CONTAMINANT LEVELS IN THE SEA-SURFACE MICROLAYER

Anthropogenic contaminants entering nearshore marine environments tend to concentrate at the sediment-water and air-water interfaces. Contaminants in marine sediments off southern California have been measured for many years; however, contaminants at the sea surface have received little attention.

The sea-surface microlayer is approximately 50 microns thick and covers 71 percent of the earth's surface. It is an important habitat for bacterioplankton, phytoplankton, zooplankton, and the early developmental stages of crustaceans and fish. The eggs and larvae of many commercially important species of fish occur in greater quantities in the surface microlayer than in the underlying waters (Hardy, 1982).

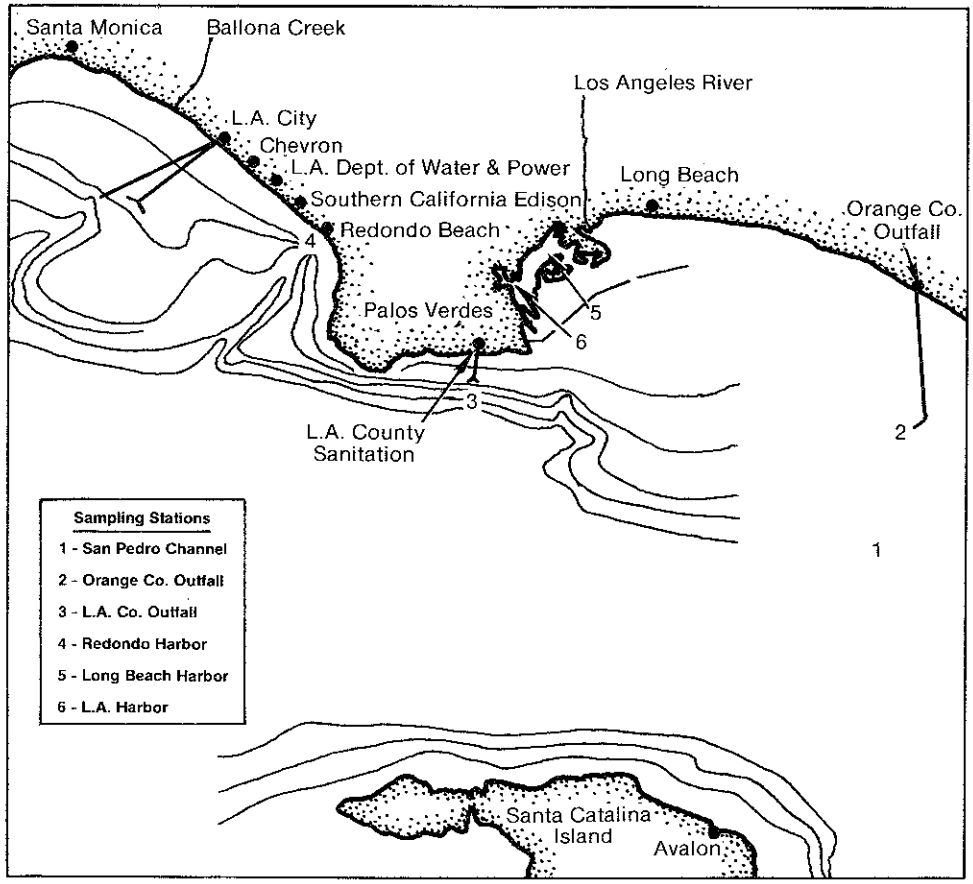

Figure 1. Sea-Surface Microlayer

The sea-surface microlayer is an important site of interchange between the atmosphere and ocean. Many anthropogenic substances — trace metals, chlorinated and petroleum hydrocarbons, and plastics — accumulate in the microlayer. The concentrations of hydrophobic contaminants are often several orders of magnitude higher in the microlayer than in the underlying water column (Hardy, 1982; Hardy et al, 1985).

To provide a first assessment of contaminant levels in the sea-surface microlayer of southern California coastal waters, J. N. Cross (SCCWRP) and J. T. Hardy (Battelle Pacific Northwest Laboratory) collected microlayer water samples from five stations receiving anthropogenic inputs and one reference site in San Pedro Channel (Figure 1).

Microlayer samples were collected in July 1986 with a teflon-coated rotating aluminum drum mounted between two floats and driven by an electric motor designed by Hardy. Six to eight liters of water were collected at each site. The water samples were analyzed for silver, cadmium, chromium, copper, iron, manganese, nickel, lead, and zinc in the particulate and dissolved phases (Tables 1 and 2). Also, the concentrations of oil and grease, total DDT, total PCB, and total resolved polynuclear aromatic hydrocarbons (PAH) were measured and are reported in Table 3.

Trace metal and polynuclear aromatic hydrocarbon concentrations in surface microlayer samples increased progressively from the offshore stations into the harbors. Chlorinated hydrocarbons were not detectable at the offshore stations but were present at very low levels in Redondo and Long Beach Harbors and at considerably higher levels in Los Angeles Harbor. Contaminant concentrations were higher in the sea-surface microlayer than in subsurface waters in the Southern California Bight measured by other investigators (Bruland and Franks, 1978; DeLappe et al, 1982). Contaminant concentrations in the microlayer from the harbors in southern California were comparable to concentrations in the microlayer from Elliott Bay, an urban bay adjacent to Seattle.

Bioassays using young stages of kelp bass *(Paralabrax clathratus)* as test organisms were conducted in full strength microlayer seawater by J. E. Hose of Occidental College and D. Diehl of SCCWRP. Eggs and sperm were obtained from adult kelp bass taken at Dana Point, a relatively uncontaminated site. Twenty-hour old fertilized eggs were held in 250 ml of microlayer sample for 96 hours (the eggs had hatched into larvae by this time). Effects measured were larval mortality, percent of larvae with at least one micronucleated yolk sac cell, and occurrence of anaphase aberrations in the yolk sac epithelial cells of the larvae.

Significantly higher mortality occurred among larvae exposed to microlayer seawater from the three harbor stations and the Los Angeles County outfall station, compared with those exposed to microlayer seawater from San Pedro Bay and the Orange County outfall station (Figure 2). Percent anaphase aberrations and percent of larvae with micronucleat-

Sta	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
1	ND	0.36	ND	0.19	7	0.14	ND	0.07	0.18
2	ND	0.02	0.76	0.68	61	1.1	ND	0.27	0.52
3	ND	0.01	2.3	1.3	272	11	ND	0.45	1.2
4	ND	0.02	6.3	9.9	1,105	20	1.8	3.3	12
5	ND	0.09	13	38	4,080	145	48	36	104
6	0.17	0.26	32	101	11,122	171	26	100	457
So. Cal.[1] Bight	---	.002	---	.004	---	---	.007	.003	.016
Eliott[2] Bay	---	1.0	---	23	2,800	---	---	21	79

ND - not detectable [1] From: Bruland and Franks. 1978 [2] From: Hardy et al 1986

Table 1. Concentration in ug/l (ppb) of trace metals in the particulate phase (> 4 um) not detectable.

Southern California Bight data is bulkwater subsurface sample presented for comparison.

Elliott Bay data are for microlayer samples from an urban bay near Seattle.

Sta	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
1	ND	0.12	0.15	0.65	0.22	2.40	0.32	0.11	6.49
2	ND	3.08	0.13	1.07	1.15	2.06	0.75	0.31	2.36
3	ND	0.21	0.13	2.08	4.48	1.69	0.58	0.33	3.93
4	0.002	0.06	0.19	4.14	2.22	2.97	0.62	0.28	3.44
5	0.008	0.50	0.26	13.0	4.94	7.15	2.18	1.30	34.5
6	0.011	1.13	1.14	18.3	2.27	8.72	3.17	0.11	124

ND - not detectable

Table 2. Concentrations in ug/l (ppb) of trace metals in the dissolved phase of the microlayer samples.

Sta.	Oil and Grease	Hexachlor-benzene	Lindane	Total DDT	Total PCB	Total PAH
1	ND	7	ND	ND	ND	35
2	ND	ND	ND	ND	ND	40
3	0.22	11	ND	ND	ND	591
4	1.04	ND	ND	26	ND	2,651
5	8.51	ND	ND	112	ND	55,771
6	21.80	ND	ND	442	38,849	38,528
So. Cal. Bight[1]	---	---	---	<.01	<.01	37
Eliott Bay [2]	---	---	---	1.0	1,941	---

ND - not detectable [1] From: DeLappe et al. 1983. [2] From: Hardy et al. 1986.

Table 3. Concentration of trace organics in the microlayer. Concentrations in ng/l (pptr) except oil and grease in mg/l (ppm).

Southern California Bight data is bulkwater subsurface sample presented for comparison.

Elliott Bay data are for microlayer samples from an urban bay near Seattle.

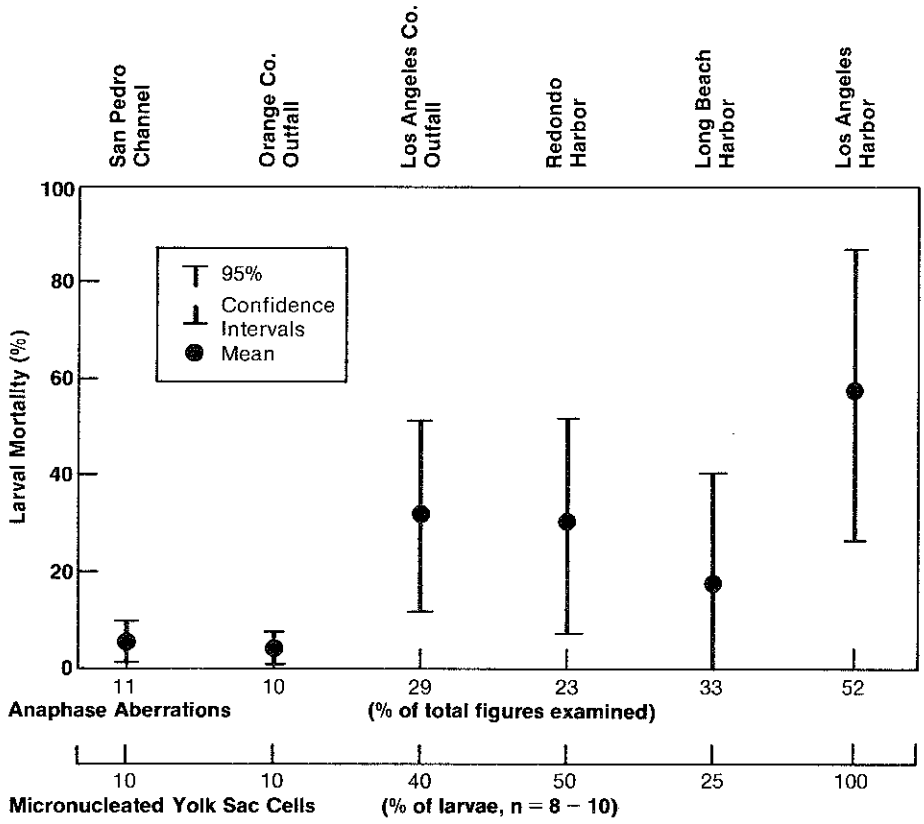

Figure 2. Toxicity Tests with Microlayer

ed yolk sac cells were also higher in the former four stations.

The survey shows that the sea-surface microlayer is higher in contaminants in coastal waters near industrial and municipal sources than is true for waters farther away from these sources and that contaminants are enriched in the microlayer compared to subsurface seawater. Contaminant concentrations in microlayer samples from southern California harbors are comparable to concentrations in microlayer samples from an urban bay in Seattle. Many of the contaminants found are toxic to certain marine organisms; the bioassay provides initial evidence that they are toxic to some of the planktonic forms occurring in the sea surface microlayer.

This method is expected to be a useful technique for detecting recent contaminant inputs to the marine environment.

References

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