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Mercury in Flounder, *Platichtys flesus,* Cod, *Gadus morhua,* and Perch, *Perca fluviatilis,* in Relation to Their Length and Environment

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During the last ten years several changes have been taken place in the use of mercury. Industrial discharges have been restricted and several fields of application have been eliminated or reduced. However the use of mercury containing batteries is still increasing.

Monitoring the mercury content of fish is however still an important aspect of environmental pollution control. It has been shown by several investigators (Johnels et al 1967; De Clerck et al 1974; Krüger et al 1975; Jacobs 1977; Vyncke et al 1979; Wiszmath and Kreuzer 1979; Akielaszek and Haines 1983) that the mercury content in fish might be correlated with biological parameters like length and age. In this paper the results are presented of a few recent Dutch monitoring studies of mercury in flounder, cod and perch in relation to biological and environmental parameters.

MATERIAL AND METHODS

In 1984 and 1985 approx. twentyfive male specimen of flounder (Platichtys flesus) were collected in October-November at two sampling locations (Waddensea and the coastal water near the Western Scheldt). In May - July 1985 approx. thirty male specimen of cod (Gadus morhua) were sampled at the central and southern part of the North Sea. From three Dutch inland waters (Lake Yssel, Rhine (Nieuwe Merwede), Lake Fluessen), with a different level of mercury contamination, approx. thirty-five male specimen of perch (Perca fluviatilis) were taken in 1983. Total length of the individual samples was recorded before filleting. The fillets were homogenized with an Ultra Turrax blender and stored at -20°C.

Mercury was determined by cold-vapor atomic absorption spectrometry. After wet digestion of one gram of wet material in 0.5 ml of 70% nitric acid in a teflon-lined stainless steel decomposition vessel for at least 3 hours at 150°C, the dissolved ionic mercury was reduced to elementary mercury by means of $SnCl_2$. The volatile elemental mercury was preconcentrated on a

crumpled gold wire (∿4g) by purging hydrogen through the reduction vessel. The gold wire was then heated to ∿320°C within 30 seconds to evaporate the mercury which was then transferred to a HGM-2300 mercury meter by means of a stream of hydrogen.

RESULTS AND DISCUSSION

In figures 1 and 2 the results of the mercury content in the muscle tissue of male flounder from the Waddensea and the coastal water near the Western Scheldt are given as a function of the length. A significant positive correlation was found between the mercury content in the muscle tissue of the flounder and the length (table 1). From the statistical data of the curves it was established that the mercury content in flounder from the Waddensea with a length 20 - 40 cm was significantly (2.2 - 2.9 times) higher than the mercury content in the corresponding flounder from the Western Scheldt coast area.
In the period 1980 - 1982 the average dissolved mercury content in water from the Waddensea (0.043 µg/l) was approx. 2 times higher than the average dissolved mercury content in the coastal seawater near the Western Scheldt. A decrease in the dissolved mercury content in water from the Waddensea to approx. 0.012 µg/l has been observed in 1983-1984 (Stokman and Mol 1984).
So male flounder from the Waddensea with an age over 2 - 3 years (length >26 cm) has been exposed to a higher level of dissolved mercury than the corresponding flounder from the Western Scheldt coast.

The data for the mercury content in the muscle tissue of cod from the central and southern part of the North Swa are given in figure 3 as a function of the length. Also for cod there is a significant positive correlation between mercury content and length (table 1).
At a length of 45 cm the mercury content in cod from the southern North Sea is significantly higher (∿1.3 times) than the mercury content in the corresponding cod from the central North Sea.
It should be remarked that the length of 1 - 2 year old cod from the southern North Sea is approx. 10% larger than the corresponding cod from the central North Sea (van Alphen and Heesen 1984). Correlation between the mercury content in cod and the length was already observed by De Clerck et al (1974), Jacobs (1977) and Krüger et al (1975).

The mercury content in the muscle tissue of perch from Lake Yssel, Rhine (Nieuwe Merwede) and Lake Fluessen are presented in figure 4 as a function of the length. As for flounder and cod a significant positive correlation exists between the mercury content and the length (table 1).
The mercury content in perch from Lake Yssel at a length of 14 respectively 17 cm is significantly higher than the mercury content in perch from Lake Fluessen and the Rhine. It has been shown that mercury in sediment from the Rhine was approx. 5 - 10 times higher than the mercury content in sediment from the

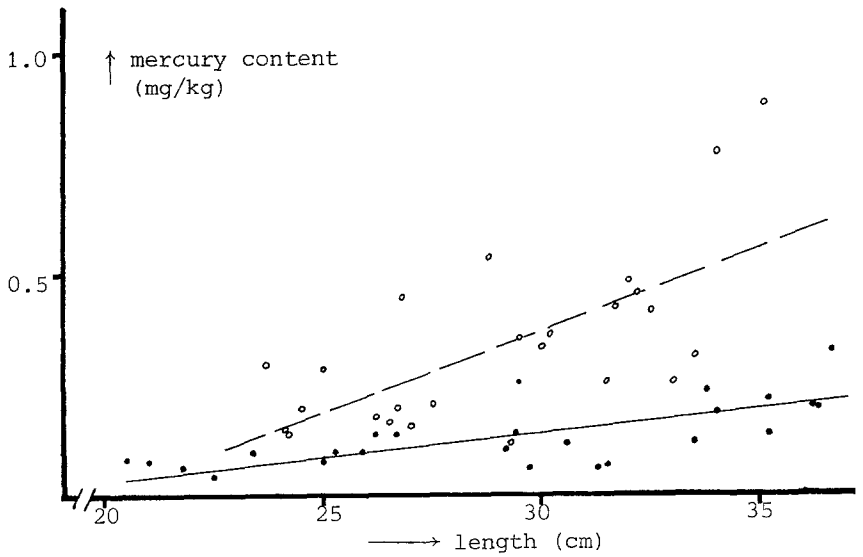

Figure 1. The mercury content in the muscle tissue of male flounder as a function of the length.
Waddensea (o); Western Scheldt coast (●); Sampling 1984

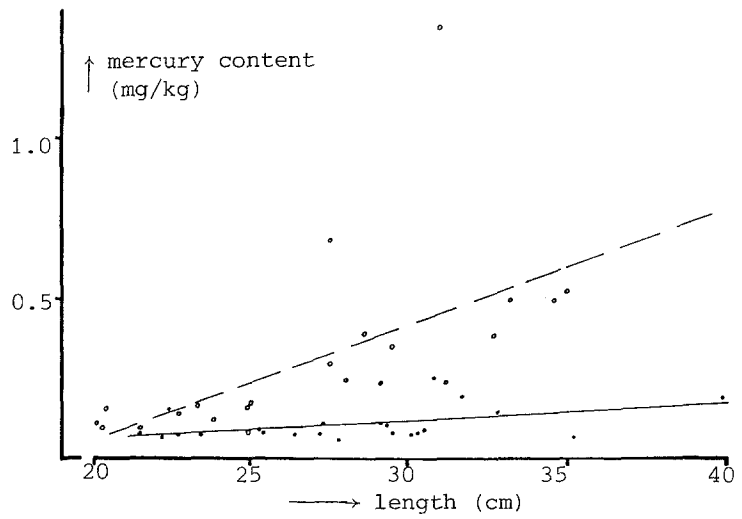

Figure 2. The mercury content in the muscle tissue of male flounder as a function of the length.
Waddensea (o); Western Scheldt coast (●); Sampling 1985

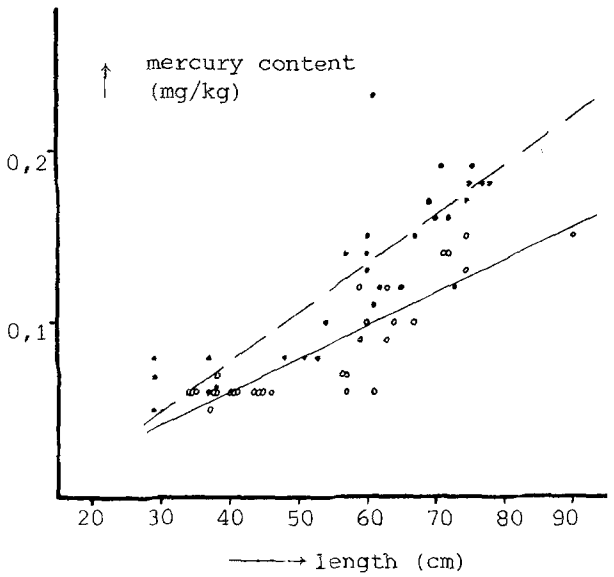

Figure 3. The mercury content in the muscle tissue of male cod as a function of the length.
Central North Sea (o); Southern North Sea (•);
Sampling 1985

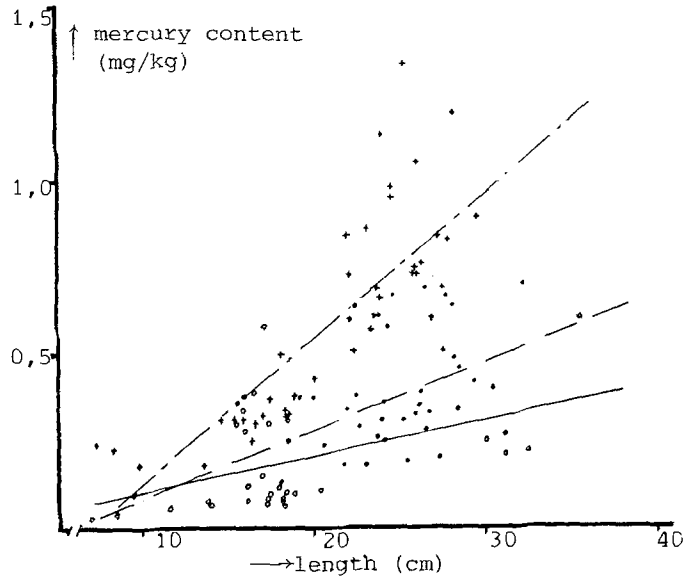

Figure 4. The mercury content in the muscle tissue of male perch as a function of the length.
Lake Fluessen (o); Rhine (•); Lake Yssel (+);
Sampling 1983

different areas of Lake Yssel. Lake Fluessen is a rather uncontaminated area. The average pH in Lake Yssel is approx. 8.4 and in the Nieuwe Merwede 7.6. As more methylmercury is produced at lower pH (Beyer and Jernelöv 1979) and the adsorption of mercury to sediment is smaller at lower pH it was expected that the mercury content in perch from the Rhine would be higher than that in perch from the two other areas. However in the case of perch from Lake Yssel the results are just the opposite, which suggests that other unknown factors affect the mercury accumulation in perch. The results for perch are in good agreement with the data on the mercury content in pike perch from Lake Yssel and Lake Fluessen reported by Pieters et al (1983). From the results it is concluded that for monitoring purposes the relationship between the mercury content in the muscle tissue and the length of the fish has to be taken into account. Furthermore, from the mercury content in the muscle tissue of perch it may be concluded that the mercury content in fish does not always reflect the state of pollution of the environment.

Table 1. Data describing the relationship of the mercury content in the muscle of male flounder, cod and perch and the length

Fish specie	Sampling location	Sampling year	Number of data pairs	[Hg]= a + b.length a (mg/kg)	b (mg/kg/cm)	Correlation coefficient
flounder	Waddensea	1984	25	-0.736	0.037	0.669*
flounder	Waddensea	1985	22	-0.651	0.036	0.597*
flounder	Western Scheldt coast	1984	25	-0.139	0.009	0.666**
flounder	Western Scheldt coast	1985	22	-0.031	0.005	0.469*
cod	Central North Sea	1985	30	-0.015	0.0019	0.869*
cod	Southern North Sea	1985	30	-0.034	0.0028	0.826*
perch	Lake Yssel	1983	45	-0.289	0.0414	0.788*
perch	Rhine (Nieuwe Merwede)	1983	33	-0.121	0.0198	0.481*
perch	Lake Fluessen	1983	32	0.0027	0.0102	0.457*

* $p < 0.01$ ** $p < 0.025$

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