Mercury in the Seston of the San Francisco Bay Estuary

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There is a continuous input of mercury to the San Francisco Bay estuary from wastewater effluents and influent rivers, some of which drain cinnabar deposits. While this input is not reflected in elevated levels of the element in the dissolved phase (JENNE 1972; SERNE and MERCER 1975), there is an average of 0.25µg/g mercury in the system's surface sediments (McCULLOCH et al., 1971). This relatively high concentration is paralleled in the suspended particulates, seston, as demonstrated by the following measurements.

MATERIALS AND METHODS

Samples were collected at the United States Geological Survey's vertical profile (physical/chemical) stations (Figure 1). Plankton net tows similar to those of Knauer and Martin (1972) were used. The one-half m diameter (20µm, 76µm and 366µm net aperture) nylon nets had plastic cod ends and stainless steel bridles. The smaller size nets were towed with nylon lines and the larger net with a metal cable. The collection dates are listed in Tables I, II, and III.

The 20µm and 76µm net samples were concentrated on filters of their respective size netting, and a gentle vacuum was used to remove excess water. Zooplankton collected in the 366µm net were placed in plastic beakers for over one hour to allow them to eliminate ingested material and for phytoplankton, organic detritus and sediment to settle out. Then they were concentrated on a 366µm filter. Macroscopic contaminants were removed from the filtered material, which was immediately frozen and later lyophilized.

Aliquots of each sample were analyzed for mercury with a Zeeman isotope shift atomic absorption spectrophotometer. The coefficient of variation was 9.8%. National Bureau of Standards "orchard leaves" (#1571) analyzed concurrently were within 1% of their reported mercury value. The ash weight to dry weight ratio (expressed as % ash weight) was assayed by ignition.

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TABLE I

CONCENTRATIONS OF MERCURY (μg/g dry weight) IN THE 20μm NET SIZE SESTON OF THE SAN FRANCISCO BAY ESTUARY, COLLECTED 1-2 August 1973

	Station #										
Collection Date	Rio Vista	3	6	9	12	14	19	21	24	30	36
1-2 August 1973											
mean	.22	1.6	1.2	.58	.50	.52	3.7	1.9	.69	.59	.65
range	.22-.23	1.4-1.8	-	.54-.64	.49-.52	.49-.54	2.4-4.1	1.7-2.1	.63-.80	.57-.60	.59-.75
sample size	3	3	1	3	3	3	3	3	3	3	3
% ash wt.	.91	.84	-	.85	.90	.87	.68	.85	.85	.87	.93

TABLE II

SEASONAL AND GEOGRAPHIC CONCENTRATIONS OF MERCURY (μg/g dry weight) IN THE 76μm NET SIZE SESTON OF THE SAN FRANCISCO BAY ESTUARY.

	Station #												
Collection Date	3	6	9	12	14	17	19	21	24	27	30	32	36
25-26 June 1973													
mean	.91	.20	.20	.08	.21	.53	1.7	.97	-	-	-	-	-
range	.87-.96	.16-.25	.18-.25	.07-.08	.16-.29	.50-.57	1.3-2.0	.88-1.1	-	-	-	-	-
sample size	3	3	4	3	4	3	4	3	-	-	-	-	-
% ash wt.	52	-	29	34	10	56	50	25	-	-	-	-	-
1-2 Aug 1973													
mean	.86	.95	1.2	1.2	.81	13.3	5.7	.64	.73	.71	.60	.66	.86
range	.77-.92	.91-1.0	1.1-1.4	1.1-1.3	.74-.84	8.2-15.	4.7-6.3	.57-.81	.69-.80	.68-.76	.56-.63	.65-.68	.69-1.2
sample size	4	3	3	3	3	3	4	7	3	6	3	3	6
% ash wt.	57	76	56	64	75	73	-	81	75	82	54	71	78
28-30 Aug 1973													
mean	.68	.82	.78	.62	-	.39	.48	.55	.47	.54	-	.62	.36
range	.56-1.0	.76-.93	.77-.80	.60-.65	-	.35-.43	.35-.57	.37-.86	.46-.49	.51-.56	-	.60-.64	.34-.41
sample size	9	3	3	3	-	3	3	3	3	3	-	3	3
% ash wt.	67	69	76	62	-	66	69	43	73	53	-	57	12
25-26 Feb 1974													
mean	1.2	2.3	.47	1.4	.16	.50	.31	.20	.56	.26	.79	.65	.71
range	.95-1.3	1.9-2.7	.41-.52	1.3-1.4	.15-.17	.40-.59	.30-.31	.17-.24	.49-.66	.25-.27	.63-.97	.61-.69	.66-.78
sample size	3	3	4	3	3	5	5	4	3	3	3	3	4
% ash wt.	-	64	16	-	18	66	64	20	66	25	41	30	-
4-5 April 1974													
mean	.22	.21	.37	.25	.32	.17	.46	.57	-	.51	-	1.1	-
range	.17-.24	.18-.23	.31-.45	.23-.27	.26-.37	.15-.18	.43-.50	.52-.64	-	.49-.54	-	-	-
sample size	5	6	6	3	3	3	3	3	-	3	-	1	-
% ash wt.	86	89	84	10	28	16	30	80	-	81	-	66	-

TABLE III

SEASONAL AND GEOGRAPHIC CONCENTRATIONS OF MERCURY (μg/g dry wt.) IN THE 366μm NET SIZE SESTON AT THE SAN FRANCISCO BAY ESTUARY

	Station #												
Collection Date	3	6	9	12	14	17	19	21	24	27	30	32	36
1-2 Aug 1973													
mean	-	-	.67	.32	.20	1.1	.22	.51	.16	.25	.31	.33	.26
range	-	-	-	.31-.33	.18-.21	.93-1.2	.17-.27	.46-.54	.15-.20	.23-.28	.25-.34	.22-.49	.22-.31
sample size	-	-	1	3	3	3	3	3	3	3	3	7	4
% ash wt.	-	-	-	25	12	43	14	30	18	15	17	10	9
28-30 Aug 1973													
mean	.25	-	.33	-	.19	.20	.22	.41	.36	.41	-	.18	.25
range	.21-.29	-	.32-.35	-	.16-.21	.18-.22	.22	.38-.45	.34-.38	.40-.43	-	.16-.21	.20-.32
sample size	11	-	3	-	3	3	2	3	3	3	-	3	3
% ash wt.	13	-	20	-	12	18	16	31	32	21	-	7	9
25-26 Feb 1974													
mean	.63	.40	.22	.65	.13	.50	.17	.17	.22	.23	.28	.16	-
range	.55-.76	.36-.42	.21-.23	.57-.71	.12-.14	.47-.53	.12-.19	.16-.17	.21-.23	.21-.25	.19-.28	.15-.17	-
sample size	3	3	3	3	3	4	3	3	4	4	5	4	-
% ash wt.	22	11	12	-	9	6	22	22	11	9	5	14	-
4-5 April 1974													
mean	-	-	.26	.25	.20	.17	.15	.09	-	.22	-	.15	-
range	-	-	-	.24-.27	.17-.23	.11-.32	.13-.17	.09	-	.20-.26	-	.15-.16	-
sample size	-	-	1	3	4	3	3	3	-	3	-	3	-
% ash wt.	-	-	5	10	5	19	11	10	-	12	-	12	-

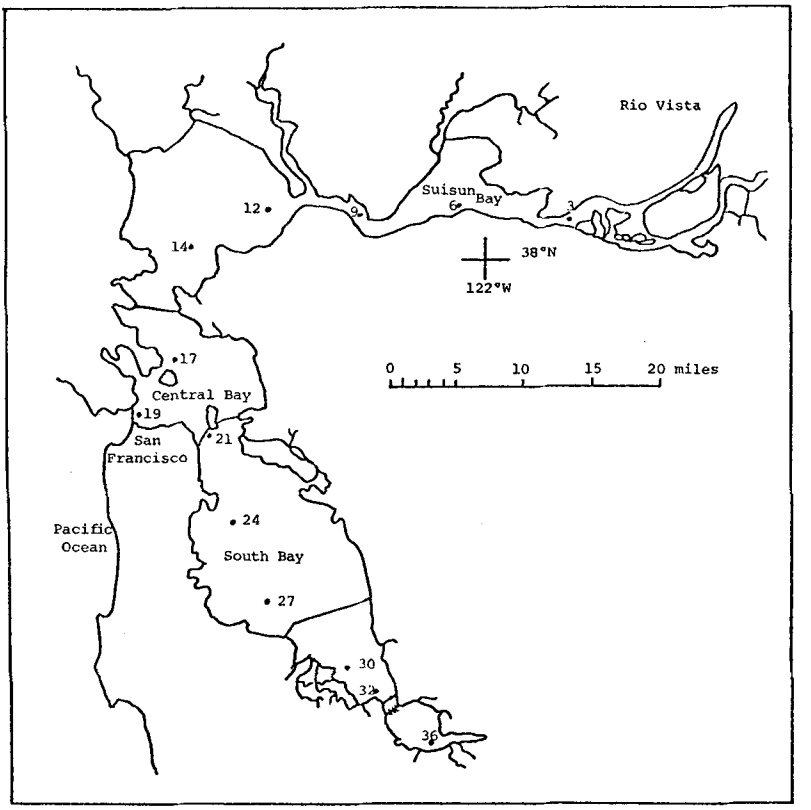

FIGURE 1

Index map of the San Francisco Bay estuary showing the location of seston sampling stations, which conform with the vertical profile stations of the U.S. Geological Survey.

RESULTS AND DISCUSSION

The mercury concentrations (µg/g dry wt.) and % ash weight of the 20µm samples are listed in Table I. The relatively low level at the head of the estuary (Rio Vista) may represent the concentration of macro-seston (>20µm) entering the system. The elevated levels immediately downstream occur in the heavily industrialized Suisun Bay area, which also has the highest concentration of mercury in its bottom sediments (McCULLOCH et al., 1971). The increases in the Central Bay area may be due to the higher organic content of the seston. This is indicated by the lower % ash weight of the samples.

The results of the 76µm and 366µm net samples are listed in Tables II and III. These net sizes are characteristically associated with macro-phytoplankton and

zooplankton, respectively. However, the presence of sediment in both sets of samples (represented by the relatively high % ash weights) precludes a direct assessment of the amount of mercury in either of those components of the biota. This interference is illustrated by the positive simple linear correlation (R=0.62) between the mercury concentration and the % ash weight of the 366µm samples.

In summary, the macro-seston (>20µm) of the San Francisco Bay system contains relatively high concentrations of mercury, compared to other estuaries (LINDBERG et al., 1975). These levels vary temporarily and spatially. They also vary with the size fraction of the seston and its organic content, and appear to be higher in the phytoplankton and/or organic detritus than in the zooplankton. Further research will be required to determine the mercury content of the total suspended particulates and its inorganic and organic components.

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