

# Total Mercury in Some Fish and Shellfish Along the Mexican Coast

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Ever since it was discovered that the tragic fate of fishermen and their families in Minamata Bay and on the island of Kyushu, Japan (KURLAND et al. 1960) was related to the consumption of fish and shellfish contaminated with organic mercury from industrial pollution, the study of pollution and poisoning by mercury has received wide attention.

Some of the most detailed studies on the current levels of mercury in biological systems have been done on fish, in Sweden (PEAKALL and LOVETT, 1972). Averages summarized by these authors from Swedish publications ranged from 0.2 to 5.0 mg/kg with many values in the range of 0.5 to 1.5 mg/kg. Their data represent over 3000 fish from 44 sites. WOBESER et al. (1970) examined the concentration of mercury in 81 specimens of 10 fish species collected from nine sites on the North and South Saskatchewan River. For seven sites the average values were in the range 1.0 to 1.8 ppm; the other two sites averaged 5.0 to 6.7 ppm. Fish from some areas of Lake Erie, the St. Clair River and the Detroit River were found to have levels up to 5 ppm (TURNNEY, 1970). McDUFFIE (1971) found levels of over 0.5 ppm in fish from the Susquehanna River and studied levels of mercury in canned tuna and swordfish.

High mercury levels in fish and shellfish have prompted legislation that has closed off certain areas to the fishing industry, has taken off the market canned fish found with levels higher than 0.5 ppm and has warned consumers on safe amounts of fish intake.

While extensive studies have been done in countries like Sweden, Japan, Canada and the United States, the extent and effect of mercury pollution is unknown in others. This paper reports a preliminary evaluation of mercury levels in fish and shellfish species from very important localities of the Gulf and Pacific coasts of México.

## METHODS AND MATERIALS

Samples of fish and shellfish were obtained from local markets, packing houses or directly from fishermen. Sources are given in each case in Tables 1 to 4. Total mercury content in muscle tissue and liver were measured by the HATCH and OTT (1968) method with a Perkin Elmer MAS-50 Mercury Analyzer. Samples were prepared as recommended by the manufacturer (APPLICATIONS DATA SHEET, 1971). Species selected for analyses were those readily available in local markets and of popular consumption because of their price and abundance. Specimens were fresh (usually kept in a bed of ice overnight) and those measured were usually the smallest sizes available. In a couple of localities, Mazatlán and Guaymas, shrimp analyzed had been frozen for an undetermined period and in Coatzacoalcos only frozen fish fillets were obtained.

Fish muscle samples were taken about 1.5 cm below the epidermis, just posterior to the pectoral fin. Fish liver samples were obtained by cutting off the healthiest looking portions of liver and trying to eliminate as many of the always-present parasites as possible. This task was never completely successful. All samples of gray mullet's liver contained at least some nematodes, and most of the white mojarra samples had some parasites. Shrimp muscle samples were obtained by severing a portion of about 1 gram of the tail section with exoskeleton and appendages removed. Mollusk samples were obtained by severing most of the foot from oysters and the clam Anadara and by using most of the soft parts of the animal in the clam Codakia.

## RESULTS

The highest levels of mercury were found in fish from Coatzacoalcos (Table 1) and from Villa Cardel, a small fishing village about 20 miles north of the city of Veracruz. Coatzacoalcos is an industrial center where pollution from oil refineries and factories of chemicals and fertilizers is very acute. Inhabitants of this region are well aware of the dangers of mercury poisoning (L.G. León, personal communication) and do not consume local fish or shellfish. However, snook fillets sold at one of the largest supermarkets in the city, and supposedly brought from some other locality, are contaminated to a degree approaching the upper permissible level of 0.5 ppm. Fish from two localities was examined in Veracruz. Mercury content was quite higher in fish from Villa Cardel than in specimens from the city of Veracruz.

TABLE 1 Mercury content in fish from Veracruz and Coatzacoalcos

Locality, source and kind of fish	sample size	Mercury content	
		mean $\pm$ S.D.	$\mu\text{g/g}$ range
VERACRUZ			
Laguna Pabellon, fish market			
<u>Mugil curema</u>	15 specimens	0.04 $\pm$ 0.02	0.01-0.10
Villa Cardel, fish market			
<u>Sphyraena guachancho</u>	11 specimens	0.11 $\pm$ 0.09	0.02-0.31
<u>Polynemus virginicus</u>	4 specimens	0.07	0.05-0.11
COATZACOALCOS			
Supermarket			
<u>Centropomis</u>	15 samples from 3 fillets	0.27 $\pm$ 0.24	0.02-0.61

Table 2 summarizes the mercury content found in muscle and liver of three species of fish from several Mexican localities. The gray mullet, Mugil cephalus, examined in Tampico, Guaymas, Topolobampo and Mazatlán showed concentrations of mercury close to the 0.05 ppm considered a safe level by the Food and Drug Administration, but one that should prompt warnings to consumers about the maximum daily average intake of foods containing such mercury levels. Anisotremus interruptus, the locally called "mojarra prieta" showed values ranging from 0.05 to 0.23 ppm. Another species of mojarra, probably of the genus Diapterus (locally called "mojarra blanca"), showed values ranging from 0.03 to 0.38 ppm.

In all the species investigated the mercury content of the liver was higher, sometimes more than double that of the muscle.

Values of mercury in shrimp (Table 3) are low except for the samples from Mazatlán and Guaymas.

Mercury contents in mollusks (Table 4) were very low, except in the tiger lucine Codakia orbicularis where one third of the measurements were above 0.10 ppm.

TABLE 2

## Mercury present in muscle and liver of fish

Locality and Source	Sample size*	MUSCLE		LIVER	
		mean $\pm$ S.D.	range	mean $\pm$ S.D.	range
TAMPICO, Industria Pesquera S.A.	15 specimens of gray mullet 30 subsamples muscle, 15 liver	0.07 $\pm$ 0.12	0.01-0.64	0.09 $\pm$ 0.04	0.05-0.17
GUAYMAS Fish market	15 specimens of gray mullet 15 subsamples muscle, 14 liver	0.03 $\pm$ 0.01	0.02-0.05	0.06 $\pm$ 0.04	0.01-0.13
TOLOLOBAMPO Fish market of Los Mochis	15 specimens of gray mullet 15 subsamples muscle, 13 liver	0.03 $\pm$ 0.01	0.01-0.07	0.01 $\pm$ 0.06	0.06-0.27
MAZATLAN Fish market	15 specimens of gray mullet 15 subsamples muscle, 15 liver	0.06 $\pm$ 0.03	0.03-0.13	0.08 $\pm$ 0.04	0.01-0.18
MAZATLAN Fishermen at Playa Norte	15 specimens of mojarra 15 subsamples muscle, 13 liver	0.12 $\pm$ 0.05	0.05-0.23	0.26 $\pm$ 0.11	0.10-0.47
CIUDAD DEL CARMEN Fish market	15 specimens of white mojarra 15 subsamples muscle, 14 liver	0.06 $\pm$ 0.09	0.01-0.38	0.07 $\pm$ 0.05	0.03-0.14

\*Specimens selected for measurements were all small, mean standard lengths ranged between 15.6  $\pm$  0.69 cm and 19.4  $\pm$  0.78 with an approximate weight of around 160 g. per specimen.

TABLE 3

## Mercury present in muscle of shrimp

Locality, source kind of shrimp	No. of samples & shrimp size	Mercury content $\mu\text{g/g}$	
		mean $\pm$ S.D.	range
TAMPICO, packing house <u>Penaeus aztecus</u>	30 small	0.06 $\pm$ 0.12	0.01-0.67
VERACRUZ, Marine Center <u>Penaeus setiferus</u>	14 small	0.04 $\pm$ 0.02	0.02-0.06
CIUDAD DEL CARMEN Packing house <u>Penaeus setiferus</u>	15 large	0.03 $\pm$ 0.04	0.01-0.16
MAZATLAN, fish market <u>Penaeus californiensis</u>	15 small	0.12 $\pm$ 0.10	0.02-0.46
TOPOLOBAMPO, fisherman <u>Penaeus stylirostris</u>	14 medium	0.05 $\pm$ 0.05	0.01-0.15
GUAYMAS, fish market <u>Penaeus stylirostris</u>	15 medium	0.09 $\pm$ 0.12	0.01-0.20

\*Size categories are standard - small shrimp averages 9.8 g per specimen; medium shrimp averages 35.4 g per specimen; large shrimp averages 45.4 g per specimen. Weights are with head removed.

TABLE 4

## Mercury present in some edible mollusks

Locality, source, kind of mollusk	No. of samples	Mercury content $\mu\text{g/g}$	
		mean $\pm$ S.D.	range
TAMPICO, Laguna Tamihaia <u>Crassostrea virginica</u>	15	0.02 $\pm$ 0.01	0.01-0.06
CIUDAD DEL CARMEN Boca de Atasta <u>Crassostrea virginica</u>	14	0.03 $\pm$ 0.02	0.01-0.06
VERACRUZ, fish market <u>Codakia orbicularis</u>	14	0.09 $\pm$ 0.06	0.03-0.22
MAZATLAN, fish market <u>Anadara tuberculosa</u>	14	0.05 $\pm$ 0.02	0.02-0.10

## DISCUSSION

Although none of the values obtained in this preliminary analysis is higher than the U.S. Food and Drug Administration (CELESTE and SHANE, 1970) permissible upper level of 0.5 part per million, the fish purchased in Coatzacoalcos is over half that value, and most others are around or over 0.05 ppm, a level that McDUFFIE (1971) has recommended be recorded in canned fish so that consumers may restrict their daily average intake to the 30  $\mu$ g (for 150 pound person) considered a safe level at the present time. Furthermore, the currently accepted level of 0.5 ppm does not leave an appreciable margin of safety for pregnant women (PEAKALL and LOVETT, 1972) since mercury seems to concentrate across the placental membrane and there is great concern for its effect on the fetuses (HERDMAN, 1971).

The high values found in fish fillet sold in Coatzacoalcos are not surprising since over one pound of mercury is released daily into the Coatzacoalcos River (SECRETARIA de RECURSOS HIDRAULICOS, REPORT, 1973). The fish from Villa Cardel is believed to be contaminated by organo-mercury compounds used in agriculture (D.E. LOZANO, personal communication).

The mercury content of fishes is related to their feeding habits (LUKENS, 1972) and it is quite different for diverse species all living in the same area. ESTABLIER (1972) for example, found concentrations lower than 0.1 ppm in anchovies, sole and sardines, but up to 2.01 ppm in swordfish, all of which were collected in the same locality.

The finding of higher levels of mercury in liver than in muscle is to be expected and has been reported previously in the literature. RIVERS et al., (1972) for example, found almost twice as much total mercury in the liver than in the muscle of the Pacific blue marlin. The levels measured by these authors were 8.03 and 4.57 ppm for liver and muscle respectively.

Concentrations of mercury found in shrimp were all around or below the 0.05 ppm safe level except for species whose history since collection was unknown. This shrimp is sold in frozen blocks during the non-fishing season and contains mostly all specimens rejected by the packing houses. It is conceivable that it has been contaminated during handling or storage rather than by incorporation of mercury during its life.

As for the mollusks examined, levels were higher in clams than in oysters. The content of mercury in filter feeder mollusk may not always reflect accurately the concentrations in the environment. CUNNINGHAM and TRIPP (1973) found that mercury accumulated by Crassostrea virginica during experiments would drop suddenly in concentration, perhaps, as suggested by the authors, due to spawning. The oysters examined from two

localities had concentrations below the 0.05 ppm level. These values are one order of magnitude higher than those obtained by BLEILER (1973) in oysters from polluted waters near Sydney, Australia. This author found levels of 0.003 to 0.017 ppm in oysters from non-industrial areas and values of 0.006 to 0.016 ppm in oysters collected in industrial areas.

Fisheries is one of the most important industries of México. In order to safeguard this great natural resource, it is critical to expand pollution studies and pass legislation to curtail pollution.

#### ACKNOWLEDGMENTS

This study was conducted at the "Estación de Biología pesquera de Tampico," "Centro Nacional de Ciencias y Tecnologías Marinas de Veracruz," "Estación de Investigaciones Marinas El Carmen"; "Estación de Investigaciones Marinas Mazatlán" and "Escuela de Ciencias Marítimas y Tecnologías de Alimentos, Guaymas." The invaluable help of scientists and staff at these institutions is gratefully acknowledged. In particular we wish to express our thanks to F. Amezcua, R. Castro, S. de la Campa, S. García, D. Lozano, E. Macías, F. Manrique, R. Marquez, A. Nuñez, F. Padilla and R. Soto for help in collection, identification of specimens and for making facilities available for our study. This work was supported by a Program Development Activity grant from the Office of Cooperative Programs between the United States and Latin America, NSF. Equipment and supplies used for mercury analyses were provided by The Pennsylvania State University.

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