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Levels of Hydrocarbons in Mussels, *Mytilus edulis*, and Surface Sediments from Danish Coastal Areas

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Until recently, most effort in oil pollution research has been spent on investigating the effects of oil spills and use of detergents. The effects of long-term low level input to the marine environment are much less elucidated.

Low level input of hydrocarbons into coastal areas may originate from domestic or industrial waste water, oil refinery effluents, run-off from industrial and residential areas, and small spills on land and in harbours.

This study represents the first step in a project concerning chronic oil pollution undertaken by the Marine Pollution Laboratory, Denmark. Results from previous studies on this subject in the area concerned which have not been internationally published, are also included.

MATERIALS AND METHODS

In a series of Danish coastal localities, samples of surface sediments (top cm) were taken from R/V Martin Knudsen and samples of blue mussels, Mytilus edulis, were collected by SCUBA diving, in the period January to May, 1980.

Sediment samples were taken with a HAPS core sampler (KANNEWORFF & NICOLAISEN 1973) with stainless steel tubes, stored in alufol beakers, and immediately frozen. All equipment was washed in acetone prior to each sampling. Mussels were frozen in alufol beakers shortly after sampling.

The samples were thawn immediately before analysing. Mussels were opened and placed on edge for 5 min to allow the intrashell water to drain. Soft parts were cut out and homogenized in a blender.

Dry weight was determined after drying at 105°C to constant weight. Loss after ignition was determined by weighing after 2 h at 550°C.

Five to ten g of homogenized mussel flesh was dried with sodium sulphate and extracted with 500 mL n-pentane in a Soxhlet apparatus for 16 h. The pentane was removed in a rotating evaporator. The sample was dried at 60°C for 0.5 h, and lipid content was determined by weighing.

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After homogenization, the sample was saponified by boiling for 2 h in 4% methanolic KOH (MeOH-H_2O, 9:1). If solid material was present the sample was vacuum filtered. The sample was extracted twice with 50 mL pentane, and the extract was dried over sodium sulphate for 1 h. The ectract was concentrated under reduced pressure and transferred to a column of 5 g Al_2O_3 and 5 g SiO_2 which had been activated over-night at 250 and 120°C, respectively, and deactivated with 5% water. The extract was eluated with 40 mL pentane + toluene (4:1), and the eluate was evaporated in a vacuum rotation evaporator. Analyses of total hydrocarbon content (C_{12}-C_{36}) were performed on a gas chromatograph with a flame ionization detector, oven temperature 85-275°C, 4°/min, gasflow (N_2) approx. 30 mL/min. An oil standard mixture of known concentration was used to determine detector response per unit weight.

TABLE 1. Total hydrocarbon content in mussels Mytilus edulis and surface sediments from Danish coastal areas.

Locality (See fig. 1)	Possible sources	Hydrocarbon content, range	
		Mussels, mg/g lipid	Sediments, mg/kg dry matter
1 Kalundborg Fjord	ABEG	12 - 19	86 - 390
2 Northern Sound	CEF	0.5 - 5.8	5 - 60
3 Hjelm Dyb	D	1.2 - 1.3	2 - 6
4 Aarhus Bugt	BCE	3.7 - 13	16 - 110
5 Great Belt	ABG	7.5 - 10	12 - 43
6 Limfjorden	BCE	5.2 - 6.3	58 - 150
7 Little Belt[a]	A	0.9 - 2.9	n.a.
8 Baaring Vig	n.d.	0.2 - 0.6	14 - 76
9 Arkona Bassin	n.d.	n.a.	54
10 The Sound at Copenhagen[b]	BCEF	11 - 47	46 -1800
11 Aabenraa Fjord[c]	DEG (minor leakage from ship)	1.1 - 8.1	n.a.
12 Ho Bugt[d]	BCE	n.a.	6 - 31

A: refinery effluent. B: harbour oil. C: wastewater from an industrial town. D: wastewater from town wothout industry. E: run-off from built-up areas. F: heavy ship traffic. G: power plant effluent. n.d.: no direct source. n.a.: not analysed. a: including figures from VANDKVALITETSINSTITUTTET, 1978a. b: from same, 1977 & 1978b. c: from same, 1979. d: from same, 1980.

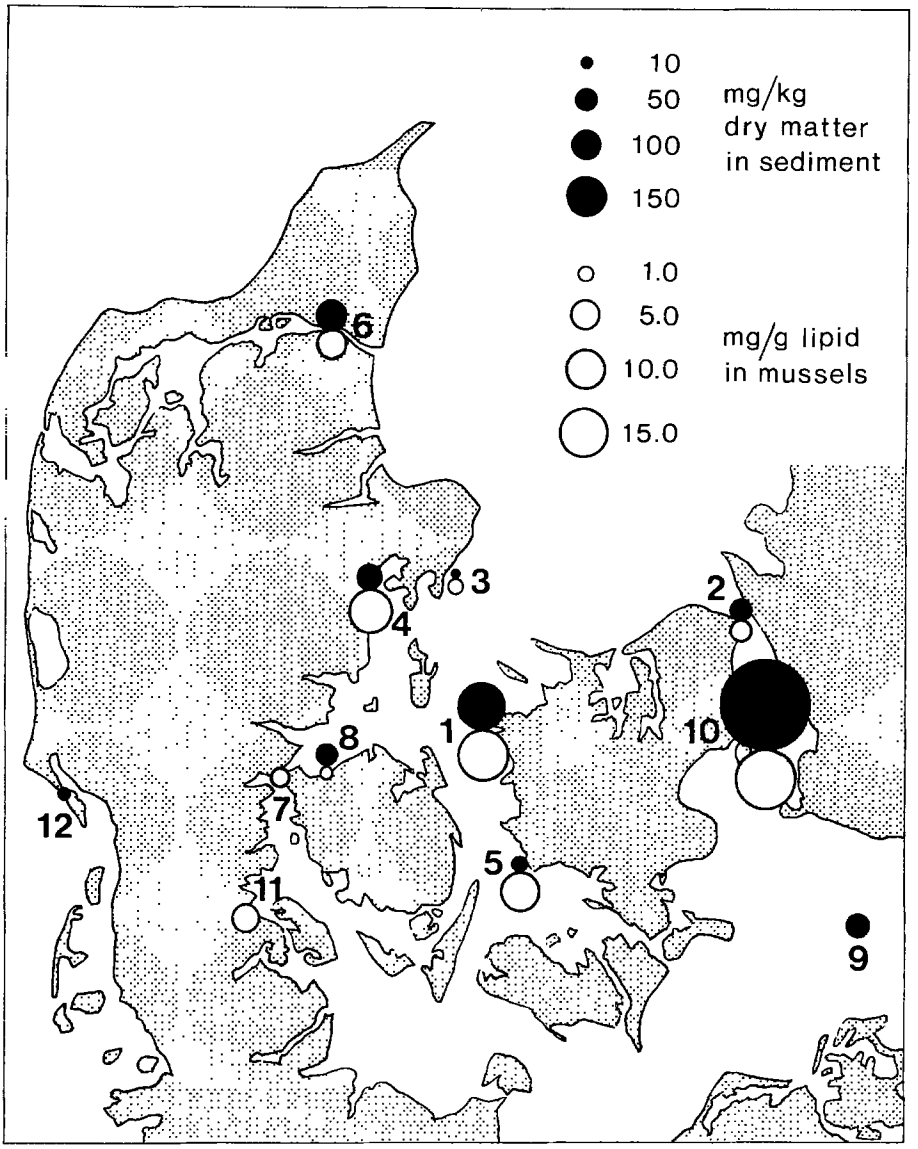

FIGURE 1. Mean concentration of hydrocarbons in mussels Mytilus edulis and surface sediments from Danish coastal areas.

RESULTS AND DISCUSSION

Results of the present study are compiled in Table 1 and Figure 1. The levels of hydrocarbons in surface sediments fall within two orders of magnitude. The highest levels are found in areas close to the largest towns, areas 4,6 and 10, or close to an oil refinery, area 1. It has been shown that in some coastal areas emission of wastewater may be the largest source of hydrocarbons (VAN VLEET & QUINN 1977,1978). In an Australian locality BURNS & SMITH (1977) have shown that industrial wastewater is the main source, and the content of oil in industrial effluents may be considerable (JØRGENSEN et al. 1976). The present study also indicates that the major source of hydrocarbons in Danish coastal areas is industrial wastewater as the highest levels of hydrocarbons in the sediments are found in areas where most industrial wastewater is emitted.

The study includes three areas which are loaded with refinery effluent. The levels in the three sites, areas 1, 5 and 7, differ significantly. Comparison should be made on the basis of levels in mussels, as the areas have very different current conditions which influence the sediment results. The very low levels in area 7 may be explained by the fact that the oil harbour in this refinery is situated far from the wastewater outflow. The activities in an oil harbour may result in many minor oil spills. DUDLEY (1976) has estimated that in an English oil harbour, spills occurred in 2% of the operations, and HANSEN et al. (1978) have observed increased levels of hydrocarbons in mussels and sediments several kilometers from an oil harbour in Greenland.

Hydrocarbons which are discharged into marine areas tend to associate to suspended solids (VAN VLEET & QUINN

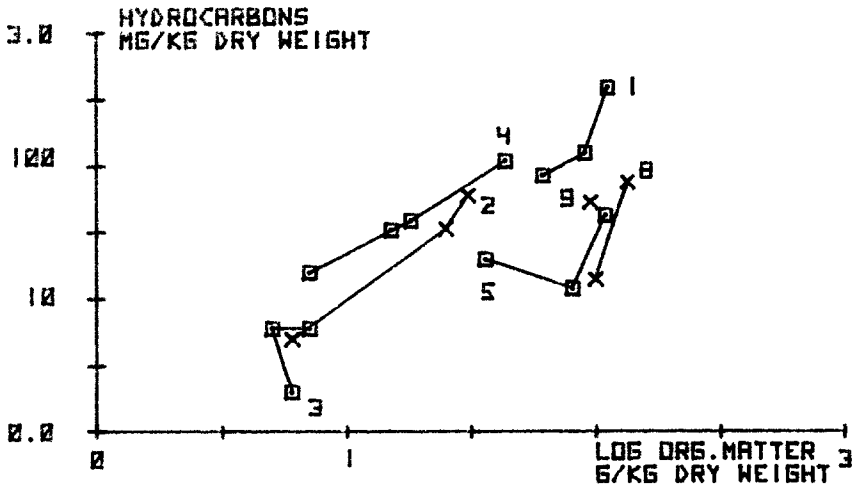

FIGURE 2. Correlation between loss at ignition and hydrocarbon content in surface sediments.

1977). Low level input of oil very often take place in areas with a great load of organic matter. Hence hydrocarbons are expected to be accumulated in areas with sedimentation of organic matter. Within one locality a certain correlation between the hydrocarbon content and the loss at ignition is recognizable (see fig. 2), and this also explains the high levels in sediments in the two areas 8 and 9 which have no direct sources of hycrocarbons.

The present study shows that low level input of oil into Danish coastal areas may lead to situations of chronic oil pollution resulting in high levels of hydrocarbons in mussels and sediments, especially in areas loaded with industrial wastewater, refinery effluent or small spills in an oil harbour.

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