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Seasonal Variations in the Organo-chlorine content of Shrimps and Oysters

by

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INTRODUCTION

Since 1966 the Burnham laboratory has conducted a programme of monitoring of the levels of organo-chlorine insecticide in marine fish and shellfish. During the period January 1970 to December 1973 the programme was extended to cover polychlorinated biphenyls (PCBs) and six metals. The main purpose of the programme was to identify long-term trends in residue levels and to identify areas where higher concentrations occurred. However, in order to make this comparison, variation due to other factors must be taken into consideration. Factors which could influence the concentration found in an animal may be biological (e.g. age, reproductive cycle, etc) or environmental (e.g. temperature or rainfall). The influence of several factors has been examined and the results of some of the work have already been reported, for example seasonal changes in the pesticide content of oysters (Portmann, 1969) and variations of heavy metal levels in fish due to age (Portmann and Neall, 1973). Since 1970 work has been carried out in order to assess the seasonal variations in the pesticide and PCB content of pink and brown shrimps (Pandalus montagui and Crangon crangon). In the light of the results of this, the oyster data (Portmann, 1969) have been further examined and results of both pieces of work are considered in this paper.

METHODS

Shrimps: Samples of pink and brown shrimps were taken at fortnightly intervals during 1970, 1971, 1972 and 1973 from the estuary of the River Crouch (south-east England). A bulked sample of 50 whole shrimps of between 40 and 60 mm total length was homogenized and a

10g sub-sample then mixed with sodium sulphate. This was extracted with n-hexane and prepared for analysis, using the method developed by Holden and Marsden (1969). 50 ml of the hexane extract were evaporated to dryness and the weight of residue was used to determine the "fat" content of the sample. Pesticide and PCB analysis was by gas-liquid chromatography (GLC), using two 6 ft x $\frac{1}{4}$ inch OD glass columns containing 80-100 mesh Chromosorb W AW DMCS coated with (a) 4% DC 200 + 6% QFI and (b) 8% DC 200.

The pesticides identified were α and γ BHC, dieldrin, pp´DDE, pp´TDE and pp´DDT; the PCB standard used was Arochlor 1254 to which the GLC peaks in the shrimps bore a close resemblance.

Oysters: Samples of European flat oysters (Ostrea edulis) were taken at fortnightly intervals during 1967, 1968 and early 1969 from the estuaries of the River Crouch and its tributary the River Roach. The tissue from five oysters was bulked and homogenized and two 8g sub-samples were then mixed with sodium sulphate. Pesticide analysis was carried out in duplicate on each sub-sample, using the clean-up technique of de Faubert Maunder et al. (1964) followed by gas-liquid chromatography. The GLC columns were 4 ft x $\frac{1}{8}$ inch OD glass filled with (a) 2.5% SE 301 + 0.25% Epikote 1001 on Chromosorb G, (b) 2% Oronite Polybutene 128 + 0.2% Epikote 1001 on Gas Chrom Q.

Each sample was analysed for α and γ BHC, heptachlor epoxide, aldrin, dieldrin, endrin, pp´DDE, pp´TDE and pp´DDT. Of these aldrin and heptachlor epoxide were not recorded as being present, and endrin occurred in only a few samples from the River Roach and then only at very low concentrations.

RESULTS

The results of the pink shrimp survey are shown in Fig. 1. For much of the time the fat and organo-chlorine concentrations follow a similar pattern throughout the year, and both reach a peak during July. However, atypical peaks of fat content occurring in the autumn are not always reflected in the organo-chlorine content. A similar increase in fat content during the summer has been noted in pink shrimps from the Wash (Warren, 1972) and is thought to be due to a combination of factors, including egg-laying and moulting. It is well known that organo-chlorine compounds concentrate in fatty tissue, and

the rise in pesticide and PCB in shrimps is almost certainly linked directly to the increase in fat levels.

A similar relationship between fat and organo-chlorine content was noted in brown shrimps but the levels were much lower and did not show any regular seasonal variation (Fig. 2). No seasonal peak is evident in fat concentration, probably because brown shrimps spawn all the year round. The yearly range and mean of fat and organo-chlorine compounds in both pink and brown shrimps are shown in Table 1. The lower concentrations found in brown shrimps may well be linked to the lower fat content.

Fig 3 summarizes the oyster data, and here peaks of organo-chlorines often occur in June/July and November/December, although they are not as striking as those found in the case of pink shrimps. Unfortunately, no fat determinations were carried out on the oyster samples, but an attempt has been made to link the peaks to biological changes which could affect the pesticide concentration. Butler (1966) found that much of the DDT in oysters was stored in the gonad, which has a high fat content. Spawning in the east coast Ostrea edulis occurs in June/July (Orton, 1933), and it seems that the summer peak of organo-chlorines could well be associated with egg and sperm production and that the subsequent drop could be due to spawning. The winter peak is more difficult to explain. Walne (1970) studied seasonal changes in the condition of Ostrea edulis from the River Roach. He found that the dry meat condition index reaches a peak during September, but this does not explain the winter peak for pesticide which occurs in November/December. It is possible that fat resources may be built up in the late autumn after spawning, and that these are utilized during the winter months when food organisms are absent.

CONCLUSIONS

From this study the seasonal variations in organo-chlorine levels found in pink shrimps and oysters appear to be attributed solely to natural factors. Pesticide spraying of crop lands adjacent to the estuary does not explain the seasonal variation, because most of the pesticides identified are no longer in use in the U.K. and, moreover, the PCB concentration seems to follow the same trends as the pesticides.

In addition, if seasonal variations were due to crop spraying, then increases in concentration would occur at the same time and to the same extent in each species.

Levels of all organo-chlorine substances found in both shrimps and oysters were generally low and no trend in mean levels could be detected over the period 1970-1973. The results of these investigations and of the previous work on metal levels in fish (Portmann and Neall, 1973), all demonstrate seasonal changes related to biological factors; the results thus emphasize the need to consider natural factors when investigations are made to determine short- and long-term trends of accumulation.

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Table 1 Yearly range and mean values (in parentheses) for organo-chlorine pesticide, PCB and fat in pink and brown shrimps from the River Crouch (all except fat in parts/10⁹ on a wet weight basis).

Year	α BHC	γ BHC	dieldrin	pp´DDE	pp´TDE	pp´DDT	PCB	%fat
	Pink Shrimps							
1970	<1.0 - 7.0 (<3.0)	<1.0 - 4.0 (<2.0)	<1.0 - 29.0 (<5.0)	<1.0 - 13.0 (<3.0)	<1.0 - 19.0 (<4.0)	<1.0 - 9.0 (<5.0)	<50.0 - 200.0 (<82.0)	<0.2 - 2.4 (<0.9)
1971	<1.0 - 6.0 (<2.0)	<1.0 - 7.0 (<2.0)	-	4.0 - 22.0 (12.0)	2.0 - 15.0 (7.0)	<2.0 - 6.0 (<3.0)	89.0 - 300.0 (200.0)	<0.2 - 3.0 (<1.1)
1972	<1.0 - 3.0 (<2.0)	1.0 - 3.0 (2.0)	<1.0 - 7.0 (<5.0)	5.0 - 20.0 (12.0)	<1.0 - 9.0 (<5.0)	<1.0 - 4.0 (<2.0)	64.0 - 280.0 (170.0)	0.2 - 2.4 (1.1)
1973	<1.0 - 3.0 (<2.0)	1.0 - 6.0 (2.0)	<1.0 - 9.0 (<5.0)	5.0 - 22.0 (11.0)	<1.0 - 9.0 (<4.0)	<2.0 - 6.0 (<3.0)	74.0 - 240.0 (160.0)	<0.2 - 2.4 (<1.2)
	Brown Shrimps							
1970	<1.0 - 4.0 (<1.0)	<1.0 - 6.0 (<2.0)	<1.0 - 3.0 (<1.0)	<1.0 - 4.0 (<1.0)	<1.0 - 5.0 (<2.0)	<1.0 - 7.0 (<2.0)	<1.0 - 110.0 (<36.0)	<0.2 - 1.7 (<0.4)
1971	<1.0 - 3.0 (<1.0)	<1.0 - 4.0 (<2.0)	-	<1.0 - 5.0 (<2.0)	<2.0 - 3.0 (<2.0)	<2.0 - 4.0 (<3.0)	<24.0 - 44.0 (<31.0)	<0.2 - 0.6 (<0.4)
1972	<1.0 - 3.0 (<1.0)	<1.0 - 4.0 (<2.0)	<1.0 - 3.0 (<1.0)	<1.0 - 7.0 (<3.0)	<1.0 - 6.0 (<2.0)	<1.0 - 4.0 (<2.0)	<17.0 - 48.0 (<29.0)	<0.2 - 1.0 (<0.5)
1973	<1.0 - 2.0 (1.0)	<1.0 - 3.0 (<2.0)	<1.0 - 4.0 (<1.0)	<1.0 - 5.0 (<3.0)	<1.0 - 3.0 (<2.0)	<1.0 - 3.0 (<2.0)	<15.0 - 43.0 (<21.0)	<0.2 - 1.2 (<0.7)

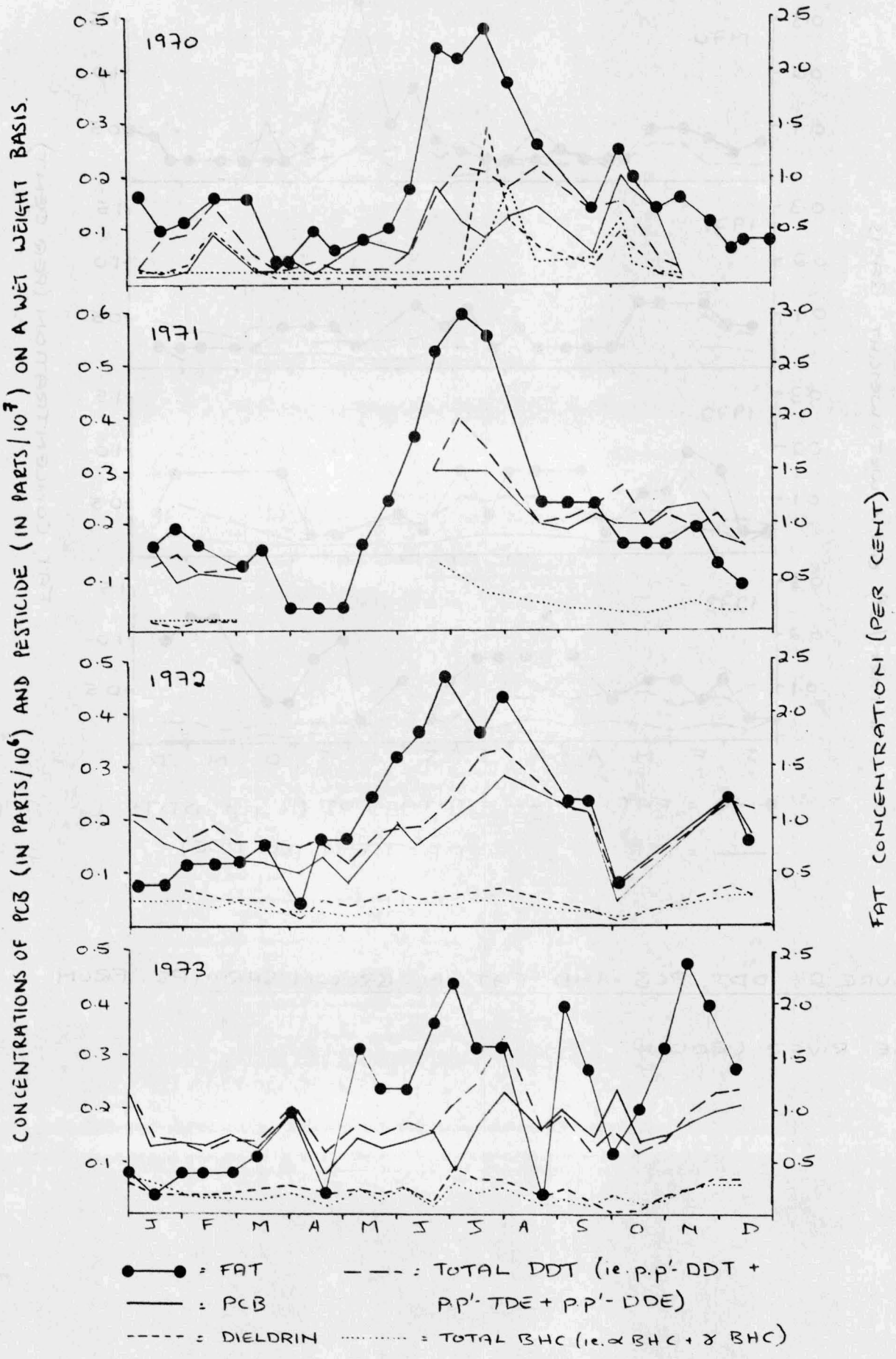

FIGURE 1: ORGANO-CHLORINE PESTICIDE, PCB AND FAT IN PINK SHRIMPS FROM THE RIVER CROUCH.

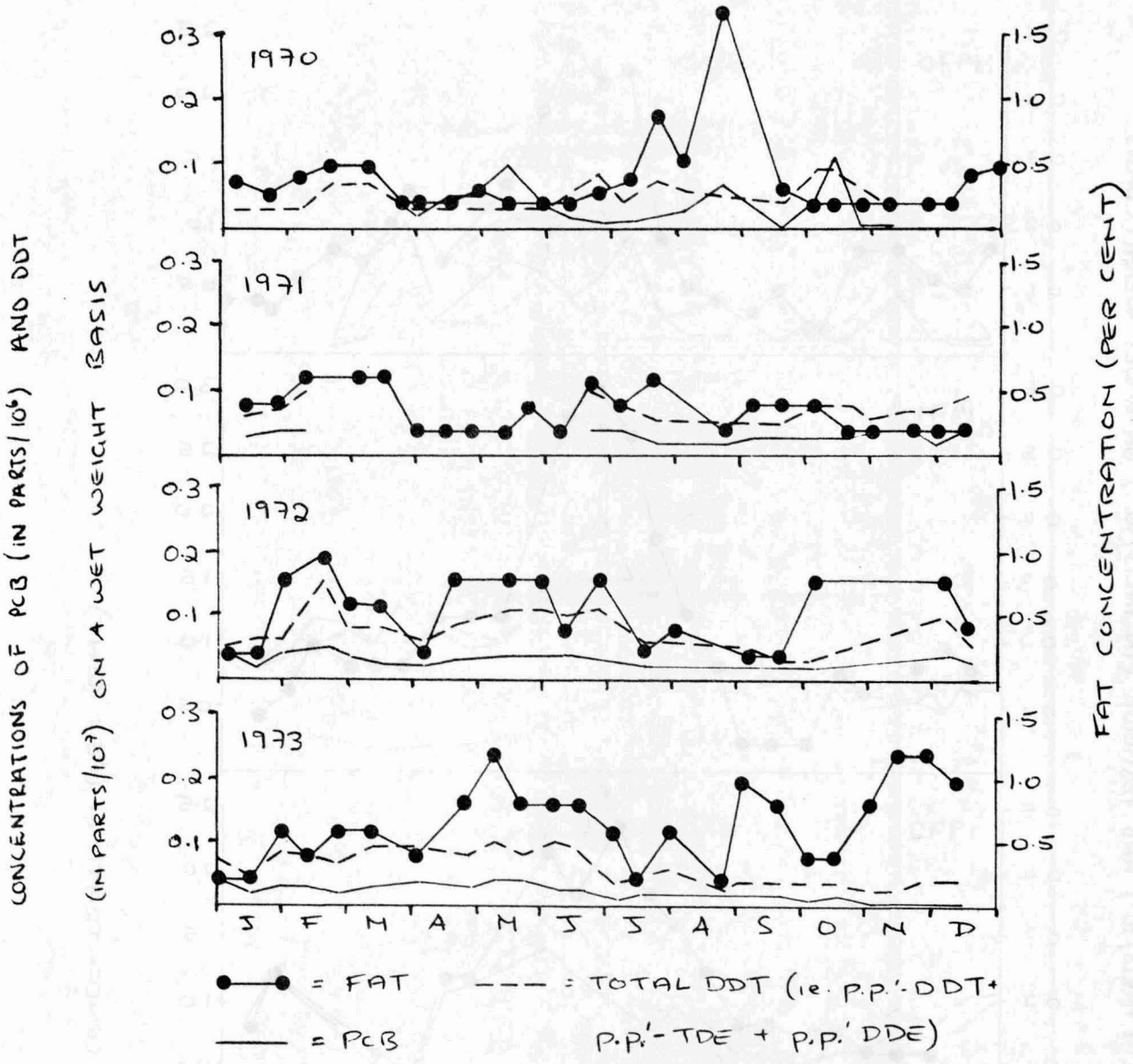

FIGURE 2: DDT, PCB AND FAT IN BROWN SHRIMPS FROM THE RIVER CROUCH

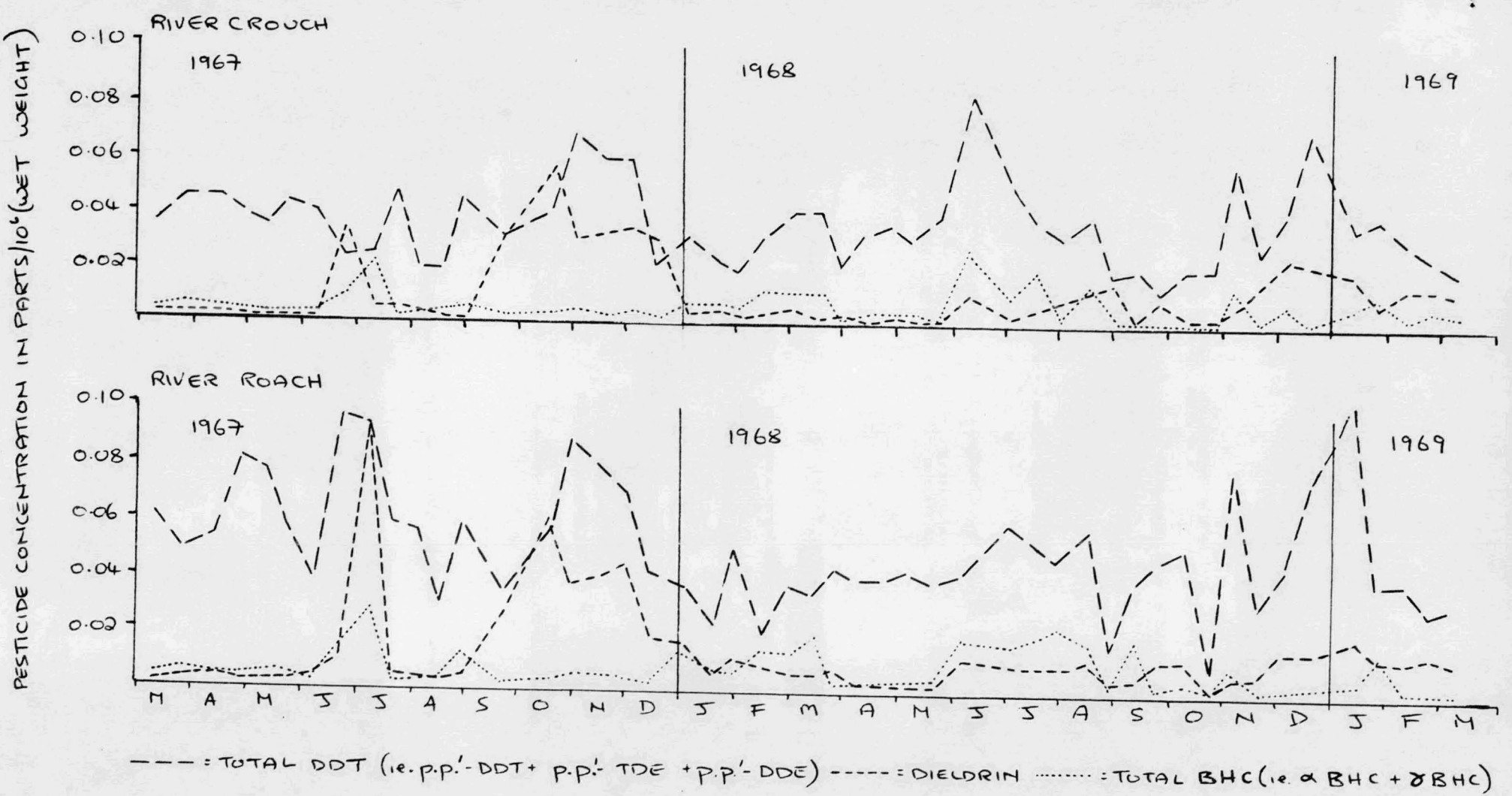

FIGURE 3: ORGANO-CHLORINE PESTICIDES IN EUROPEAN FLAT OYSTERS FROM THE RIVERS ROACH AND CROUCH