa Monica Bay. A similar survey by Hyperion Treatment Plant personnel yielded liver to flesh ratios of 14 to 128 (median = 28) for the identifiable chlorinated hydrocarbons. Sprague and Duffy reported* that Atlantic salmon, cod, hake, and flounder contained viscera to flesh ratios of 1 to 15, with a median value of 8. As is discussed elsewhere in this report, we have obtained median gonad to flesh DDT ratios of 6 and 23, respectively, for male and female cancer crabs collected off Los Angeles and Orange Counties; corresponding ratios for PCB were 9 and 11. These results are consistent with those reported for another marine invertebrate, the purple sea urchin. Risebrough and his coworkers found that levels of DDT compounds in gonads from specimens collected off northern California were at least five times as large as in the other tissues of the urchins.** These investigators also reported that DDT compounds in sea birds collected off San Francisco were 23 to 28 times as concentrated in the subcutaneous fat as in the breast muscle. Finally, for harbor seals from this general area, Shaw reported a concentration ratio of 31 for these synthetic organisms in blubber and muscle tissue.

Thus, it is seen that, relative to values for flesh, considerably higher levels of DDT and PCB compounds can be expected in various tissues of marine fishes and other organisms. In light of the physiological and ecological implications of such concentrations and total organ accumulations, during the coming year we intend to conduct specific investigations into the distributions of these materials throughout species of interest from off the southern California coast.

*J. Fisheries Res. Board of Canada 28:59 64 (1971). **Nature 216:589-91 (1967).

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TABLES

Table 1.
Total DDT in the flesh of fishes caught off Palos Verdes, 1973.*

		Concentration (mg/dry kg)			Federal Limit (5 ppm) Exceeded
Species	**Median**	**Range**	**No. of Fish**	**No. of Fish**	**Percent**
Black perch	7.9	0.82--87	60	39	65
Kelp bass	4.0	0.37--29	28	13	46
Dover sole	4.0	2.6--13	4	1	25
Green striped rockfish	46	21--330	5	5	100
Miscellaneous	4.0	1.3--11	3	1	33
Total			100	59	59

*Monitoring data of the County Sanitation Districts of Los Angeles County.