Mercury Concentrations in Fish, North Atlantic Offshore Waters—1971

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ABSTRACT

Mercury concentrations were determined in muscle and liver of 41 species of fish and a limited number of plankton, sediment, and invertebrate samples collected from North Atlantic offshore waters in 1971. The average mercury concentration in fish muscle was 0.154 ppm with a standard deviation of 0.124. Invertebrate samples had mercury concentrations which were generally less than 0.1 ppm. In a single lobster sample, however, 0.31 ppm mercury was found in the tail muscle and there was 0.60 ppm in the liver. Mercury levels in all 9 plankton and 10 sediment samples taken were less than 0.05 ppm.

Introduction

Recently, much has been published about mercury in freshwater lakes in Japan, Sweden, Canada, and the Great Lakes area of the United States. Mercury discharged into these waters was found to accumulate in tissues of fish and other organisms to levels that in certain species were considered potentially dangerous to human health (*1*).

This mercury was traced to many industrial and domestic uses, such as the manufacture of sodium hydroxide and chloralkali plants, paper manufacturing, plastics production, and application of fungicides to control yeast and mold growth on grass and in pulp mills.

The degree and source of mercury contamination of freshwater fish and waters were readily established. Levels in marine fish and waters, however, were not so easily determined. The Food and Drug Administration (FDA), U.S. Department of Health, Education, and Welfare, conducted a survey of mercury levels in several species of both domestic and foreign marine fisheries products and found that certain species of tuna and swordfish contained mercury above the 0.5 ppm action level, the maximum allowable concentration in fish intended for sale.

As a result of these findings, a program was initiated within the National Marine Fisheries Service, U.S. Department of Commerce, to determine mercury levels in other marine fish as part of an overall program on the effects of chemical contamination of living marine resources. The present paper reports on part of this program, a survey of mercury concentrations in groundfish collected from U.S. waters of the North Atlantic Ocean.

Experimental Methods

SAMPLE COLLECTION

Fish and invertebrates were collected by otter trawl during the annual assessment of groundfish stocks conducted by the National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole, Mass. After the catch, fish and invertebrates were sorted and dissected aboard the vessel. Livers and a 1-inch-thick steak immediately posterior to the head were taken from each fish. Invertebrate samples varied: whole squid were analyzed although scallop samples were composed of only the edible muscle and lobster samples consisted of the digestive diverticula and tail muscle.

Bottom sediments were obtained from selected areas with a Smith-McIntyre sampler. Samples were removed for analysis with a plastic tube 1½ inch in diameter and 6 inches long, which was inserted into the bottom sediment, capped, and frozen.

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Approximate geographic sampling areas are shown in Figure 1. Common and scientific names of fish and invertebrates obtained in the survey are presented in Table 1.

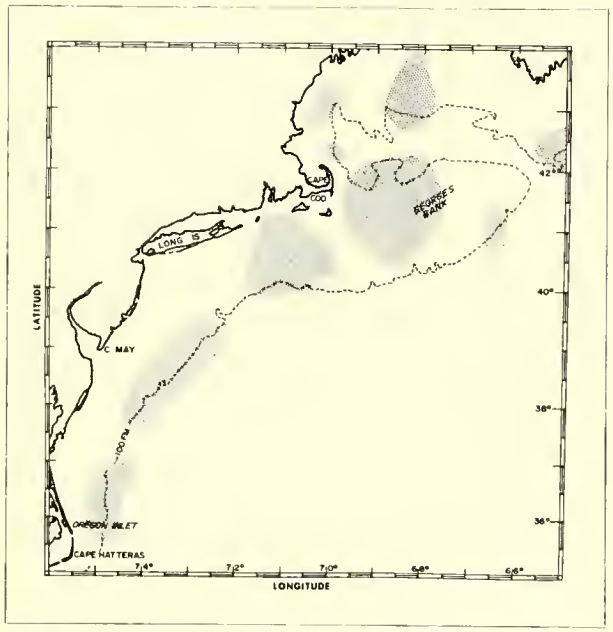

FIGURE 1. *Collection sites of fish sampled for mercury concentrations, North Atlantic offshore waters—1971*

TABLE 1. *Fish sampled for mercury concentrations, North Atlantic offshore waters—1971*

Common Name	Scientific Name
American plaice	*Hippoglossoides platessoides*
American shad	*Alosa sapidissima*
Angel shark	*Squalus dumerili*
Atlantic cod	*Gadus morhua*
Atlantic herring	*Clupea harengus harengus*
Atlantic mackerel	*Scomber scombrus*
Atlantic wolffish	*Anarhichas lupus*
Beardfish	*Polymixia lowei*
Blackbelly rosefish	*Helicolenus dactylopterus*
Black sea bass	*Centropristis striata*
Butterfish	*Peprilus triacanthus*
Cusk	*Brosme brosme*
Daubed shanny	*Lumpenus maculatus*
Fawn cusk-eel	*Lepophidium cervinum*
Fourspot flounder	*Paralichthys oblongus*
Gulf Stream flounder	*Citharichthys arctifrons*
Haddock	*Melanogrammus aeglefinus*
Lanternfish	Unclassified
Little skate	*Raja erinacea*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Mailed sculpin	*Triglops nybelini*
Northern searobin	*Prionotus carolinus*
Ocean pout	*Macrozoarces americanus*
Pollock	*Pollachius virens*
Redfish	*Sebastes marinus*
Red hake	*Urophycis chuss*
Round herring	*Etrumeus teres*
Silver hake	*Merluccius bilinearis*
Spiny dogfish	*Squalus acanthias*
Spot	*Leiostomus xanthurus*
Striped searobin	*Prionotus evolans*
Thorny skate	*Raja radiata*
White hake	*Urophycis tenuis*
Windowpane flounder	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*
Winter skate	*Raja binoculata*
Witch flounder	*Glyptocephalus cynoglossus*
Yellowtail flounder	*Limanda ferruginea*

SAMPLE PREPARATION FOR CHEMICAL ANALYSIS

At the laboratory fish steaks were thawed, skinned, and boned. Muscle and liver tissues of 5-10 fish from each station were combined into single composite samples for mercury analysis although some muscle and liver tissues were also analyzed individually. Invertebrates were pooled into composites of 10 animals per station. Samples were homogenized in an electric blendor composed of stainless steel blades and a glass jar.

Plankton samples were processed in a Vir-Tis model 10-100 freeze-drier for 48 hours. Plankton data are reported on a wet-weight basis. Entire sediment samples about 3-5 inches deep and 1½ inches in diameter were thoroughly mixed by hand in a plastic bag prior to analysis.

MERCURY ANALYSIS

Samples were analyzed according to the procedure of the Division of Laboratories, Ontario Ministry of the Environment (*2*). Plankton samples and ground flesh or liver samples ranging from 0.1 to 0.5 g were weighed into 30-ml Kjeldahl flasks. Ten ml 4:1 reagent grade concentrated sulfuric acid:nitric acid were added and the sample was shaken in a 50°-60° C water bath. Digestion was considered complete after 1½-2 hours when a clear solution was obtained. Flasks and samples were cooled at room temperature for 1 hour and placed in ice while 15 ml 6 percent potassium permanganate was slowly added to each sample. After addition of permanganate, samples were left overnight at room temperature.

A 20 percent sulfuric acid solution was added and samples were transferred to glass washing bottles equipped with fritted stems. Twenty ml reductant consisting of 100 ml concentrated sulfuric acid, 15 g sodium chloride, 30 g hyroxylamine sulfate, and 60 g stannous sulfate made up to 1,000 ml with distilled water were added to the sample and stirred for 1 minute. Mercury was swept by air through a 2.5-cm cell mounted in the light path of a Perkin Elmer model 305 atomic absorption spectrophotometer. Air flow rate was adjusted to give about 60 percent recorder response for 0.3 μg mercury. Peak heights of sample recorder response were compared to those of standards carried through the same digestion procedure described above for quantitation.

The method was checked for accuracy by comparing its results with those obtained by other procedures. A sample of oil-packed yellow fin tuna prepared by the National Canners Association was analyzed for mercury residues by nine laboratories using a variety of methods. The average mercury level obtained was 0.86 ppm; range was 0.80-1.02 ppm. The tuna sample studied at this laboratory was routinely analyzed with small batches of samples taken in the present study. An average value of 0.90 ppm with a relative standard deviation of 17.94 percent was obtained for 39 replicate determinations.

The procedure for mercury analysis of sediment samples was obtained from the Chemistry Laboratory Manual—Bottom Sediments, December 1969, compiled by the Great Lakes Region Committee on Analytical Methods, Federal Water Quality Administration, a predecessor of the U.S. Environmental Protection Agency. Samples ranging between 0.2 and 0.5 g were weighed into 125-ml Erlenmeyer flasks and 10 ml distilled water and 5 ml of 1:3 lactic acid:HCl (aqua regia) were added. Samples were heated for 2 minutes in a 95° C water bath and cooled in tap water for 10-15 minutes. Fifty ml distilled water and 15 ml of a 6 percent potassium permanganate solution were added to each flask. Then samples were reduced and analyzed by atomic absorption spectrophotometry as described for fish tissue except that sediment samples were analyzed the day they were digested.

Percent recoveries of $HgCl_2$ added to fish muscles and sediment prior to digestion are given in Table 2. Mercury was added to fish muscle before any acids or other reagents and was not allowed to equilibrate with muscle prior to addition of acid. Mercury added to sediment was allowed to stand for 2 hours prior to addition of water and acid. Sensitivity was about 0.05 ppm.

TABLE 2. *Percent recovery of mercury from fish and sediment, North Atlantic offshore waters—1971*

Species	Mercury Added, μg [1]	No. Replicates Analyzed	Recovery, %	
			Range	Average
Fishmeal	0.05	6	81.9-118.1	95.4
Swordfish	0.1	6	100.7-127.9	113.7
Yellow perch	0.2	6	80.9-108.0	96.9
Carp	0.2	6	89.7-102.3	95.1
Yellowfin tuna	0.3	5	95.4-105.1	98.6
Skipjack tuna	0.5	5	103.1-111.9	108.2
Sediment	0.3	6	105.0-119.0	111.5

[1] $HgCl_2$ used for mercury addition.

Results

Mercury concentrations among individual specimens were similar for most fish species although variations among individuals were observed for cusk and spiny dogfish (Table 3). One cusk collection had mercury concentrations ranging from 0.14 to 1.33 ppm in the liver and from 0.15 to 0.59 ppm in the muscle. In a second collection, variation among individuals was less: residues ranged from 0.16 to 0.34 ppm in the muscle and from 0.13 to 0.40 ppm in the liver.

Variation among four of six collections of spiny dogfish individuals was substantial. Mercury levels in these samples were: 0.20-0.61 ppm, 0.35-0.69 ppm, 0.35-0.93 ppm, and 0.22-0.65 ppm. Mercury content among individuals in the other two collections ranged only from 0.17 to 0.29 ppm and from 0.14 to 0.29 ppm.

MERCURY LEVELS AND FEEDING HABITS

In an attempt to correlate mercury concentrations with feeding habits, fish were grouped according to similar feeding patterns. The majority collected were bottom-feeders, others were primarily pelagic and plankton feeders and a few species could not be grouped into a particular feeding habit and were listed as miscellaneous. Feeding habits and mercury concentrations did not correlate (Table 4).

MUSCLE

Highest levels of mercury in fish muscle were found in cusk, spiny dogfish, northern searobin, and striped searobin (Table 5). The highest mercury concentrations in these samples were 0.49, 0.53, 0.35, and 0.35 ppm, respectively. The 36 other fish species had mercury levels in muscle that were less than 0.30 ppm. Mercury levels in all fish muscle sample averaged 0.154 ± 0.124 ppm.

LIVER

Highest mercury levels in fish livers were detected in blackbelly rosefish, cusk, northern searobin, and American shad (Table 5). The highest mercury levels in these samples were 0.40, 0.83, 0.56, and 0.67 ppm, respectively. The other 36 species of fish had mercury levels below 0.30 ppm in the liver (Table 5). Concentrations in livers of all fish examined averaged 0.164 ± 0.157 ppm.

MUSCLE AND LIVER

Mercury residues in fish samples averaged 0.154 ppm in muscle and 0.164 ppm in liver. Investigators have shown that liver accumulates metals to a greater extent than do most other tissues and organs (*3-5*). Data in this study, however, reflected an important difference: similar concentrations of mercury occurred in muscle and liver for most species examined. Exceptions to this rule were spiny dogfish, blackbelly rosefish, American shad, and Atlantic herring. Levels in spiny dogfish were two to three times higher in muscle than in liver, whereas in the other species mercury concentrations were greatest in the liver. Ratios of mercury levels in liver to those in muscle for other species were blackbelly rosefish, 2:1; American shad, 13:1; and Atlantic herring, 5:1.

PLANKTON, SEDIMENT, AND INVERTEBRATES

Mercury levels in all 9 plankton and 10 sediment samples were less than 0.05 ppm (Table 6). Pandallis shrimp, scallops, and squid generally had mercury levels less than 0.05 ppm (Table 7). However, the mercury levels of one squid sample and one shrimp sample were 0.06 ppm and 0.09 ppm, respectively. The single lobster sample obtained had mercury levels of 0.31 ppm in the tail meat and 0.60 ppm in liver (Table 7).

Discussion

This study measures total mercury: organic and inorganic forms. Methylmercury is considered more toxic to humans than are inorganic mercury salts and thus its occurrence in fish is of more toxicological significance

TABLE 3. *Mercury concentrations in individual fish samples, North Atlantic offshore waters—1971*

Species	Tissue	No. Fish Analyzed	Mercury Content, ppm wet weight		
			Range	Average	Standard Deviation
American dab	muscle	5	0.03-0.16	0.08	0.064
Atlantic cod	muscle	4	0.10-0.15	0.14	0.081
	liver	4	0.08-0.15	0.12	0.017
	muscle	5	0.10-0.38	0.24	0.135
	liver	5	0.10-0.36	0.18	0.109
Atlantic herring	liver	5	0.20-0.44	0.26	0.103
Atlantic wolffish	muscle	5	0.08-0.25	0.16	0.063
Blackbelly rosefish	muscle	5	0.12-0.31	0.22	0.095
Cusk	muscle	6	0.16-0.34	0.27	0.089
	liver	6	0.13-0.40	0.24	0.095
	muscle	6	0.15-0.59	0.41	0.189
	liver	6	0.14-1.33	0.65	0.440
Fourspotted flounder	muscle	5	0.09-0.19	0.16	0.031
Haddock	liver	5	0.05-0.09	0.06	0.014
Little skate	muscle	5	0.05-0.18	0.12	0.060
	liver	5	0.06-0.15	0.10	0.033
Mackerel	muscle	5	0.07-0.10	0.08	0.016
Pollock	muscle	5	0.06-0.12	0.10	0.029
	liver	5	0.05-0.09	0.06	0.016
Redfish	muscle	6	0.15-0.29	0.20	0.050
Red hake	muscle	5	0.05-0.09	0.06	0.000
Silver hake	muscle	5	0.06-0.14	0.09	0.034
Spiny dogfish	muscle	4	0.17-0.29	0.23	0.052
	muscle	10	0.20-0.61	0.34	0.160
	muscle	5	0.35-0.69	0.54	0.135
	muscle	5	0.35-0.93	0.58	0.270
	muscle	5	0.22-0.65	0.44	0.154
	muscle	5	0.14-0.29	0.18	0.064
Thorny skate	muscle	5	0.11-0.41	0.19	0.116
	muscle	4	0.15-0.36	0.26	0.113
	liver	4	0.12-0.17	0.15	0.033
White hake	muscle	5	0.08-0.17	0.12	0.037
	liver	5	0.05-0.18	0.12	0.055
Windowpane flounder	muscle	5	0.06-0.18	0.10	0.045
Winter flounder	muscle	5	0.06-0.12	0.08	0.022
	liver	5	0.12-0.26	0.18	0.044
Witch flounder	muscle	5	0.08-0.11	0.09	0.000
	liver	5	0.07-0.17	0.12	0.045
Yellowtail flounder	muscle	5	0.07-0.13	0.10	0.022

TABLE 4. *Mercury concentrations in fish grouped according to feeding habits, North American offshore waters—1971*

Fish	No. Collections Analyzed [1]	Mercury Content, ppm wet weight			
		Muscle		Liver	
		Range	Average	Range	Average
Bottom Feeders					
American dab	2	0.06-0.08	0.07	0.11-0.14	0.13
Atlantic cod	2	0.14-0.25	0.20	0.11-0.20	0.16
Atlantic wolffish	2	<0.05-0.15	0.08	<0.05-0.06	<0.05
Blackbelly rosefish	1	0.22	0.22	0.40	0.40
Black sea bass	1	0.08	0.08	0.18	0.18
Cusk	4	0.15-0.49	0.31	0.14-0.83	0.42
Fourspot flounder	2	0.16	0.16	0.23-0.27	0.25
Gulf Stream flounder	2	0.05	0.05	ND	ND
Haddock	2	<0.05-0.09	0.06	<0.05	<0.05
Little skate	2	0.13-0.16	0.15	0.10-0.23	0.17
Longhorn sculpin	2	0.08-0.09	0.09	0.09-0.16	0.13
Ocean pout	2	<0.05-0.11	0.07	<0.05-0.09	0.06
Red hake	2	<0.05-0.05	<0.05	<0.05-0.08	0.06
Striped searobin	1	0.35	0.35	0.38	0.38
Thorny skate	2	0.21-0.26	0.24	0.09-0.15	0.12
White hake	2	0.10-0.12	0.11	0.12-0.16	0.14
Windowpane flounder	1	0.10	0.10	0.12	0.12
Winter flounder	3	0.06-0.14	0.09	0.07-0.18	0.11
Winter skate	1	0.15	0.15	0.18	0.18
Witch flounder	2	0.07-0.10	0.09	0.13-0.16	0.15
Yellowtail flounder	2	0.10-0.24	0.17	0.17-0.25	0.21
Pelagic Feeders					
Pollock	2	0.08-0.10	0.09	<0.05-0.06	<0.06
Redfish	2	0.10-0.20	0.15	0.15	0.15
Spot	1	<0.05	<0.05	<0.05	<0.05
Silver hake	1	0.09	0.09	0.10	0.10
Plankton Feeders					
American shad	1	0.05	0.05	0.67	0.67
Atlantic herring	2	<0.05-0.09	0.06	0.26-0.28	0.27
Mackerel	1	0.08	0.08	ND	ND
Miscellaneous					
Angel shark	1	0.08	0.08	<0.05	<0.05
Cusk-eel	1	0.11	0.11	0.19	0.12
Spiny dogfish	8	0.07-0.53	0.32	<0.05-0.19	0.10

NOTE: ND = no data.
[1] Each collection includes 6-10 animals.

than is the occurrence of total mercury. Reports conflict concerning methylmercury:total mercury ratios in fish. Japanese investigators report that methylmercury does not exceed about 15 percent of the total mercury in fish whereas Swedish scientists have reported that these mercury concentrations are mostly methylmercury (*6*).

The Food and Drug Administration bases its administrative guideline of 0.5 ppm mercury in fish on total mercury content. Thus data presented here can be compared to the guideline. The only muscle samples in this survey that approached this level were those in cusk and spiny dogfish. Cusk measuring 61-67 cm had an average mercury content of 0.49 ppm. Levels in three groups of spiny dogfish muscle averaged 0.44, 0.47, and 0.53 ppm, whereas levels in five other groups of dogfish ranged from 0.07 to 0.34 ppm. The average of 0.154 ± 0.124 ppm for all fish muscle samples shows most fish well below the guideline level.

With the exception of cusk and spiny dogfish, fish examined in this study do not have abnormal mercury concentrations in relation to levels in marine fish reported by other investigators. Twelve of 15 species of Oregon groundfish had mercury levels in the range of 0.08-0.24 ppm. Yellow rockfish, lingcod, and spiny dogfish had average levels of 0.37, 0.35, and 0.60 ppm, respectively (*7*). The latter concentration was higher than the level reported for spiny dogfish in the present study.

Of about 21 species of marine fish and shellfish, only swordfish consistently had mercury levels at or over 0.5 ppm in an FDA study of marine and freshwater fish (*8*). Three thousand samples of canned tuna had an average mercury content of 0.25 ppm; less than 4 percent of these samples had levels over 0.5 ppm. The average mercury content of 19 other species of marine fish and shellfish was 0.3 ppm although most were below 0.1 ppm.

Mercury levels in fish landed in England and Wales have also been determined (*9*). Investigators there reported that mercury levels in fish from deep-water fishing areas averaged 0.06 ppm. Those caught away from coastal waters in the North Sea had an average concentration of 0.10 ppm whereas residues in fish caught in

TABLE 5. *Mercury concentrations in composite fish samples, North Atlantic offshore waters—1971*

Species	Sample Data					Mercury Content		
						Average, ppm wet weight		
	Latitude	Longitude	Depth, fathoms [1]	Date	Length, cm [1]	Whole Muscle	Animal	Liver
American dab	42° 48′	70° 38′	15-62	4-17	32-36	0.08		0.14
	41° 21′	68° 46′	28-62	10-19	ND	0.06		0.11
American shad	ND	ND	23-62	ND	ND	0.05		0.67
Angel shark	36° 11′	74° 48′	58-105	4-4	43-58	0.08		<0.05
Atlantic cod	41° 44′	69° 40′	58-115	10-18	ND	0.25		0.20
	42° 12′	70° 06′	15-62	11-4	54-61	0.14		0.11
Atlantic herring	41° 38′	68° 37′	28-62	10-18	ND	<0.05		0.26
	40° 23′	71° 02′	28-62	3-10	20	0.09		0.28
Atlantic wolffish	42° 42′	66° 07′	30-52	4-25	78-93	0.15		<0.05
	42° 55′	65° 01′	50-105	11-7	20-74	0.07		<0.05
Beardfish	37° 07′	74° 33′	58-105	4-5	13-14		0.06	
Blackbelly rosefish	39° 11′	72° 32′	95-200	10-7	16-34	0.22		0.40
Black sea bass	36° 50′	74° 42′	28-62	4-5	22-24	0.08		0.18
Butterfish	36° 37′	75° 20′	10-32	4-3	10		0.06	
Cusk	42° 46′	66° 37′	48-105	11-13	61-67	0.49		0.83
	42° 48′	70° 07′	55-130	4-18	44-68	0.27		0.23
Daubed shanny	43° 44′	69° 08′	5-62	4-21	8-12		0.05	
Fawn cusk-eel	40° 13′	71° 04′	58-105	10-8	25-29	0.11		0.19
Fourspot flounder	40° 24′	71° 57′	28-62	3-11	16-19	ND		0.27
	39° 09′	73° 12′	28-62	10-6	21-34	0.16		0.23
Gulf Stream flounder	38° 01′	74° 14′	28-62	10-5	6-12	0.05		ND
Haddock	41° 32′	69° 31′	10-35	10-18	ND	0.09		<0.05
	41° 01′	67° 06′	28-62	3-16	46-68	<0.05		<0.05
Lanternfish	41° 35′	61° 55′	95-200	10-22	ND		<0.05	
Little skate	40° 22′	68° 46′	28-62	10-16	ND	0.16		0.23
	40° 57′	71° 18′	13-33	3-30	45-50	0.13		0.10
Longhorn sculpin	40° 46′	68° 35′	10-34	10-17	ND	0.09		0.16
	41° 12′	71° 17′	13-33	3-10	25	0.08		0.09
Mackerel	39° 59′	71° 40′	28-62	3-11	30-35	0.08		ND
Mailed sculpin	43° 35′	66° 41′	50-115	4-23	8-13		<0.05	
Northern searobin	37° 53′	74° 41′	10-32	10-9	24-27	0.35		0.56
Ocean pout	40° 23′	73° 06′	11-32	3-31	45-55	0.11		0.09
	40° 55′	71° 63′	11-35	3-10	46	<0.05		<0.05
Pollock	42° 48′	66° 37′	48-105	4-24	51	0.08		<0.05
	41° 25′	69° 08′	58-115	10-19	ND	0.10		0.06
Redfish	41° 42′	69° 16′	58-115	3-24	38	0.20		0.15
	41° 57′	69° 02′	58-115	10-19	41-57	0.10		0.15
Red hake	40° 24′	71° 57′	28-62	3-11	25-30	<0.05		<0.05
	40° 33′	71° 57′	28-62	9-30	27-34	0.05		0.08
Round herring	40° 09′	73° 31′	11-32	10-4	15-16		<0.05	
Silver hake	39° 55′	72° 05′	28-62	10-7	28-31	0.09		0.10
Spiny dogfish	42° 20′	65° 35′	48-105	4-29	68-75	0.23		0.07
	42° 17′	66° 34′	90-160	3-21	ND	0.32		0.06
	44° 16′	66° 51′	50-135	11-15	81-84	0.34		0.09
	40° 32′	71° 20′	28-62	3-11	37	0.07		<0.05
	36° 28′	75° 08′	10-32	4-3	80-92	0.53		0.19
	38° 14′	73° 44′	58-105	4-8	82-95	0.47		0.07
	40° 29′	72° 26′	11-32	10-1	60-86	0.44		0.15
	40° 43′	70° 26′	11-35	10-15	ND	0.18		0.12
Spot	37° 29′	75° 13′	10-32	10-10	27-29	<0.05		<0.05
Striped searobin	36° 00′	74° 53′	28-62	4-4	28-37	0.35		0.38
Thorny skate	42° 41′	66° 12′	30-52	4-25	60-93	0.21		0.09
	44° 07′	66° 35′	15-62	11-15	60-81	0.26		0.15
White hake	42° 44′	69° 40′	90-155	4-18	57-68	0.12		0.12
	42° 16′	70° 22′	15-62	11-3	27-72	0.10		0.16
Windowpane flounder	41° 09′	70° 47′	11-35	9-29	22-31	0.10		0.12
Winter flounder	40° 11′	67° 56′	15-62	4-21	22-46	0.07		0.08
	40° 42′	72° 31′	11-32	10-1	28-35	0.14		0.18
Winter skate	40° 46′	68° 35′	10-34	10-17	ND	0.15		0.18
Witch flounder	38° 13′	73° 51′	95-200	4-8	31-36	0.07		0.16
	40° 32′	70° 57′	28-62	10-8	42-50	0.10		0.13
Yellowtail flounder	40° 16′	73° 24′	11-32	3-31	28-32	0.24		0.17
	40° 29′	71° 49′	28-62	9-30	33-38	0.10		0.25

NOTE: ND = no data.
[1] Values reported in ranges only; depth range represents a bottom contour from which the fish was taken.

the Irish Sea were twice as high. The average level of about 0.15 ppm for all groundfish examined in the present study falls midway between North Sea and Irish Sea data.

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TABLE 6. *Mercury concentrations in plankton and sediment, North Atlantic offshore waters—1971*

Sample Data				Mercury Content
Latitude	Longitude	Depth, fathom	Date	Average, ppm wet weight
Plankton				
42° 50′	64° 32′	50-100	4-27	<0.05
43° 33′	68° 44′	55-110	4-21	<0.05
42° 13′	69° 59′	55-130	11-4	<0.05
43° 05′	68° 40′	60-120	11-17	<0.05
41° 29′	66° 47′	28-62	10-22	<0.05
36° 03′	74° 52′	28-62	4-4	<0.05
36° 51′	75° 20′	10-32	4-3	<0.05
39° 19′	73° 51′	10-32	4-1	<0.05
37° 14′	74° 58′	10-32	10-12	<0.05
Sediment				
42° 50′	64° 32′	50-100	4-27	<0.05
43° 33′	68° 44′	55-110	4-21	<0.05
43° 12′	70° 05′	55-130	11-8	<0.05
43° 05′	68° 40′	60-120	11-17	<0.05
43° 14′	68° 42′	60-120	11-17	<0.05
36° 03′	74° 52′	28-62	4-4	<0.05
36° 51′	75° 26′	10-32	4-3	<0.05
39° 19′	73° 51′	10-32	4-1	<0.05
40° 19′	70° 29′	23-62	10-15	<0.05
37° 14′	74° 58′	10-32	10-12	<0.05

TABLE 7. *Mercury concentrations in invertebrates, North Atlantic offshore waters—1971*

	Sample Data					Mercury Content		
						Average, ppm wet weight		
Species	Latitude	Longitude	Depth, fathoms	Date	Length, cm	Muscle	Whole Animal	Liver
Lobster *(Homarus americanus)*	39° 21′	72° 15′	95-200	4-9	6-19	0.31 [1]		0.60
Pandallid shrimp (unclassified)	42° 04′	68° 44′	58-115	4-19	ND		0.09	
	42° 48′	70° 38′	15-62	4-17	ND		<0.05	
	41° 19′	61° 20′	10-35	3-23	ND		<0.05	
Scallops *(Placopecten magellanicus)*	38° 10′	74° 07′	28-62	10-6	5-7	<0.05		—
Squid *(Illex illecebrosus)*	40° 13′	71° 07′	58-105	3-11	ND		<0.05	
	39° 38′	72° 60′	28-62	10-4	ND		<0.05	
	40° 02′	71° 11′	95-200	10-8	18-22		<0.05	
	36° 19′	74° 48′	95-200	4-4	ND		0.06	

NOTE: ND = no data.
[1] Lobster muscle sample from tail only.