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MERCURY IN MUSSELS

In 1974 and 1975, two studies were undertaken to assess the bioavailability of mercury in the nearshore environment. In the first study, we performed mercury analyses on tissues of specimens of the intertidal mussel, *Mytilus californianus*, collected from nineteen stations throughout the Southern California Bight. The second effort was an uptake experiment in which mussels from an area where mercury levels are relatively low were suspended near the Los Angeles County Sanitation Districts wastewater outfall off Whites Point and monitored for mercury uptake as a function of time.

BIGHT-WIDE SURVEY

During 1974, mussels 3.5 to 6.5 cm in length were collected at 14 coastal stations and 5 island control stations in the Bight (Figure 1). Three specimens from each site were then dissected, and composite samples of their digestive glands, adductor muscles, and gonadal tissues were prepared. Analyses for total mercury were performed using a wet-digestion, flameless atomic absorption technique; procedures are described elsewhere (Eganhouse 1975).

To determine the variability of mercury levels in the tissues of mussels obtained at a single location, we conducted a preliminary analysis of ten composite samples from Emma Woods State Beach (Station 4). The results (Table 1) showed that, of the three tissues tested, digestive gland not only contained the highest levels of mercury, but also exhibited the least variability. Analysis of digestive glands may provide more reliable information on relative environmental levels of mercury than those of the two other tissues; however, the adductor muscle and gonadal tissue data more clearly indicate the extent of biological incorporation, partly because they are easily separated from sediments that are present in the digestive track of these animals.

The survey results, shown in Figure 2, demonstrate the correlation between mercury levels in the three tissues analyzed. The data for the island samples were relatively uniform; however, mussels from the coastal stations showed considerable variation. Highest levels were found in mussels collected in Santa Barbara Harbor (Station 3), outside Oxnard Harbor (Station 5), in Santa Monica Bay (Station 7), on Palos Verdes Peninsula (Station 8 and 9), and on Point Loma in San Diego (Station 14).

The elevated levels observed near Santa Barbara and Oxnard Harbors are probably related to vessel activities (e.g., sediment deposits of mercury-bearing antifouling paints). No large discharges of municipal or industrial

wastes exist in these regions. Although mussels from Station 7 off Santa Monica Pier did not have relatively high mercury levels in adductor muscle and gonadal tissue, they exhibited a higher concentration of mercury in digestive gland than the island control samples: The enhanced level in the digestive gland may reflect the influence of the Hyperion discharge (Figure 1, Ml). The high values in Palos Verdes and Point Loma specimens appear to be related to the submarine outfalls (M2 and M4) located in these areas. However, the commercial and naval harbors at San Pedro and San Diego are also possible sources of mercury for the local biota.

MUSSEL UPTAKE STUDY

During January 1976, specimens of *M. californianus* were collected from the Point Sal area, a coastal control site north of Point Conception. The mussels were placed in nylon cages and suspended at four depths on a buoy in 30 meters of water off Royal Palms, Palos Verdes. Additional specimens were obtained from San Clemente Island and frozen. Several of the buoy mussels at each depth were collected over a 12-week period and stored in a freezer. Dissection and total mercury analysis of the samples were performed in the manner described in the preceding section.

Table 2 lists the data for Point Sal, San Clemente Island, and Royal Palms mussels. The agreement between Point Sal and San Clemente Island values indicates that the mussels chosen for the experiment represent suitable control specimens. By comparison, tissues of the Royal Palms mussels contained two to three times as much mercury on a wet weight basis.

The buoy experiment results, presented in Figure 3, show that mercury uptake by the digestive gland tissue was characterized by a rapid increase in mercury content followed by a decline to levels intermediate between control (time = 0 weeks) and Royal Palms values. As in the case of the chlorinated hydrocarbon' uptake patterns described elsewhere in this report, there was no significant correlation with depth. These data provide no evidence that the sediments are acting as a source of mercury to the biota.

Adductor muscle showed no substantial uptake over the 12-week study period, indicating that a different, if not unrelated, mechanism may be responsible for the observed elevated levels found in the adductor muscles of the Royal Palms mussels. The gonads did show a small but significant increase in mercury content with time. The experiment, which is still in progress, will be conducted for a full 24 weeks to better determine the uptake characteristics.

SUMMARY AND CONCLUSIONS

The results of these experiments demonstrate the value of *M. californianus* as an environmental bioindicator. Our studies showed that, of the three tissues analyzed, digestive gland contained the highest levels of mercury and experienced the fastest uptake. Adductor muscle and gonadal tissues had

markedly slower accumulation rates. These results tend to support the idea that digestive gland analyses reflect environmental mercury levels, but that adductor muscle and gonadal tissues are more accurate indicators of the extent of physiological incorporation. The digestive gland mercury concentrations appear to reflect relatively short-term changes in the environment. The gradual accumulation of
mercury in adductor muscle and gonadal tissues, however, appears to result primarily from a chronic exposure to mercury.

REFERENCES

Eganhouse, R.P., Jr. 1975. The measurement of total and organic mercury in marine sediments, organisms, and water. TM 221, Coastal Water Research Project, El Segundo, Calif.

Table 1. Mercury content in tissues of mussels from Emma Woods State Beach (Station 4).

Tissue	No. of Samples	Mean (mg/wet kg)	Total Mercury Standard Deviation	Range (mg/wet kg)
Digestive gland	7	0.022	0.005	0.017–0.032
Adductor muscle	9	0.012	0.005	0.008–0.021
Gonads	8	0.005	0.002	0.002–0.010

Table 2. Total mercury (µg/wet kg) in tissues of *Mytilus californianus* From Point Sal, San Clemente Island, and Royal Palms, 1976.

Station	Digestive Gland	Adductor Muscle	Gonad
Point Sal	26.7	20.6	5.1
	26.4	19.3	4.5
	26.1	28.3	5.8
San Clemente Island	23.0	21.5	6.4
Royal Palms	62.8	61.8	14.2

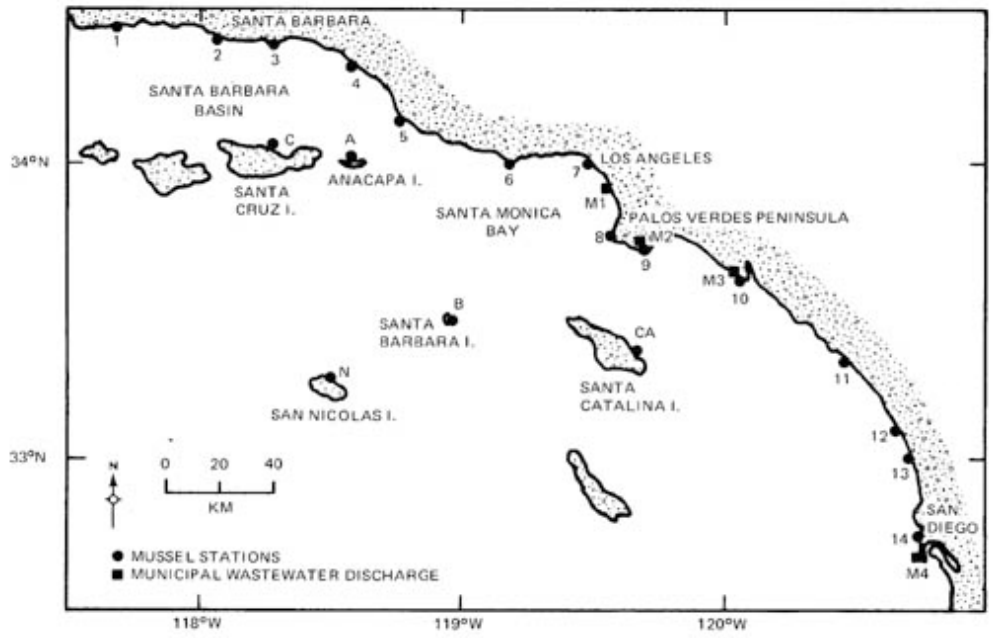

Figure 1. Station locations for mussel survey. Pt. Sal is approximately 72 km upcoast of Station 1.

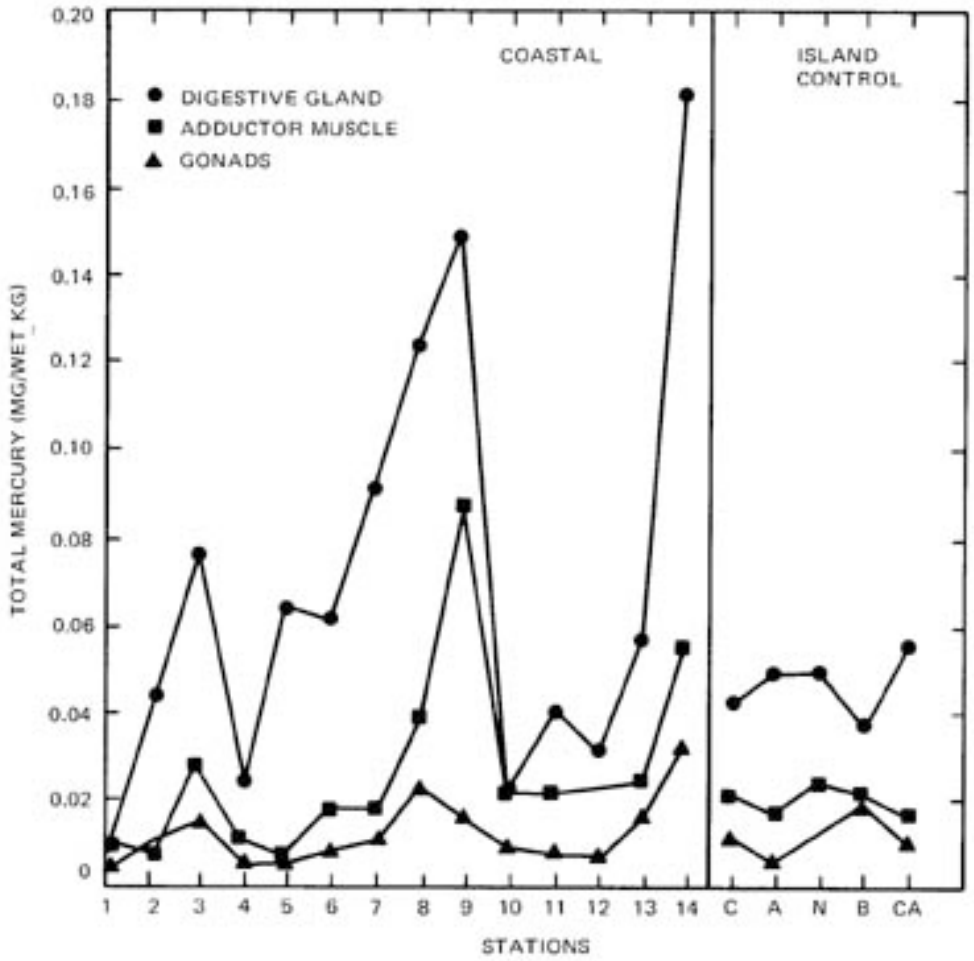

Figure 2. Total mercury content (mg/wet kg) in tissues of the interdial mussel, *M. californianus*, at various coastal and island stations, 1974.

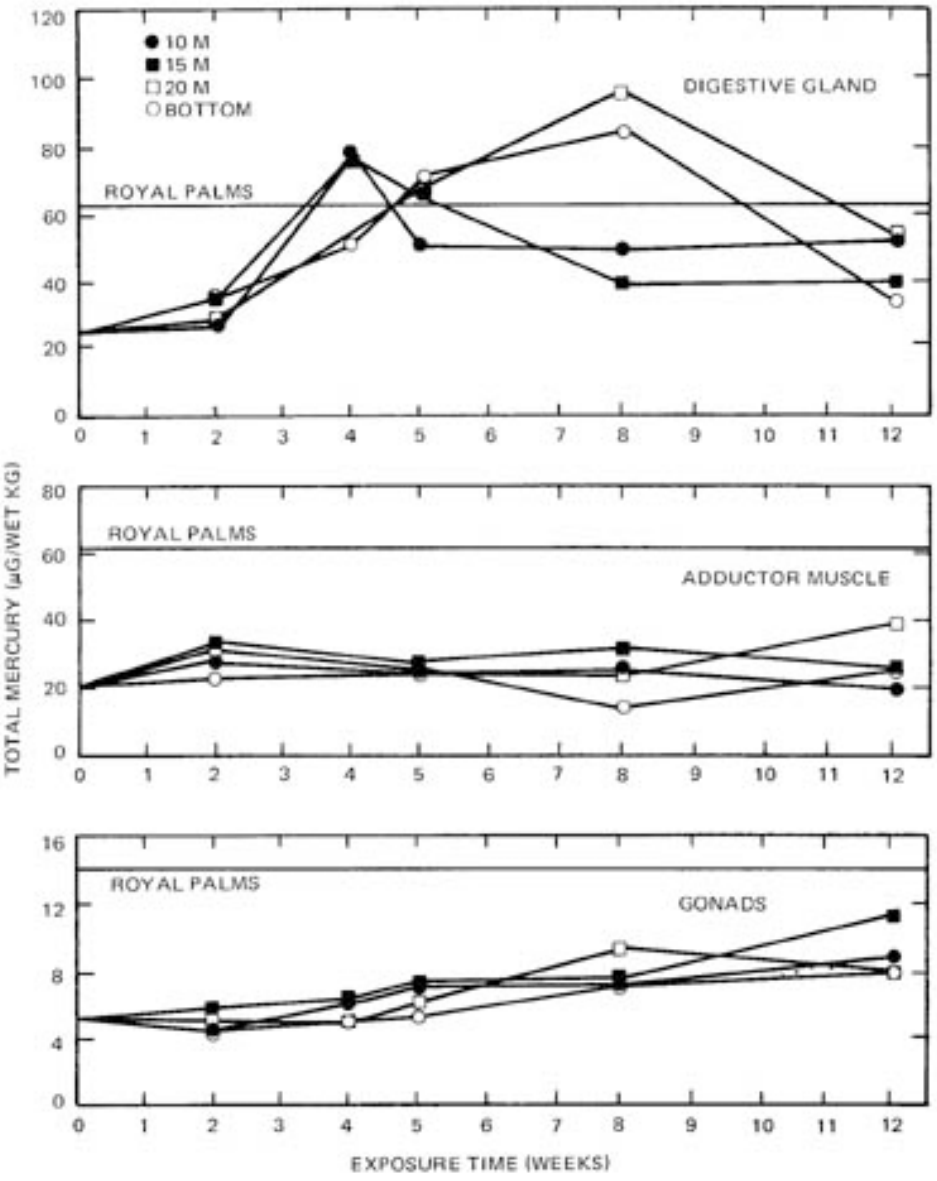

Figure 3. Mussel uptake study: Total mercury in tissues vs. exposure time.