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Trace Metal Residues in Biota and Sediments from Lake Pontchartrain, Louisiana

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Lake Pontchartrain, Louisiana is a shallow, oligohaline, 1631 square kilometer estuary located in the deltaic plain of the Mississippi River. Three passes [The Rigolets, the Chef Menteur Pass, and the Inner Harbor Navigation Canal (IHNC)] provide an indirect, restricted connection to the Gulf of Mexico. The lake serves an adjacent metropolitan area of over 1.5 million people as a major recreational area and as a source of substantial quantities of crabs, shrimp, and other aquatic foods (McFall et al. 1979 and Stone 1980). Anthropogenic pollutants include rivers, bayous, municipal and agricultural run-off and the overflow from the Mississippi River during times of potential flooding.

As part of our continuing studies to characterize and identify chemical pollutants in natural bodies of water (McFall et al. 1979, Laseter and Ledet 1979, Overton et al. 1980, Laseter et al. 1981, and Ferrario et al. 1985) and as part of a preliminary study of the nutrient and toxic substances chemistry for the three passes into Lake Pontchartrain, the present study was conducted to establish baseline values of twelve USEPA priority pollutant trace metals in indigenous biota and sediment samples from the three passes of Lake Pontchartrain. The twelve metals included arsenic, beryllium, copper, cadmium, lead, mercury, nickel, thallium, selenium, chromium, silver, and zinc.

MATERIALS AND METHODS

Samples of oysters (Crassostrea virginica), clams (Rangia cuneata), and surface sediments were collected in May-June, 1980, from the entrances of the Inner Harbor Navigation Canal (IHNC), the Chef Menteur Pass, and The Rigolets, at Lake Pontchartrain. All samples were immediately packed in ice, then frozen and kept at -5°C until analysis.

Tissue samples were processed for the determination of beryllium, cadmium, chromium, copper, lead, nickel, silver, thallium, and zinc by the procedure of Rogerson and Galloway (1974). The resulting digestate was analyzed by flame atomic absorption spectrophotometry (FAAS) or graphite furnace atomic absorption spectrophotometry (GFAAS).

For the determination of arsenic, mercury, and selenium in the tissue, samples were processed as described by Martin and Knauer (1972) and EPA (1979). A wet 5.0 gram homogenized aliquot of tissue was subjected to ULTREX sulfuric/nitric (10 ml/5 ml) acid digestion. Five milliliters of potassium permanganate was added to increase oxidation and the resulting solution heated at 80°C for 2 hours. Hydrogen peroxide (30%) was added to dryness until the color disappeared. A small increment of 5% potassium permanganate was added to stabliize the metals. The solution was filtered through Whatman #42 filter paper into 100 ml polypropylene volumetric flask. Sodium chloride-hydroxylamine hydrochloride solution (6 ml) was added and the solution brought to volume (100 ml). The sample was analyzed by gas hydride - atomic absorption spectrophotometry (GHAAS).

Sediment samples were processed for the determination of beryllium, cadmium, chromium, copper, lead, nickel, silver, thallium, and zinc by the method of Eisler et al. (1977) and subsequently analyzed by FAAS/GFAAS.

For the determination of arsenic, mercury, and selenium, the sediment samples were processed as follows. A wet 2.0 gram of homogenized sediment was weighed into a 100 ml glass beaker. Ten milliliters of 50% solution of ULTREX nitric acid was added to the sample. Five milliliters of 5% potassium permanganate was further added. The solution was heated at 95°C for one hour. Hydrogen peroxide (30%) was added dropwise until color disappeared. A small increment of 5% potassium permanganate was added to stabilize the metals. The solution was filtered through Whatman #42 filter paper into a 100 ml polypropylene volumetric flask. Sodium chloride-hydroxylamine hydrochloride solution (6 ml) was added to the solution brought to volume (100 ml). The sample was subsequently analyzed by GHAAS.

The final sample solutions were analyzed by flame or flameless graphite furnace AAS on a Perkin-Elmer (PE) 5000 atomic absorption spectrophotometer equipped with an automated control box, a PE HGA-500 graphite furnace, AS-40 automated sampler, and an MHS-10 metal hydride system. For flame AAS, the burner heads utilized either air-acetylene or nitrous oxide-acetylene mixtures. For flameless graphite furnace AAS, the samples were further processed by sequential drying, charring (ashing), and atomization using standard flameless AAS parameters. The volatile metals were analyzed by use of the metal hydride system, which utilized a sodium borohydride solution to reduce the acid solution. The reduction released a metallic hydride which was stripped by argon gas and subsequently analyzed by AAS.

In order to verify the accuracy and precision of the analyses, National Bureau of Standards standard reference materials (SRMs) were used: NBS #1566 - OYSTER TISSUE and NBS #1645 - RIVERINE SEDIMENT. These SRMs were analyzed as blind replicates and the observed values compared to the certified values. The recovery values (Table 1) for all metals measured were in the acceptable range, except for Ni and Cd in the sediment SRM, which were determined at 65% and 75%, respectively. In addition, selected tissue samples examined by the standard addition method, gave better than 80% recoveries for all metals tested.

TABLE 1. National Bureau of Standards, Quality Control Tissues and Sediment Samples Observed and Certified Values (ug/g), dry weight.

Metal	VALUE Observed	VALUE Certified	% Recovery
TISSUES (NBS SRM #1566)			
Ag	1.14 ± 0.39	0.89 ± 0.09	128%
Zn	887 ± 33	852 ± 14	104%
Ni	1.25 ± 0.25	1.03 ± 0.19	121%
Cu	64.8 ± 2.7	63.0 ± 3.5	103%
Cd	3.13 ± 0.09	3.5 ± 0.4	89%
SEDIMENTS (NBS SRM #1645)			
Zn	1723 ± 9	1720 ± 169	100%
Ni	29.8 ± 0.85	45.8 ± 2.9	65%
Cu	107 ± 3	109 ± 19	98%
Cd	7.6 ± 0.2	10.2 ± 1.5	75%
Pb	677 ± 13	714 ± 28	95%

RESULTS AND DISCUSSION

The concentrations of the trace metal residues in the oyster samples from the IHNC and in clams from the Chef Menteur Pass and The Rigolets and the sediments of those respective areas are presented in Table 2. Of the twelve metals tested, only thallium was not observed in the tissue samples. The oysters collected

TABLE 2. Concentrations of Trace Metals in the Sediment and Molluscs of Lake Pontchartrain, Louisiana, PPM* (ug/g, dry weight**)

Station	Ag	Be	Cd	Cr
IHNC				
oyster	5.5 ± 2.1	0.051 ± 0.47	9.11 ± 1.4	1.3 ± 0.90
sediment	0.004 ± 0.01	0.071 ± 0.048	0.17 ± 0.10	1.6 ± 1.2
CHEF MENTEUR				
clam	0.4 ± 0.6	0.083 ± 0.046	0.90 ± 0.50	2.1 ± 0.90
sediment	0.004 ± 0.009	0.32 ± 0.15	0.19 ± 0.10	8.8 ± 3.8
THE RIGOLETS				
clam	2.4 ± 2.3	0.38 ± 0.07	0.90 ± 0.44	3.8 ± 0.9
sediment	0.009 ± 0.011	0.48 ± 0.09	0.12 ± 0.06	8.6 ± 1.8
	Cu	**Ni**	**Pb**	**Tl**
IHNC				
oyster	0.6 ± 0.2	2.1 ± 0.9	3.8 ± 1.6	< 0.01
sediment	1.4 ± 2.4	1.2 ± 1.7	8.4 ± 16.3	0.03 ± 0.02
CHEF MENTEUR				
clam	9.9 ± 1.5	28.2 ± 5.4	0.2 ± 0.4	< 0.01
sediment	7.0 ± 3.4	8.8 ± 4.9	6.9 ± 4.6	< 0.01
THE RIGOLETS				
clam	9.0 ± 0.6	28.7 ± 4.9	0.5 ± 0.1	< 0.01
sediment	7.6 ± 1.9	8.6 ± 2.1	8.2 ± 3.1	0.03 ± 0.03

TABLE 2, continued

	Zn	As	Hg	Se
IHNC				
oyster	10900 ± 3500	0.16 ± 0.08	0.029 ± 0.017	0.013 ± 0.008
sediment	15.2 ± 20.9	0.50 ± 0.30	0.007 ± 0.0015	0.007 ± 0.012
CHEF MENTEUR				
clam	100 ± 0	0.14 ± 0.01	0.003 ± 0.006	0.032 ± 0.012
sediment	28.1 ± 13.8	1.1 ± 6.2	0.012 ± 0.008	0.031 ± 0.078
THE RIGOLETS				
clam	80 ± 4.8	0.172 ± 0.06	< 0.001	0.041 ± 0.014
sediment	29.5 ± 8.0	1.5 ± 0.4	0.015 ± 0.004	0.05 ± 0.028

*mean ± standard deviation
**except for As, Hg, and Se which are reported as wet weight

at the IHNC contained extremely high concentrations of zinc, whereas the clams from the other two passes contained higher concentrations of copper. Both metals have been shown to be important in the various biochemical processes of life cycles of molluscs (Forstner and Wittman, 1981). The oyster samples from the IHNC possessed higher concentrations of lead, cadmium, and mercury than the clams which is thought to reflect the industrial activities along the canal itself.

Comparisons of the levels of heavy metals in the biota and surface sediments of other Gulf Coast estuaries revealed similar concentrations (Tables 3 and 4). For comparison purposes, wet weight values were converted to dry weight by factors of 10X (*C. virginica*) and 7X (*R. cuneata*). St. Louis Bay is of particular interest due to its proximity and characteristics to Lake Pontchartrain.

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TABLE 3. Concentrations of trace metals (ppm, dry weight) in molluscs of the Gulf Coastal Region of the U.S.

Location	As	Cd	Cr	Cu	Pb	Hg	Se	Zn	References
C. virginica									
St. Louis Bay, MS	1.2	16.1	<0.1	315	<0.5	0.7	2.8	8210	Lytle & Lytle, 1982
Lake Pontchartrain, LA	1.6	9.1	1.3	0.6	3.8	0.3	0.1	10900	This work
San Antonio Bay, TX	1.3	3.2		161	<0.8	0.05		322	Sims & Presley, 1976
R. cuneata									
St. Louis Bay, MS	<0.05	<0.05		16.5	<0.5	0.74	3.28	110	Lytle & Lytle, 1982
Lake Pontchartrain, LA	1.0	0.9	3.0	9.5	0.4	<0.01	0.27	90	This work
San Antonio Bay, TX	2.4	1.19	0.99	23		0.11		13	Gutherie et al., 1979

TABLE 4. Concentrations of trace metals (ppm, dry weight) in surface sediments of Gulf Coastal Region of the U.S.

Location	As	Cd	Cr	Cu	Pb	Hg	Se	Zn	References
St. Louis Bay, MS	3.3	<0.09	7.98	6.38	12.24	0.193	<0.13	47	Lytle & Lytle, 1980
Lake Pontchartrain, LA	1.03	0.16	6.33	5.33	7.83	0.015	0.04	24	This work
Laguna Madre, TX	<1.0	0.2	3.9	8.9	4.3	0.04		14	TX Water Qual Bd, 1975
Lavoca Bay, TX	3.9	0.5	32	15.2	15	0.36		62	TX Water Qual Bd, 1978

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