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Seasonal Fluctuations of Organochlorine Compounds in the Water of the Strimon River (N. Greece)

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Organochlorine pesticides and polychlorinated biphenyls (PCBs) are among the most persistent globally distributed organic pollutants. Owing to their stability for long periods, serious environmental changes have resulted, especialy in the coastal marine environment. The uptake and accumulation of these pollutants, by planktonic organisms and fishes can introduce such compounds in the human food chain, (Macek and Korn 1970; Kerr and Vass 1973; Addison 1976).

The Strimon River (Fig.1) is one of the main rivers which discharge into the N.Aegean Sea with mean annual inflow 60 m/sec. The river originates on Mt.Scombio (Bulgaria) and flows through Lake Kerkini and the Serres plain to the Strimonikos Gulf (N.Aegean Sea).

The river has a total length of 330 Km, of which 115 Km lies in N. Greece and the remainder through Bulgaria. The water is used mainly for the irrigation of the extensively cultivated Serres plain and receives agricultural, domestic and industrial untreated wastes through a number of canals and streams.

A previous study (Kilikidis et al. 1981), which concerned the pollution of three gulfs of the N.Aegean Sea by organochlorine compounds, showed that the Strimonikos Gulf is polluted with these compounds. The Strimon River was considered responsible for this pollution.

This study aims to monitor the water pollution of the Strimon River by organochlorine compounds and the effects on mussels (Mytilus galloprovincialis) of the Strimonikos Gulf.

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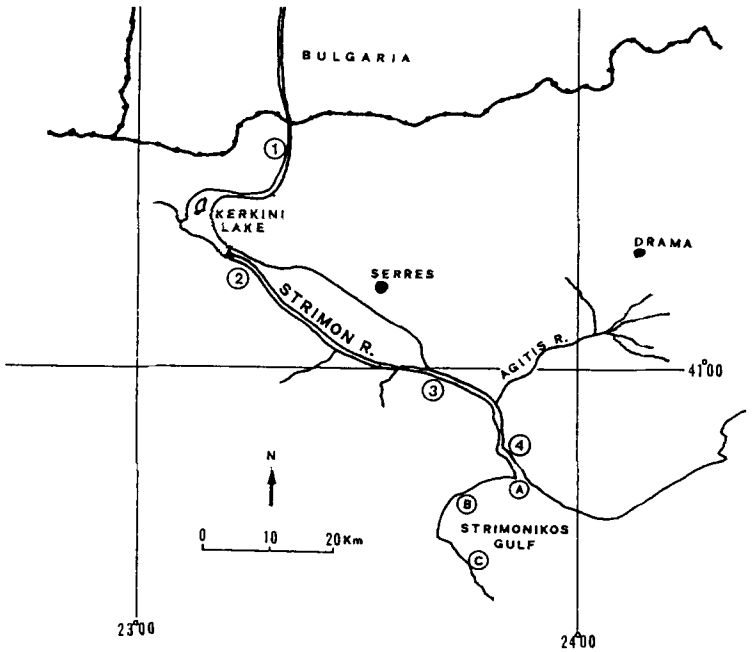

Figure 1. Map of sampling locations.

MATERIALS AND METHODS

Four sampling locations were selected along the river, for the determination of the organochlorine compounds in the water of the Strimon River,(Fig. 1).

Sampling took place monthly from Oct.1985 to Sep.1986. Five liters of water were collected, using a Van Dorn water sampler, from each sampling location in glass bottles and transferred to the laboratory for analysis, normally within 24 hr of collection.
In addition, samples of mussels were collected seasonally, using a grab from a boat, from three sampling locations (A,B,C) in the Stimonikos Gulf during the same period for the determination of organochlorine compounds in these biologi-cal indicators. About 50 mussels (shell length 4-5 cm) were taken for each sample. Mussels were placed in glass jars and held at -20°C until analysed. All the containers were prerinsed with hexane and acetone to prevent contamination.

Water samples were extracted with petroleum ether (bp 40-60 °C) and mussels were homogenized with anhydrous sodium sulfate and then Soxhlet - extracted with petroleum ether.The extractable organic matter from all the samples was then analysed by the methods of Johnson (1965), Jensen et al. (1973), Bernhard (1976) and U.S.

Environmental Protection Agency (1986).

For the identification and quantification of organochlorine compounds a gas - chromatograph (Perkin Elmer, Beaconfield U.K., Model F 11) with electron capture detector (^{63} Ni) was used.

The glass column (2m x 2 mm i.d.) was packed with 15% QF-1 and 10% DC-200 on Chromosord W. (80-100 mesh). Operation conditions were as follows:
a) Temperatures: Detector and injector 300°C, Column 210°C.
b) Flow rate of nitrogen: 14 mL/min.

All determinations were conducted in duplicate and mean values were calculated. Organochlorine compounds were identified by comparing the retention time with that of standards, chromatographed separately or added to the samples. Blank determinations were performed to avoid contamination from the solvents. The recovery of the method was 85-97% for all the organochlorine compounds.

RESULTS AND DISCUSSION.

The concentrations of organochlorine compounds found in the water of the Strimon River are given in Table 1. Of the compounds sought (hexachlorobenzene, lindane, aldrin, dieldrin, heptachlore, heptachlore hepoxide, p,p'DDT, p,p'DDD, p,p'DDE and PCBs), only HCB and lindane were found from Oct. 1985 to Sept. 1986 and aldrin from Jan. 1986 to April 1986. The fluctuations of the organochlorine compounds detected in the water of the Strimon River are shown in Fig. 2.

Table 1. Mean concentrations of organochlorine compounds in water of Strimon River (ng/L)

	HCB				LINDANE				ALDRIN			
Date	1	2	3	4	1	2	3	4	1	2	3	4
10/85	0.9	1.8	1.3	1.1	1.3	2.6	1.7	1.2	-*	-	-	-
11/85	2.1	2.2	2.2	1.5	3.4	4.5	6.7	7.7	-	-	-	-
12/85	1.8	2.1	2.4	2.2	4.6	6.3	7.8	7.9	-	-	-	-
1/86	1.3	1.0	0.8	1.2	1.8	2.3	1.6	3.4	5.8	5.0	5.3	4.2
2/86	0.9	1.2	1.0	1.8	1.3	2.4	2.4	3.6	5.9	5.0	5.8	6.6
3/86	1.1	1.5	1.6	1.5	2.1	2.3	5.1	8.2	15.3	12.0	12.4	15.4
4/86	1.3	1.8	1.7	1.6	11.0	12.6	11.8	12.1	8.8	9.7	10.2	14.2
5/86	2.4	2.0	1.9	2.8	10.8	10.5	11.0	11.3	-	-	-	-
6/86	2.2	2.5	3.0	2.0	9.0	3.0	3.1	2.3	-	-	-	-
7/86	1.4	1.0	0.8	1.2	4.6	2.1	2.3	2.8	-	-	-	-
8/86	0.9	1.0	0.8	0.9	1.2	0.6	0.4	0.5	-	-	-	-
9/86	1.0	0.8	0.5	1.0	0.6	0.4	0.3	0.7	-	-	-	-

* Below detection limit (<0.9 ng/L)

The presence of organochlorine pesticides in the water of the Strimon River indicates the agricultural origin of the river's pollution. This is confirmed by the increase in the concentrations of these substances in periods of increased agricultural activity. The presence of aldrin in the water of the Strimon River is surprising, since the use of this pesticide has been forbidden in Greece since 1972. It would appear that its use has continued unofficially, or that the substance is brought by the flow of water from the neighboring country. The second explanation seems more likely, considering that the substance was detected in the water of the river only in the winter period. Furthermore, at the beginning of this period the concentration of aldrin was higher at the sample location 1, near the Greco-Bulgarian border, than at sampling location 4, near the mouth of the Strimon River; whereas at the end of the period the reverse was true.

The presence of the industrially - related substances polychlorinated biphenyls in the water samples of the Strimon River was not detected. This was confirmed by

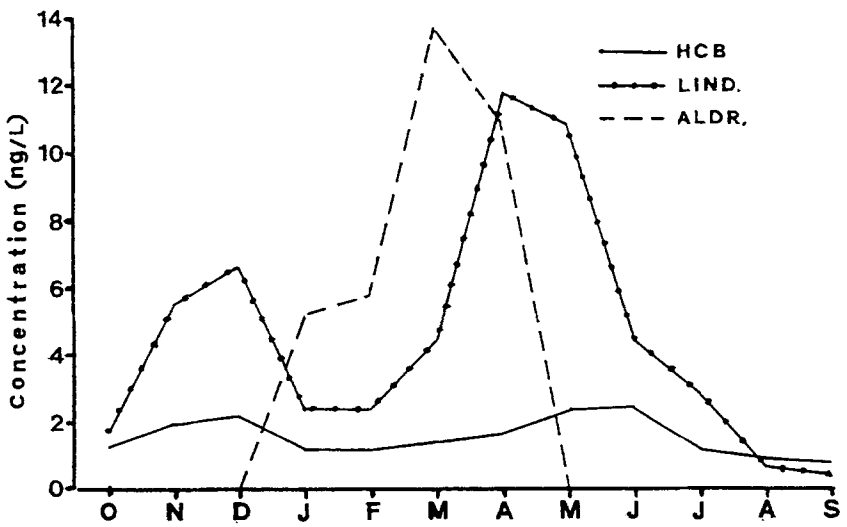

Figure 2. Fluctuations of organochlorine compounds in water of Strimon River during Oct 1985-Sept 1986.

the absence of these compounds from mussels caught in the Strimonikos Gulf. This finding disagrees with the previous research data of Kilikidis et al. (1981), which indicated that the Strimonikos Gulf was polluted by PCBs. The absence of PCBs from both water samples and mussel samples clearly shows that pollution by these substances of the Strimonikos Gulf and presumably of the Strimon River, has decreased. Comparison of these results with those of the previous study by Ki-

likidis et al. (1981) shows reduced pollution of mussels in the Strimonikos Gulf by organochlorine pesticides (Table 2). This must be attributed to the fact that the use of certain pesticides (e.g., DDT) is now forbidden. However, the presence of the widely - used lindane is significant.

Table 2. Mean concentrations of organochlorine compounds in mussels of Strimonikos Gulf (ng/g w.w.)

Organochlorine compounds	Sampling Stations			Previus study*
	A	B	C	A
HCB	1.7	1.9	0.5	2.0
LINDANE	1.3	1.1	0.4	0
ALDRIN	0	0	0	0.7
p,p'DDT	5.0	4.0	1.6	6.0
p,p'DDD	6.0	3.8	2.6	7.0
p,p'DDE	6.7	3.3	2.1	8.0
PCBs	0	0	0	261.0

* Kilikidis et al (1981)

The presence of both HCB and lindane in the mussel samples as well as in the water samples shows the influence of Strimon River on the pollution of the Strimonikos Gulf. Indeed, in the mussel samples collected from areas further from the mouth of Strimon River (sampling locations A and C), the concentrations of HCB and lindane were smaller than they were in those from near the river mouth (sampling location A).

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