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Polychlorinated Biphenyl (PCB) Congeners in Mussel and Other Mollusc from Da Chen Island, East China Sea

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Polychlorinated biphenyls(PCBs) are among the most persistent and toxic pollutants in environment. Determination of these contaminants in fish, shellfish and other mollusc is very important, not only because these aquatics are important food for mankind, but also because they can bioconcentrate contaminants preferentially in their adipose tissue, and serve as biomarker of the aquatic pollution. Mussels and oysters have been widely used to monitor the pollution in the coastal environment (Goldberg,et al, 1978; Nicholson,et al, 1994; Botello,et al, 1994). The aim of this study was to investigate the concentrations and the main source of PCBs in mussels and other mollusca from the coastal areas of East China Sea.

MATERIAL AND METHODS

Three stations, one (A) at the Da Chen Island, another (B) close to the mouth of river, which flows into the sea, the station (C), in the fresh water river flowing into the bay, were investigated (Figure 1). The samples were collected in November, 1992. The organisms were separately wrapped in aluminum foil previously cleaned with acetone. All samples were transported to the laboratory frozen until analysis.

The solvents used were distilled in all-glass still. Basic alumina was heated at 600°C for 6 hours, cooled and deactivated with 2% water. Silver nitrate modified silica gel was prepared according to the literature (Lamparski, 1979).

The PCBs concentrations were determined according to the modified method developed in our laboratory. The samples (about 20 gram) were ground, homogenized and saponified with 20 ml ethanol and 20 ml H2O/ 10 g KOH for 1 hour. After saponification 20 ml water was added

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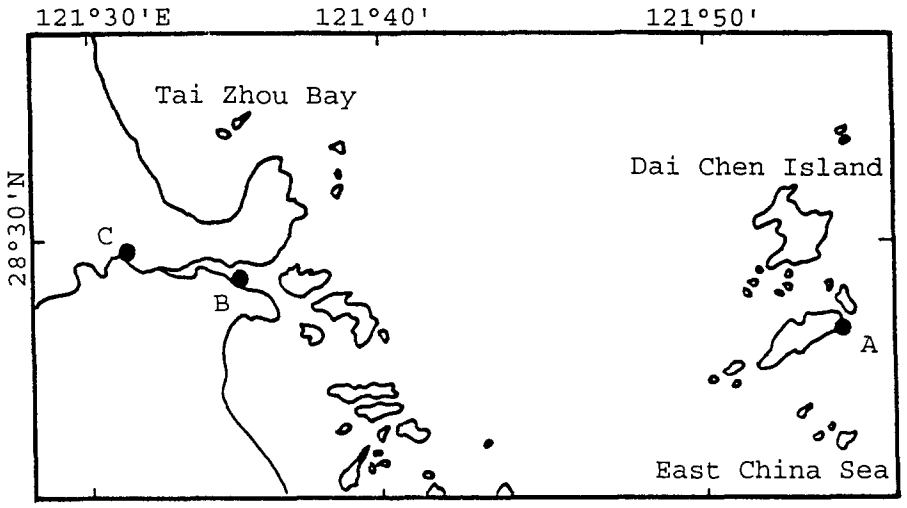

Figure 1. Location of sampling stations

to the solution and the mixture was extracted with hexane. The extract was then concentrated in Kuderna-Danish apparatus to about 2 ml. Direct treatment of fat containing extracts with concentrated H2SO4 was employed for removal of lipids at the first step. The sample solution was shaken with concentrated H2SO4 in a test tube, and then the sulfuric acid layer was discarded. This treatment should be repeated several times until the hexane layer was clean. The PCBs fraction was cleaned up in the second step with column chromatography using a glass column of 300 x 11 mm I.D., in which deactivated basic alumina and modified silica gel were successively packed with hexane and 1 g anhydrous Na2SO4 was placed at the top. During the sample analysis, the first 20 ml hexane eluate was discarded,and then 100 ml of eluate was collected and concentrated to 0.2 ml for gas chromatographic determination.

The PCBs fraction was analyzed by capillary gas chromatography and electron capture detection in Varian 3740 gas chromatograph, connected to Shimadzu C-R3A chromatopac. The fused silica capillary column coated with SE-54 (18 m x 0.25 mm i.d, J & W Scientific Inc. U.S.A) was connected to splitless injector. The temperatures of injector and detector were 300°C and 350°C respectively. The temperature program was 50°C initial temperature for 2 min., then increased at a rate of 4°C/min. to 280°C and held for 25 min.. Aroclor 1242 and Aroclor 1254 were used as standards, of which their weight-percent composition had been previously determined (Capel,et al. 1985) for qualitative and quantitative analysis.

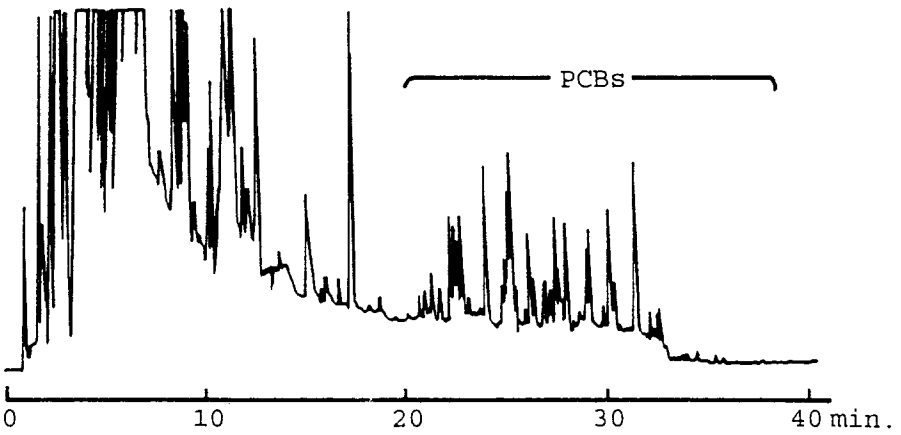

Figure 2. Chromatogram of PCBs fraction from mussel

RESULTS AND DISCUSSION

The analysis data are reported in Tables 1 with the concentration of individual congeners of PCB indicated separately on the wet weight basis. Figure 2 shows the chromatogram of PCBs fraction from mussel.

Polychlorinated biphenyls are complex mixtures of theoretically 209 congeners. Most of the earlier quantitative publications only gave values for total PCB concentration, provided that the PCB pattern in the sample was similar to that found in the commercial PCBs standard. However, it has been mentioned that this speculation would result very possibly in an erroneous report because the PCBs residues in the environmental samples can not be adequately described precisely by the commercial PCBs standard. In consideration of the toxicological differences of the components,the congener-specific analysis of environmental samples is important for a contamination perspective as well as for the study of biological, transport and transformation processes.

In this report, the total contaminant concentrations are found to be correlated with distance of sampling sites from the estuary of the river which collect wastewater from the somewhat polluted area, however, it has been found also that the distribution of individual congeners is different between the sample collected from the island and from the river. Figure 3 shows the distribution of PCB congeners with different number of substituted chlorine atoms in the three samples. The difference between the patterns of PCBs fraction from

Table 1. Concentrations (ng g-1) of PCB congeners in organisms from the investigation region

IUPAC No	A(1)	A(2)	A(3)	B(4)	C(5)
8	0.07	0.36	0.14	0.42	0.96
18+17	0.03				0.99
16+32					0.07
26					0.15
31+28	0.02			0.53	1.36
33			0.05	0.13	0.08
22		0.03	0.01	0.04	0.14
45	0.02	0.05			
52	0.14	0.28	0.29	0.76	
49	0.07	0.08	0.04		
47+48	0.04	0.08	0.05	0.28	
44	0.02	0.13	0.09	0.31	
37+42					0.37
41+64	0.01	0.08		0.45	0.41
40				0.05	0.04
100	0.01				
74	0.05	0.08			0.55
70	0.15	0.10	0.05		0.79
66	0.14	0.21	0.12		0.96
60+56	0.01				
101	0.07		0.08		
99	0.03		0.01		0.30
83	0.03		0.03		
97	0.02				
87	0.04	0.03			
85	0.03				
110	0.07	0.05			
82	0.01	0.05	0.01		
118+108	0.07	0.13	0.08	0.47	0.51
146	0.08	0.15	0.26	0.33	0.48
153	0.02	0.03	0.02	0.11	0.11
141					0.05
138	0.11	0.26	0.37	0.88	0.72
178		0.03	0.09		
175	0.01		0.07		0.05
187+159					0.05
128	0.01		0.06		0.06
185	0.01		0.01		0.03
174	0.01				
177		0.03	0.02		
180				0.03	0.09
170		0.05	0.06	0.10	0.02
Totals	1.40	2.29	2.01	4.89	9.34

(1)Mussel, (2)Grochidae, (3)Thais clauigera, (4)Batillaria cuminga, (5)Bellamya purificata

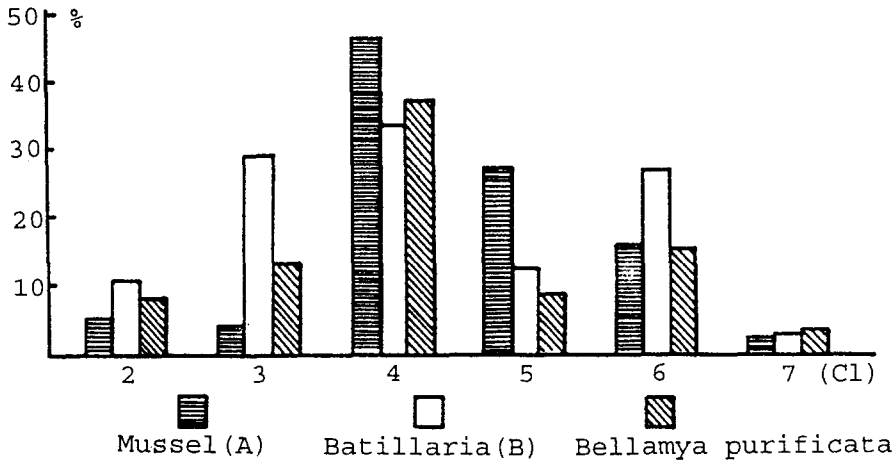

Figure 3. The distribution of PCB congeners with different number of substituted chlorine atoms in the three samples.

island and river is more obvious than that from different organisms collected at the same station(A). The concentrations of PCBs congener No.31 and 28 are obviously high. This might be related with the fact that the PCBs contaminant pollution source is similar to Aroclor 1242. The data also suggest that the PCBs contamination in the coast region is not strictly related to local sources.

Table 2. Concentration of PCBs (ng g-1 wet wt) in mussel and other mollusca from different sites

Location	Species	PCBs(ng/g)	Ref.
Spain			
Ampoll	1	1100	(Risebrough,1983)
California Coast			
Harbours	2	390	(Risebrough,1983)
Northern Coast	3	14	(Risebrough,1983)
Brazil			
Todos os Santos Bay	4	0.2-2.1	(Tavares, 1988)
China			
Dalian City	2	32.4	(Wu, 1989)
Da Chen Island	2	1.4	(This paper)

1.Mytilus galloprovincialis, 2.Mytilus edulis
3.Mytilus colifornianus, 4.Trachycardium muricatum

The production of PCBs in China began in 1966 and about 10000 tons were produced during the decade. Most of the product, which is similar to Aroclor 1242, had been

widely used as dielectric fluids in transformers and capacitors. Table 2 listed some results of investigation about mussel and other mollusca from different area.

In aquatic system, persistent lipophilic chemicals can be taken up and concentrated by aquatic organisms. Mussels are common aquatic organism suitable for testing toxicity and bioconcentration of chemicals (Geyer, et al, 1991). In comparison our result with other data, it is clear that the coast region investigated is not yet seriously polluted by PCB contamination.

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REFERENCES

Botello AV, Diaz G, Villanueva SF (1994) Organochlorine compounds in oyster and sediments from coastal lagoons of the Gulf of Mexico. Bull Environ Contam Toxicol 53:238-245

Capel PD, Rapaport RA, Eisenreich SJ, Looney BB (1985) PCBQ: Computerized quantification of total PCB and congeners in environmental samples. Chemosphere 14: 439-450

Geyer HJ, Scheunert I, Bruggemann R, Steinberg C, Korte F, Kettrup A (1991) QSAR for organic chemical bioconcentration in Daphnia, algae and mussels. Sci Tot Environ 109/110: 387-394

Goldberg D, Bowen VT, Farrigton JW, Harvey G,Martin JH, Parker PL, Risebrough RW, Robertson W, Schneider E, Gamble E (1978) The mussel watch. Environ Conserv 5: 101-125

Lamparski LL, Nestrick TJ, Stehl RH (1979) Determination of part-per-trillion concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin in fish. Anal Chem 51:1453-1458

Nicholson GJ, Theodoropoulos T, Fabris GJ (1994) Hydrocarbons, pesticides, PCB and PAH in port Phillip Bay (Victoria) sand flathad. Mar Pollut Bull 28:115-120

Risebrough RW, Delappe BW, Walker W, Simoneit BRT, Grimalt J, Albaiges J, Garcia Regueiro JA, Ballester i Nolla A, Marino Fernandez M (1983) Application of the mussel watch concept in studied of the distribution of hydrocarbons in the coastal zone of the Ebro Delta. Mar Pollut Bull 14:181-187

Schwartz TR, Stalling DL (1987) Are polychlorinated biphenyl residues adequately described by Aroclor mixture equivalents? Isomer-specific principal components analysis of such residues in fish and

turtles. Environ Sci Technol 21:72-76
Tavares TM, Rocha VC, Porte C, Barcelo D, Albaiges J (1988) Application of the mussel watch concept in studies of hydrocarbons PCBs and DDT in the Brazilian Bay of Todos os Santos (Bahia). Mar Pollut Bull 19: 575-578
Wu Shipei, Liao Hualan, Ma Yongao (1989) Study on the method of determining the residue of organochlorine pesticide and PCB in mussels by gas-chromatography. Mar Environ Sci (China). 8(3): 83-92