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Aliphatic Hydrocarbon Levels in Turbot and Salmon Farmed Close to the Site of the *Aegean Sea* Oil Spill

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After the *Andros Patria* oil spill, the most serious oil tanker accident to occur off the coast of Galicia (N.W. Spain) was the running aground and subsequent conflagration of the *Aegean Sea* supertanker outside the northern Spanish port of La Coruña (December 3rd 1992). Approximately 60,000 tonnes of Brent oil were spilled into the Atlantic Ocean in the cited coastal region. Subsequently, au impropitious combination of a high tide and a change in wind direction caused the resulting slick to rapidly spread into the port. Measures aimed at cleaning up affected areas and evacuating the ca. 11,215 tonnes of oil remaining in the supertanker were immediately implemented. However, within just a few days the resulting contamination had killed some 15000 turbot juveniles and larvae, which are cultivated in fish farms close to the accident site. The enviromnental impact of major oil spillages has been widely studied (Atlas et al. 1981; Blackman and Law 1981; Burns and Knap 1989). Several scientist have suggested that, in terms of the negative effects on the seawater quality and productive capacity of the affected maritime regions, the magnitudes of the *Aegean Sea* and *Amoco Cadiz* accidents are comparable.

In this work we report variations over time of aliphatic hydrocarbon levels in turbot (*Scophthalmus maximus* L.) and Atlantic salmon (*Salmo salar*) sampled from fish farms close to the site of the *Aegean Sea* oil spill (Fig. 1).

MATERIALS AND METHODS

In the course of the ca. two year study, twenty fish of each species

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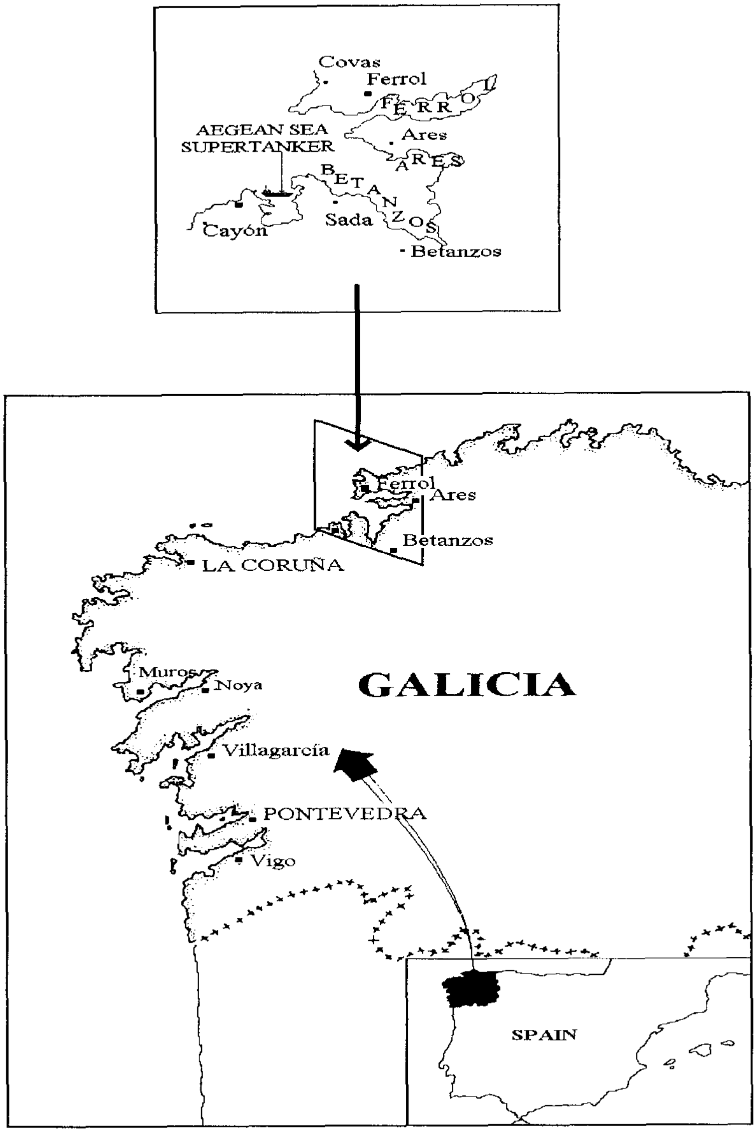

Figure 1. Map showing the location of grounded Aegean Sea Supertanker

were collected and immediately frozen (-18° C) pending analysis. Subsequently, muscle tissues were thawed and homogenized, and a subsample of 25 g of homogenate was dried in an oven for 24 hr (40° C) and then extracted with 1:1 hexane/dichloromethane (200 mL) in a Soxhlet apparatus. The extracts were allowed to cool dried (anhydridous sodium sulphate), transferred to a Kuderna-Danish type evaporative concentrator, concentrated to a volume of 1 mL and cleaned up on Sep-Pak® Florisil minicolumns prior to determination of the hydrocarbons by gas chromatography with flame ionization detector and Alltech RSL-200 capillary column (for full details of sample preparation and chromatographic analysis, see Hermida et al. 1993).

Aliphatic hydrocarbons were identified on the basis of both absolute retention time and relative retention time with respect to C_{18} in the FID trace. Quantification was relative to an external standard, as usual when complex samples are analyzed.

RESULTS AND DISCUSSION

Prior evaluation of the organoleptic properties of the fish samples indicated a strong mineral oil flavour in all the salmon samples and in the turbot collected in April 1994.

Figure 2 shows the chromatogram corresponding to turbot sampled in January 1993. This chromatogram and that of extracts of salmon collected in the month following the oil spill both include a peak envelope due to unresolved low molecular weight hydrocarbons (< C_{18}), which are a major component of Brent oil. Additionally, eight hydrocarbons of molecular weight > C_{18} were resolved and determined; for all samples, Table 1 lists the concentrations of these

Table 1. Levels of eight aliphatic hydrocarbons in turbot and salmon after the Aegean Sea oil spill (mg kg^{-1} fresh weight)

	TURBOT		SALMON			
DATE	January 93	April 94	December 92	January 93	January 94	February 94
SAMPLES	7	13	7	6	3	4
W C[a]	78.21	75.86	68.90	62.38	71.43	74.80
PRISTANE	0.78 ± 0.62[b]	0.81 ± 0.62	11.66 ± 16.49	9.75 ± 4.77	6.49 ± 1.63	4.96 ± 2.46
C_{18}	0.37 ± 0.29	0.52 ± 0.12	ND[c]	1.04 ± 0.75	0.11 ± 0.13	0.46 ± 0.14
C_{19}	0.25 ± 0.23	0.12 ± 0.06	ND	1.01 ± 0.96	0.07 ± 0.06	0.24 ± 0.13
C_{20}	0.18 ± 0.07	0.38 ± 0.13	0.98 ± 1.38	0.38 ± 0.19	0.18 ± 0.11	0.31 ± 0.09
C_{24}	0.80 ± 1.11	0.29 ± 0.17	10.29 ± 14.55	0.42 ± 0.59	0.10 ± 0.17	0.36 ± 0.02
C_{28}	0.42 ± 0.73	0.18 ± 0.12	11.04 ± 15.62	0.20 ± 0.28	ND	ND
C_{32}	0.03 ± 0.05	0.09 ± 0.04	ND	ND	0.01 ± 0.02	ND
C_{36}	0.06 ± 0.1	ND	6.55 ± 9.22	ND	0.28 ± 0.32	ND
TOTALS	24.5 ± 22.2	15.1 ± 6.9	189.6 ± 37.7	104.3 ± 49.9	36.8 ± 4.7	28.1 ± 20.9

[a]W C water content % wt/wt [b] arithmetic mean ± standard deviation. [c] not detecteable

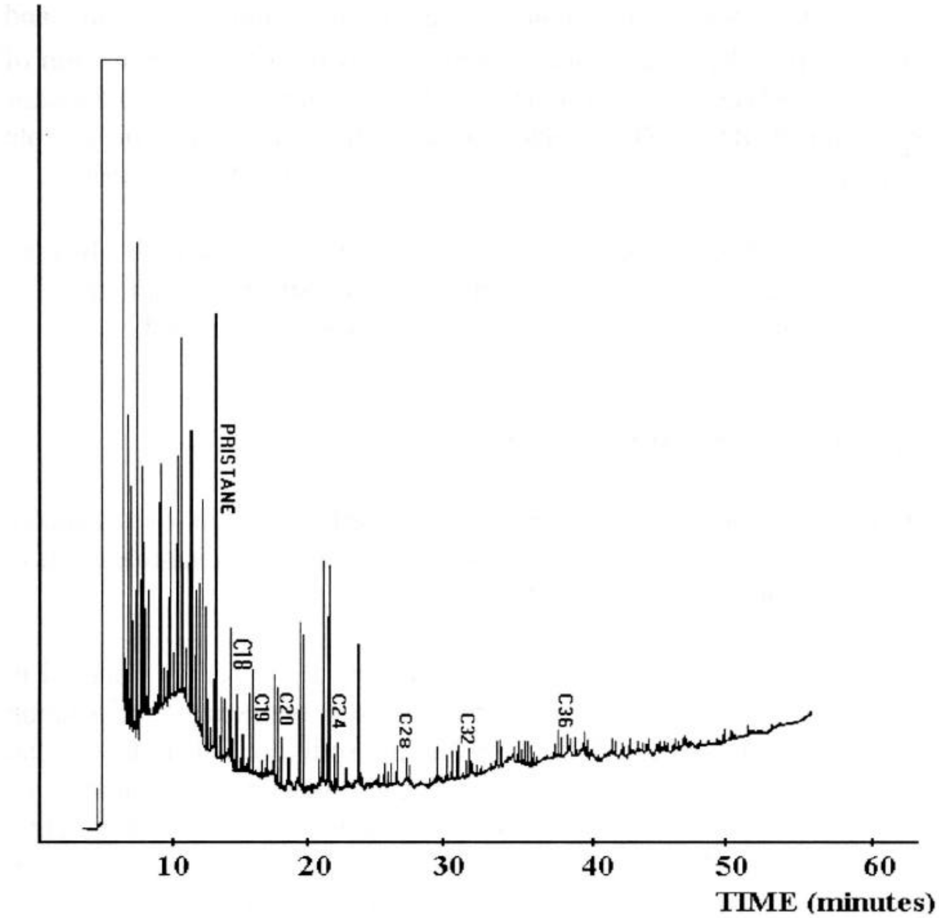

Figure 2. Gas chromatogram of turbot sample

hydrocarbons, and also the total hydrocarbon content (which includes low molecular weight hydrocarbons).

The highest hydrocarbon levels were measured in salmon collected within a few days of the oil spill (189.62 mg kg^{-1}). A month later these levels had decreased by almost half, and they continued to fall throughout the course of the study, although subsequent decreases were less marked.

The concentration of hydrocarbons in turbot collected during the month following the oil spill was considerably lower than the corresponding value for salmon (24.54 against 104.28 mg kg^{-1}). This difference could be attributable to the lower fat content of turbot, which also accounts for the lower level of hydrocarbons found in turbot compared to salmon at the end of the study (15.05 against 28.06 mg kg^{-1}).

In both species, levels of individual hydrocarbons generally decreased during the course of the study, apart from slight increases in the concentrations of pristane and C_{18}, C_{20} and C_{32} hydrocarbons in turbot, and C_{18} and C_{19} hydrocarbons in salmon.

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