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The levels of certain metals in fish from coastal
waters around England and Wales

by

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INTRODUCTION

As reported at the 1970 ICES meeting, this laboratory has operated a monitoring system for PCBs and organo-chlorine pesticide residues in fish and shellfish from around England and Wales since 1968 (Portmann 1970). During the past two years there has been an increasing concern over the presence and distribution of a variety of other substances in the marine environment. Of particular concern has been the concentration of metals such as mercury and cadmium in marine fish and shellfish eaten by man. Since very little reliable information was available on the normal levels of metals found in marine animals, it was decided, early in 1970, to extend the organo-chlorine monitoring programme to include the metals: cadmium, chromium, copper, lead, mercury and zinc. However, because metals are naturally present in sea water, it was also necessary to extend the sampling network beyond the immediate coastal zone in order to permit an assessment of the concentration of metals in fish from deep-water areas.

METHODS AND RESULTS

Samples of fish, each usually consisting of ten individuals of each species, were collected twice yearly from nine representative ports around England and Wales. The species sampled were: cod, whiting, plaice, herring and mackerel. In addition, samples of these and other common commercial species were collected from the North Sea and distant-water fishing grounds. The muscle tissue of each individual fish was analysed, together with a homogenate of the bulked livers of each sample.

There is evidence that the concentration of metal in muscle varies in different parts of a fish, and that the bone and skin are also different. In order to eliminate sampling errors which could be introduced by these variations, a full length fillet was cut from each fish,

extending from head to tail and as deep as the backbone. After the skin and larger bones had been removed, the flesh was minced and homogenized, and a sub-sample taken for analysis.

Following wet ashing with concentrated nitric or nitric/sulphuric acids, the resultant solution was diluted to an appropriate concentration and analysed for cadmium, chromium, copper, lead and zinc by atomic absorption spectrophotometry (AAS). The concentration of total mercury was estimated by using a modification of the flameless AAS method described by Uthe et al. (1970).

The results of the surveys undertaken until July 1971 are given in Tables 1 and 2. Table 1 summarizes the results of analyses of all fish by area. Table 2 compares the concentrations of metals in two selected species from coastal waters, the North Sea and distant-water fishing grounds. All concentrations are expressed on a wet weight basis.

Cadmium

The mean concentration of cadmium found in deep-water fish was less than 0.05 ppm, although concentrations of up to 0.15 ppm were found in individual fish. In the North Sea and Irish Sea, the mean concentrations were slightly higher at 0.12 and 0.07 ppm respectively. In the coastal areas the mean concentrations were similar to those found in the North Sea and no areas of abnormally high concentration have been detected. Cod appeared to contain more cadmium than plaice, but the difference was not great.

Copper

The mean concentration of copper varies according to the sampling area, but the highest concentrations were found in fish from distant-water areas. Although the results in Table 1 may be slightly biased according to the species most heavily sampled, the highest concentrations of copper in fish from coastal waters were found in samples from the south-east, north-west and north-east coasts. Table 2 shows that both cod and plaice from the distant-water ^{grounds} contain higher copper concentrations than those from either the North Sea or coastal waters. In all areas, plaice appear to contain higher concentrations of copper than cod.

Chromium

The levels of chromium found in fish were usually below the limit of detection of the method used (0.5 ppm) and only samples taken off the coast of South Wales exceeded this mean concentration. However, concentrations of chromium in individual fish of 0.5 ppm were encountered

in all other coastal areas. The source of this chromium is assumed to be from industrial effluents and from the road drainage of towns and cities using chromium - containing paints for road markings.

Mercury

The results of the mercury survey were not available for publication at the time of writing this paper. They will however be presented in the form of an addendum which will be sent to all delegates in October.

Lead

The mean concentration of lead in fish from the North Sea and distant-water fishing grounds was below 0.5 ppm. However, the concentration found in individual fish, even from distant-water grounds, at times reached 4 ppm. In three of the coastal regions, the mean concentration of lead in fish exceeded the limit of detection but the highest concentration found in an individual fish was only 6 ppm. When the mean concentrations for cod and plaice from coastal, North Sea and distant-water fishing areas were compared, the mean concentration of lead in plaice only slightly exceeded the 0.5 ppm level.

Zinc

The concentrations of zinc found in fish from the different fishing areas followed the same pattern as that found for copper in that the highest concentrations tended to be in fish from distant-water regions rather than, as might be expected, in fish from coastal waters. There was, however, very little difference between the concentrations of zinc in fish from different areas, the range of mean concentrations of zinc in fish from all areas being 4.60 to 6.28 ppm. Plaice contained higher concentrations of zinc than cod.

The results of analysis for zinc and copper where higher values occur in distant waters demonstrate the need for data on fish from many different areas if a realistic assessment is to be made of the origin of these metals.

REFERENCES

- PORTMANN, J. E., 1970. Monitoring of organo-chlorine residues in fish from around England and Wales, with special reference to polychlorinated biphenyls (PCBs). ICES C.M. 1970/E:9 (mimeo).
- UTHE, J. F., ARMSTRONG, F. A. J. and STAINTON, M. P., 1970. Mercury determination in fish samples by wet digestion and flameless atomic absorption spectrophotometry. J. Fish. Res. Bd Can., 27 (4), 805-811.

Table 1 Metals in the muscle of fish landed in England and Wales from selected areas

Origin		Cd	Cu	Cr	Pb	Zn
North-east coast* (North Shields to Spurn Head)	A†	6	11	11	11	11
	B	54	101	101	101	101
	C	0.16	1.08	< 0.50	< 0.50	5.38
East coast* (Spurn Head to Dover)	A	9	14	14	14	14
	B	63	86	86	86	86
	C	0.14	0.81	< 0.50	0.99	5.70
South-east coast* (Dover to Portland Bill)	A		9	9	9	9
	B		61	61	61	61
	C		1.22	< 0.50	0.83	6.11
South-west coast* (Portland Bill to Bristol)	A	14	31	31	31	31
	B	92	244	244	244	244
	C	0.06	0.67	< 0.50	< 0.50	5.05
South Wales coast* (Bristol to Cardigan)	A	9	17	17	17	17
	B	82	145	145	145	145
	C	0.08	0.88	0.58	< 0.50	4.60
North-west coast* (Conway to Solway Firth)	A	3	9	9	9	9
	B	15	78	78	78	78
	C	0.12	1.05	< 0.50	0.62	6.28
Irish Sea (more than 25 miles from coast)	A	13	6	6	6	6
	B	74	40	40	40	40
	C	0.07	0.80	< 0.50	0.50	5.70
North Sea (more than 25 miles from coast)	A	9	6	6	6	6
	B	21	53	53	53	53
	C	0.12	< 0.50	< 0.50	< 0.50	4.83
Distant water (Iceland, Barents Sea, Norway Coast)	A	4	7	7	7	7
	B	22	36	36	36	36
	C	< 0.05	1.80	< 0.50	< 0.50	6.10

*All these were coastal fish taken within 25 miles of the coast

†A - Total number of samples

B - Total number of fish

C - Mean concentration, ppm (mg/kg) wet weight

Table 2 Metals in the muscle of two selected species of fish landed in England and Wales

Species	Area		Cd	Cu	Cr	Pb	Zn
COD	Coastal	A†	7	20	20	20	20
		B	58	149	149	149	149
		C	0.12	0.47	< 0.50	< 0.50	4.35
	North Sea	A	1	1	1	1	1
		B	3	10	10	10	10
		C	0.18	0.65	< 0.50	< 0.50	5.16
	Distant water	A	2	3	3	3	3
		B	13	16	16	16	16
		C	< 0.05	1.00	< 0.50	< 0.50	4.70
PLAICE	Coastal	A	13	23	23	23	23
		B	95	211	211	211	211
		C	0.07	0.85	< 0.50	0.54	5.36
	North Sea	A	1	2	2	2	2
		B	12	18	18	18	18
		C	0.12	0.85	< 0.50	< 0.50	5.70
	Distant water	A	2	2	2	2	2
		B	9	9	9	9	9
		C	0.05	1.50	< 0.50	< 0.50	6.60

†A - Total number of samples

B - Total number of fish

C - Mean concentration, ppm (mg/kg) wet weight