PRECIS

Ce communiqué concerne les niveaux de mercure dans le foie et les tissus musculaires du jeune flétan (2-6 ans) ainsi que les joues et les muscles du corps du flétan adulte (8-22 ans et plus). Les résultats de cette enquête préliminaire démontrent que l'accumulation de mercure est pratiquement non-existante au cours des 6 premières années de la vie du poisson mais qu'il se produit une accumulation graduelle par la suite. Les données indiquent également qu'il existe un rapport entre la teneur en mercure du poisson d'une classe d'année identique et le secteur de pêche, et le communiqué considère la possibilité d'un rapport entre ces différences de secteur et la teneur en mercure des différentes espèces qui sont la proie du flétan et peut-être aussi la teneur en mercure de l'eau de mer à proximité du lit marin.

This paper not to be cited without prior reference to the authors

International Council for the Exploration of the Sea

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SOME OBSERVATIONS ON THE MERCURY CONTENT OF THE NORTH ATLANTIC HALIBUT (HIPPOGLOSSUS HIPPOGLOSSUS)

by

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ABSTRACT

This paper reports on the levels of mercury in liver and muscle tissue of young halibut (2-6 yrs) and cheek and body muscle of adult halibut (8-22+ yrs). The results of this preliminary survey demonstrate that there is little or no accumulation of mercury in the first 6 years of the fish's life, but a gradual accumulation occurs thereafter. The data also show that the mercury content of fish of a similar year class is related to catch area and the possibility is explored that these area differences are related to the mercury content of the individual prey species and perhaps also the mercury content of the near-bottom sea water.

INTRODUCTION

Recent surveys of mercury in commercially exploited marine fish (MAFF, 1971 and 1973; Simpson et al. 1974; Zook et al. 1976 and Hall et al. 1976) have shown that most species of fish contain levels of mercury well below the arbitrary permissible level of 0.5 ppm adopted by a number of countries (Hancock, 1976). Only a few species - principally the larger fish - tuna, swordfish and halibut - were found to contain mercury levels which exceeded this. The range of values quoted for Pacific Halibut landed in Canada, USA and Japan was given as 0.04-1.52 ppm. Following the publication of the Food and Drug Administration (US) survey (Simpson et al. 1974), chemists at the Marine Laboratory, Aberdeen have measured the levels of mercury in halibut from Scottish fishing grounds. This paper describes the results of an examination of muscle and liver tissue of 2-6 year class halibut collected during a recent research cruise to the Faröes and an examination of cheek and body muscle from large specimens landed between April and June in 1976 and 1977 at Aberdeen by commercial fishing vessels.

METHOD

Samples of small halibut were collected by trawling over grounds at the Faröe Islands and at Faröe Bank by FRV 'Explorer' during May 1975. The fish were measured, weighed and aged on board and then dissected to obtain whole length fillets and livers. The individual samples were placed in polythene bags and kept deep frozen until analysis. Individual tissues were thawed and homogenised to provide a suitable sub sample for chemical analysis.

Additional samples of muscle tissue from large halibut (> 10 Kg) were collected at irregular intervals during April and June in 1976 and 1977 from wholesale fish merchants in Aberdeen. Because of the high market value of this fish, their great size, and since many were sent to retailers outside Aberdeen, it was not feasible to use whole fish to secure muscle samples on a regular basis. To overcome this problem, samples of cheek tissue were taken from the heads which are normally sent for fish meal. Halibut cheeks, located on the top and underside of the head, weighing up to 1 Kg each in the very large fish, have a more fibrous texture than the body tissue and are considered by many people to be a delicacy. A comparison of the mercury content of cheek and body tissue showed that within the limits of analytical error the mercury content of both tissues was the same (Table 1). Cheek tissue from each head was separately bulked and homogenised to provide a suitable sample for chemical analysis. It was possible to obtain otoliths from the heads and so, although age determination of the large fish is difficult, some estimate of age was obtained. It was not possible to secure samples of liver tissue from the large halibut because fish landed commercially are normally gutted at sea. Total mercury analysis was carried out using a dry combustion/cold vapour atomic absorption technique which has been previously described (Topping et al. 1975). Methyl mercury analysis was performed by gas-liquid chromatography after toluene extraction according to the method of Westöö (1968).

RESULTS AND DISCUSSION

The results of the analyses of fish collected during the research cruise together with details of year class, length and weight are given in Table 2. Table 3 contains the results of the analyses of fish market samples together with details of year class and weight of fish. Both sets of data were used to examine the relationship between year class and concentration of mercury in muscle tissue (Fig. 1).

The data in Table 2 show that muscle and liver levels of mercury in young fish were very similar and that the concentration range of 0.01-0.05 ppm for muscle tissue is similar to the range of values normally encountered in other commercial fish landed in Scotland (Topping 1973). However the levels of mercury in large halibut (Table 3) were significantly higher than most other fish species and, in general were similar to the levels found in Pacific halibut (Zook et al. 1976 and Hall et al. 1976). Organic mercury analyses, carried out on a number of cheek tissue samples over the size range, indicated that 90-100% of the mercury was present in the methyl form. Although young halibut showed no accumulation of mercury with age between 2-6 years there was a marked increase in mercury content of muscle tissue with age for the adult fish (Fig. 1). This relationship has also been observed for Pacific halibut (Hall et al. 1976) and is in line with observations made by other workers for saithe (Topping et al. 1975), cod and plaice (Portmann 1973).

McIntyre (1952) reported that there was a change in the feeding habits of halibut with age from a mixed diet dominated by crustacea in the juveniles to an almost entirely fish diet in the adults. This dietary change could be a significant factor in explaining differences between mercury levels of juvenile and adult halibut since the mercury content of fish is higher than that of crustaceans (MAFF, 1971). McIntyre also stated that juveniles feed in inshore areas and move offshore as they mature to deeper water where larger food organisms are available in greater numbers.

In addition to demonstrating an age/Hg content relation, Hall et al. (1976) showed that there are significant differences in mercury content of adult Pacific halibut of the same weight range from different sea areas eg in the weight range (61-81 lbs) they found mean values of 0.15, 0.18, 0.33, 0.69 and 0.88 ppm for the sea areas Bering Sea, Gulf of Alaska, S E Alaska, British Columbia and Washington-Oregon. Halibut landed at Aberdeen are caught mainly in three areas - Northern North Sea, Faroe Islands/Faroe Bank and West of Scotland. The data in Table 3 and Figure 1 show that halibut caught at Rockall and adjacent grounds contain significantly higher levels of mercury than the halibut of a similar year class or weight, collected off the North Coast, Fair Isle and Faroe. The differences in the food of halibut from one region to another may well provide one explanation for the variation in mercury content. According to McIntyre (1952) the main fish types in the food of large halibut from the North Sea and Faröe grounds are gadoids, flat-fish and clupeoids. The food of halibut on Rockall Bank, and its adjacent grounds, may consist of these species plus the deep water pelagic types (Rae, 1958). One of the features of this area is the occurrence of large stocks of several relatively unexploited pelagic fish species eg blue whiting, common and blue ling. Studies of fish populations in general show that unexploited stocks contain a much greater proportion of older fish than exploited stocks. If we assume that the mercury content of these unexploited fish increases with age it might follow that the mature halibut in the Rockall area will consume large numbers of older fish containing relatively high mercury levels. Recent work by Topping and Graham (in preparation) has confirmed that mercury levels in common ling increase with age/size and some of the oldest and heaviest fish contain levels of ca 0.5 ppm. This compares with an average mercury level of 0.08 ppm for intensively exploited fish species such as cod, haddock, whiting, plaice (MAFF, 1971). The mercury content of large halibut at the time of capture will therefore reflect the composition of the fish it has consumed during its lifetime.

An alternative explanation for these relatively high values of mercury might be that the halibut had been eating fish contaminated by mercury introduced by man. This argument is not supported by data here or in the literature since previous studies of mercury in marine life have shown that elevated levels influenced by industrial discharges are invariably found in inshore and coastal waters. An examination of mercury levels in sea water (Jones, 1975) indicates that in general, levels in the open ocean are low. Elevated levels have however been found in deep water in the vicinity of the Mid Atlantic Ridge and are ascribed to natural input via volcanic activity (Carr et al. 1974). Since the Rockall area has associations with past volcanic activity, it is possible, therefore, that the water might contain elevated levels which might be responsible for these high levels of mercury in halibut. If this were so then one might expect fish, other than halibut, from this area also to contain higher levels of mercury than the same species from other areas around Scotland. The survey of mercury in common ling, (Topping and Graham, in preparation) collected from the North Sea, N. Minch, Faröe and Rockall areas does not confirm this.

In an attempt to gather supporting evidence the Marine Laboratory is to continue its study of mercury in large halibut. Future work will focus on the areas where high values have been found and will include mercury levels in species known to be preyed on by halibut.

REFERENCES

Carr, R.A., Jones, M.M. and Russ, E.R.	1974	Anomalous mercury in near-bottom water of a mid-Atlantic rift valley. Nature (Lond.) 251, 489.
Hall, A.S., Teeng, F.M., Lewis, L.G., Hardman, W.H. and Gauglity, E.J.	1976	Mercury in Fish and Shellfish in North East Pacific. I. Pacific Halibut 'Hippoglossus stenolepis'. Fish Bull. 74, (4), 783-789.
Hancock, D.A.	1976	Mercury in Fish. Aust. Fish 35(1), 4-7.
Jones, P.G.W.	1975	Meeting of sub-group on contaminant levels in sea water. ICES. Charlottenlund, 21-23 May.

McIntyre, A.D. 1952 The food of halibut from North Atlantic Fishing Grounds. Mar. Res. (3), 19 pp

MAFF 1971 Survey of mercury in foodstuffs. 1st report of the Working Party on the Monitoring of Foodstuffs for Heavy Metals. Ministry of Agriculture, Fisheries and Food, HMSO, 33 pp.

MAFF 1973 Survey of mercury in foodstuffs: A Supplementary Report. Ministry of Agriculture, Fisheries and Food, HMSO, 24 pp.

Portmann, J.P. 1973 The relationship between age of fish and the level of accumulated substances, ICES CM 1973/E:12.

Rae, B.B. 1958 The occurrence of Plerocercoid larvae of 'Grillotia erinaceus' (van Beneden) in Halibut. Mar. Res. (4), 31 pp.

Simpson, R.E., Horivity, W. and Roy, C.A. 1974 Surveys of mercury levels in fish and other foods. Pestic. Monit. J. 7, 127-138.

Topping, G. 1973 Heavy metals in fish from Scottish waters. Aquaculture 1 (4), 373-377.

Topping, G. and Graham, W.C. 1977 Mercury levels in common ling in relation to year class, size and fishing area. In preparation.

Topping, G., Pirie, J.M. Graham, W.C. and Shepherd, R.J. 1975 An examination of the heavy metal levels in muscle, kidney and liver of saithe in relation to year class, area of sampling and season. ICES CM 1975/E:37.

Westöö, G. 1968 Determination of Methylmercury salts in various kinds of biological material. Acta Chem. Scand. 22, 2277-2280.

Zook, E.G., Powell, J.J., Hackley, B.M., Emerson, J.A., Brooker, J.R. and Knobl, J.M. (Jr) 1976 National Marine Fisheries Service preliminary survey of selected sea foods for mercury, lead, cadmium, chromium and arsenic content. J. Ag. Food Chem. 24, 47-53.

Table 1 Comparison of Mercury concentrations in cheek and body muscle of halibut

Weight of gutted fish (Kg)	Total Mercury conc. ($\mu g\ g^{-1}$) Cheek	body
33.1	0.35	0.31
-	0.27	0.25
39.0	4.5	4.2
42.2	3.0	2.7
43.5	1.3	1.2
52.6	2.0	1.7
56.2	1.9	2.0
58.5	2.2	1.8
84.4	0.82	0.76

Table 2 Mercury in muscle and liver tissue of halibut caught at the Faroes

Age yr	Length cms	Weight gm	Total Mercury content ($\mu g\ g^{-1}$ wet weight) Muscle	Liver
2	49	1 301	0.03	0.03
2	48	1 171	0.02	–
2	48	1 189	0.02	0.01
2	31	297	0.02	–
2	47	1 044	0.01	0.05
2	31	319	0.02	0.07
3	48	1 202	0.03	0.03
3	59	2 118	0.02	0.03
3	41	1 327	0.02	0.03
3	49	1 405	0.02	0.02
4	45	926	0.02	0.02
4	65	3 249	0.04	0.05
5	74	4 223	0.04	0.03
5	74	5 254	0.05	0.02
6	72	4 269	0.03	0.03
~20	~125	50 000	0.49	0.07

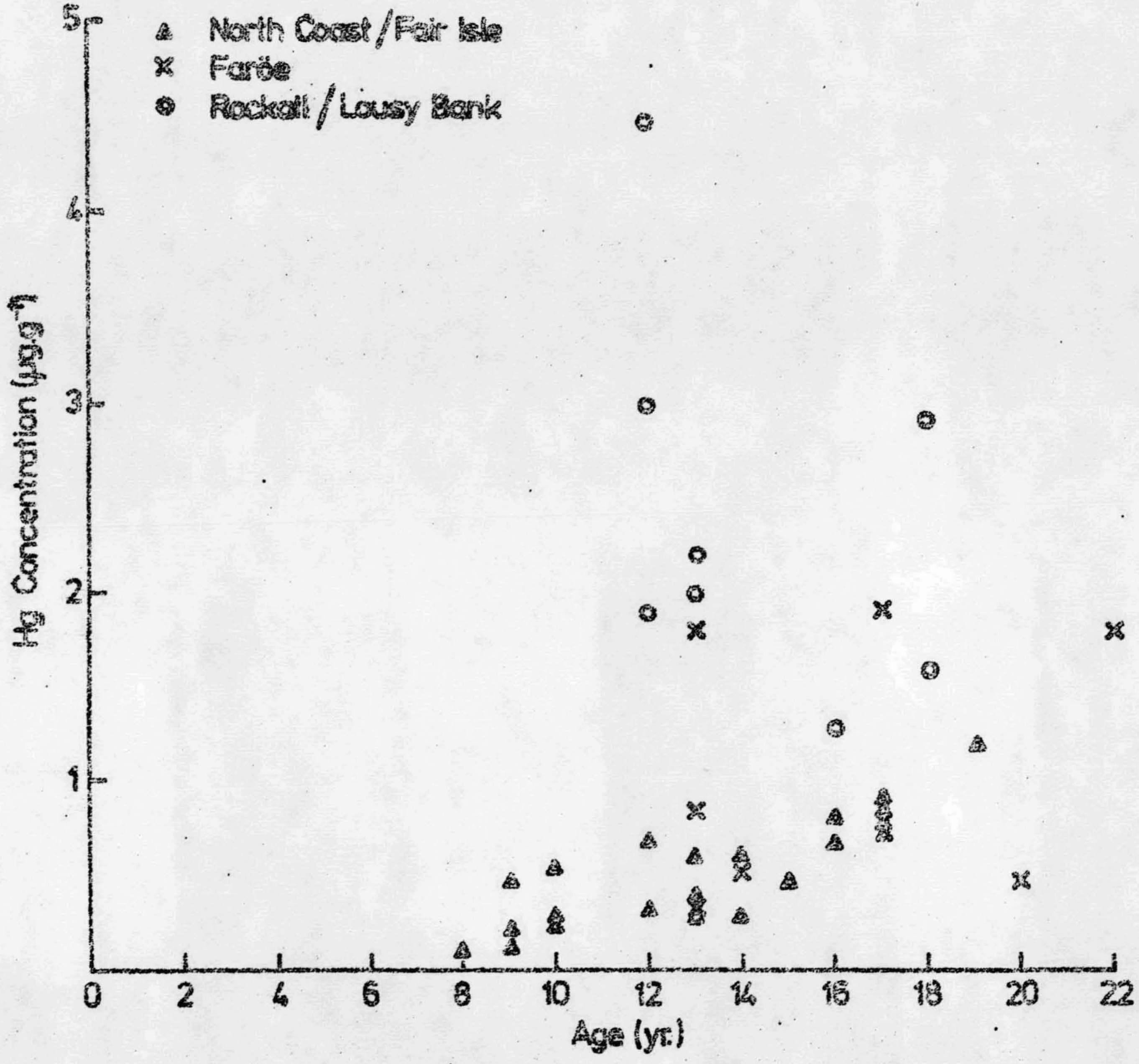
Table 3 Mercury in cheek tissue of halibut

($\mu g\ g^{-1}$ wet weight)

Age yr	Weight of gutted fish (Kg)	Total Mercury content ($\mu g\ g^{-1}$ wet weight)	Area
8	–	0.09	North Coast/
9	22	0.47	Fair Isle
9	–	0.13	" "
9	10	0.22	" "
10	46	0.56	" "
10	44	0.25	" "
10	44	0.25	" "
10	25	0.28	" "
12	28	0.36	" "
12	46	0.70	" "
13	44	0.30	" "
13	41	0.39	" "
13	57.2	0.60	" "
14	48	0.29	" "
14	44	0.63	" "
15	68	0.48	" "
15	44	0.46	" "
16	88.9	0.69	" "
16	84.4	0.82	" "
17+	76	0.75	" "
17	68.2	0.82	" "
17+	46	0.87	" "
17+	75	0.87	" "
17+	64	0.93	" "
19	82.6	1.2	" "

Table 3 (continued)

Age yr	Weight of gutted fish (Kg)	Total Mercury content ($\mu g\ g^{-1}$ wet weight)	Area
13	33.1	0.35	Faröe
13	78.0	0.85	"
13	104.3	1.8	"
14	50.8	0.52	"
17	71.2	1.9	"
22	91.2	1.8	"
12	56.2	1.9	Rockall/
12	42.2	3.0	Lousy Bank
12	39.0	4.5	" "
13	52.6	2.0	" "
13	58.5	2.2	" "
16	43.5	1.3	" "
18	65.0	1.6	" "
18	38.1	2.9	" "


North Coast / Fair Isle
Faröe
Rockall / Lousy Bank
Hg Concentration (µg.g⁻¹)
0
1
2
3
4
5
2
4
6
8
10
12
14
16
18
20
22
Age (yr.)