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A NEW OFFSHORE MONITORING SYSTEM

During the year, with the support of the Environmental Protection Agency, the Project has developed a new offshore "caged animal" bimonitoring system and tested it with synthetic organics at ocean outfall sites.

In June 1974, approximately 1,200 mussels, *Mytilus californianus*, between 4 and 6 cm in length were collected from Point Sal, a relatively uncontaminated region north of Point Conception. They were transported alive to a special taut-line buoy system (Figure 1) that had been installed in 35 m of water above highly-contaminated sediments approximately 3 km northwest of the Los Angeles County Sanitation Districts' 90-inch outfall off Whites Point. From this system, four nylon mesh bags, each containing about 60 mussels, were suspended at each of five depths below the surface—0.5 m (surface), 4 m, 15 m, 25 m, and 35 m (bottom). The bottom bags were hung within a metal mesh cage that rested directly on the sediments in the discharge field.

For the first 7 weeks, samples were collected every 7 days; thereafter, they were collected at increasingly longer intervals. Five males and five females were taken from each level each time; their whole soft tissues (except the byssal threads) were excised while they were still fresh, and the tissues were homogenized as two separate composites. Aliquots of the homogenates were dried over-night at 60°C to obtain individual dry-to-wet-weight ratios (the average value found was 0.28 + 0.02, with 95 percent confidence).

The homogenates were extracted by mechanical grinding in acetonitrile. Chlorinated hydrocarbons were extracted from the acetonitrile with hexane (leaving the lipids behind). The hexane extract was then cleaned on a Florisil column and analyzed by gas chromatography. Multiple extractions of contaminated tissues indicate a better than 90 percent recovery with this technique; blanks are negligible.

At the time of the Point Sal collection, samples of 5-cm *M. californianus* also were obtained from the rocky intertidal zone at Royal Palm State Beach, located at the base of the Whites Point submarine outfalls. Fresh individuals from both collections were separated by sex, and six male and six female replicate composites of whole soft tissues (five mussels per composite) were analyzed. Table 1 presents mean concentrations, and standard errors, of total DDT and 1254 PCB in the male and female replicates from the outfall and control regions.

These data indicate that, on the average, mussels living inshore of the buoy contained roughly 50 times as much DDT and 20 times as much PCB as did the Point Sal specimens at the time of their transfer to the buoy northwest of the out-falls. Thus, the exposure of the Point Sal mussels to chlorinated hydrocarbons was greatly increased upon their transfer to the discharge region. Resultant uptake with time is illustrated in Figures 2 and 3.

The results show that there is a direct relationship between uptake of DDT and PCB and proximity of the bio-indicators to the contaminated bottom sediments and to the wastewater plume, which is largely trapped beneath the thermocline. The bottom specimens became approximately 10 times as contaminated as did the surface specimens. Typical "steady state" total DDT concentrations for the two levels of suspension appear to be about 20 and 2 mg/dry kg, respectively; corresponding estimates for 1254 PCB are 2 and 0.2 mg/dry kg. The highest total DDT concentrations found in the water above the JWPCP outfalls is about 20 parts per trillion, and the 1254 PCB numbers appear to be an order of magnitude lower. This suggests a

concentration factor for DDT and PCB compounds in the soft tissues of Mytilus in excess of 100,000, on a wet-weight basis.

The concentrations of total DDT in the mussels reached about 10 mg/dry kg, or half the projected equilibrium level, in the first 2 weeks of the experiment. This is consistent with earlier Project findings of a biological half-life of about 2 weeks for total DDT in this species (half the remaining DDT was rejected each 2 weeks). However, the data suggest the half-life for PCB is somewhat higher, perhaps on the order of 1 month. Part of the variability observed in these uptake studies, such as the dip in some of the curves at Week 7, may be due to spawning.

The principal objective of this pilot study was to demonstrate the feasibility of a caged-animal biomonitoring system that is capable of rapidly indicating zones of relatively high availability of pollutants, including synthetic organic compounds in the water column around a submarine waste discharge. Although *M. californianus* is a shallow-water organism, less than 10 percent mortality was observed even at the 35 m depth over the 5-month study period. Thus, this invertebrate's hardiness, its ubiquitous distribution along many coastlines around the world, its very high ability for concentrating chlorinated hydro-carbons, and its ability to rapidly respond to changes in environmental levels of such contaminants make it a very useful bioindicator both in natural intertidal communities and on offshore monitoring substrates. The advantage of this mussel buoy scheme is, of course, that one can be installed nearly anywhere, including places where mussels do not ordinarily live. Additional tests around several different types of submarine outfalls should prove extremely useful in developing this widely-applicable offshore monitoring system.

Table 1. Average chlorinated hydrocarbon concentrations (mg/dry kg) ± standard errors, for six male and six female soft-tissue composites of the mussel, Mytilus californianus, collected in June 1974 from the rocky intertidal zone at Royal Palm State Beach and Point Sal, California. Each composite consisted of five mussels, 4 to 6 cm in length.

	Royal Palm, 26 Jun		Point Sal, 25 Jun	
Compound	Male	Female	Male	Female
Total DDT	4.1 ± 0.70	6.4 ± 0.32	0.11 ± 0.004	0.11 ± 0.007
p,p'–DDT	0.04 ± 0.005	0.06 ± 0.005	0.008 ± 0.0005	0.007 ± 0.0006
o,p'–DDT	0.03 ± 0.003	0.04 ± 0.004	0.004 ± 0.0001	0.004 ± 0.0005
p,p'–DDE	3.5 ± 0.64	5.4 ± 0.28	0.077 ± 0.003	0.067 ± 0.003
o,p'–DDE	0.41 ± 0.06	0.73 ± 0.05	0.015 ± 0.001	0.026 ± 0.007
p,p'–DDD	0.11 ± 0.01	0.18 ± 0.007	0.009 ± 0.0006	0.008 ± 0.0004
1254 PCB	0.53 ± 0.06	0.76 ± 0.04	0.028 ± 0.004	0.035 ± 0.003

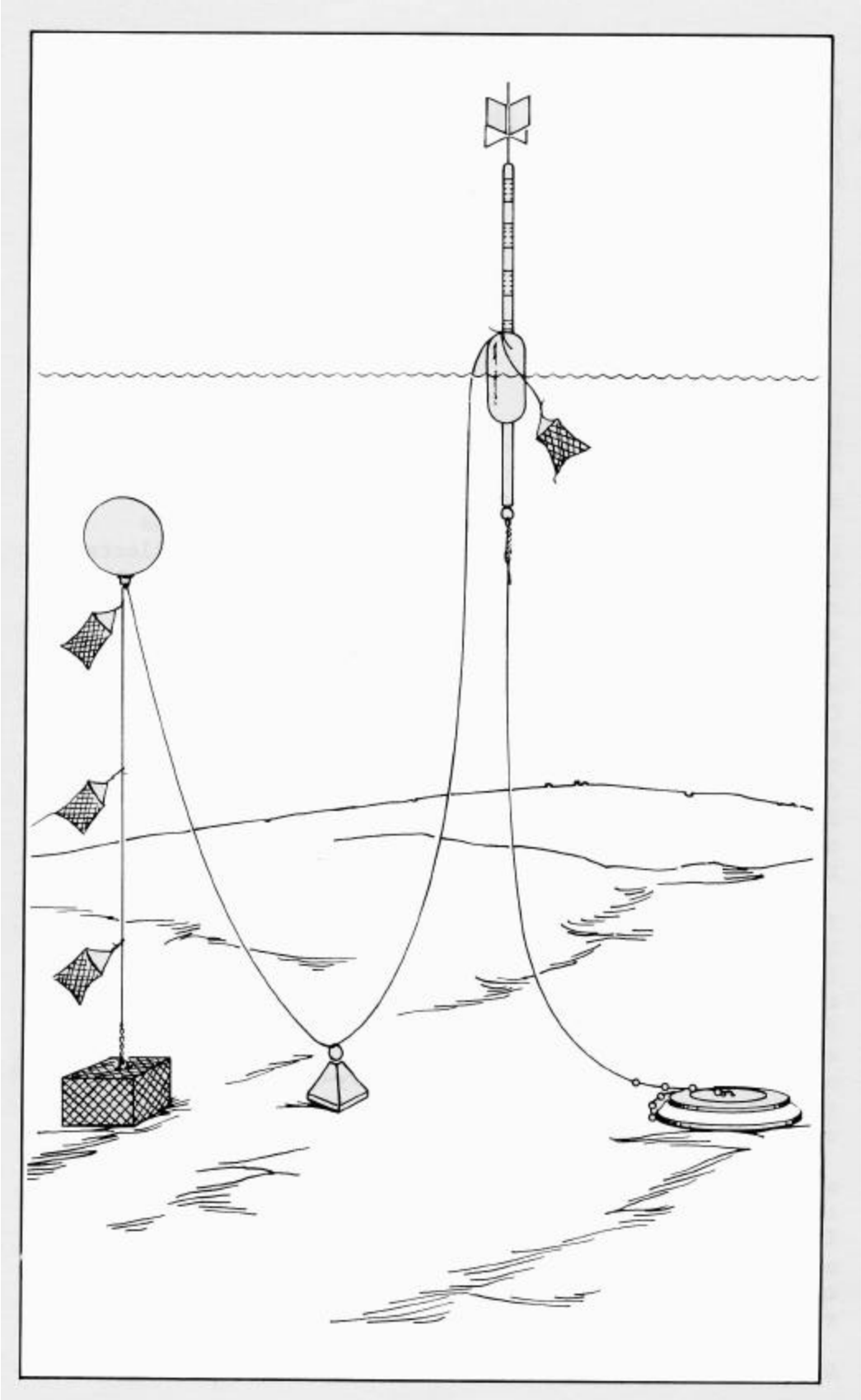

Figure 1. Taut-line buoy system used in survey of synthetic organics off Palos Verdes Peninsula. Mussels are kept in the cage on the bottom and the four bags at various depths.

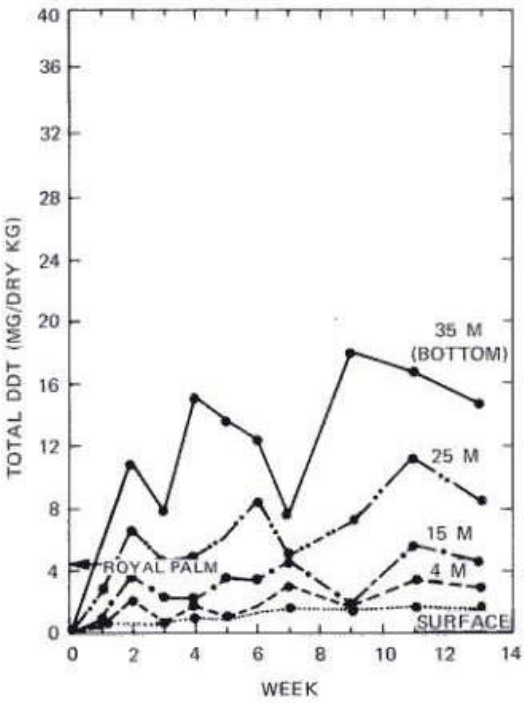

Figure 2. Uptake curves for total DDT in whole soft tissue Composites of male mussel, Mytilus californianus, translocated In June 1974 from Point Sal to the taut-line buoy system off Palos Verdes Peninsula.

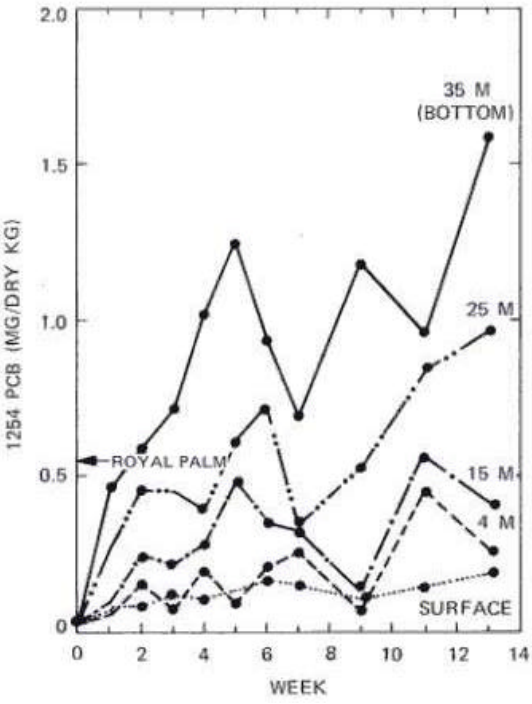

Figure 3. Uptake curves for 1254 PCB in whole soft Tissue composites of male mussel, Mytilus californianus, translocated in June 1974 from Point Sal to the taut-line buoy system off Palos Verdes Peninsula.