

CONTENTS OF POLYCHLORINATED BIPHENYLS IN *CARASSIUS AURATUS* FROM THE MAJOR RIVER SYSTEMS IN S.KOREA

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Introduction

Polychlorinated biphenyls (PCBs) are widespread toxic organic pollutants. Their persistence and lipophilicity have led to vast accumulation in the environment.¹ PCBs are used as isolators in electrical transformers and as additives in plastic and painting industries.² Because of their persistency and bioaccumulating properties, PCBs can be transported through the atmosphere and water far away from the pollution source.³ There are four major river systems in South Korea including the Han, Kum, Nakdong and Youngsan River. We selected 31 sampling sites, 21 sites from the 4 major rivers, along the various rivers in South Korea. This study presents the homolog and total PCBs levels from muscle of crucian (*Carassius auratus*).

Methods and Materials

Sampling fishes: Crucians were caught from August 1999 to April 2000 at the 31 sampling sites located along the four major rivers, several small scaled rivers and two well-known wetlands shown in Fig. 1. We caught crucians from 29 sites and failed to catch them from 2 sites. Only the muscle was separated and stored at below -20°C before analysis.

Standard Materials: Standard reference material CARP-1 was obtained from National Research Council of Canada to evaluate and to validate the procedure and recovery rates. Total 62 congeners were determined in this study including 17 coplanar congeners, 18 congeners recommended by U.S. NOAA and EPA as congeners for the estimation of total PCB levels, and other abundant 9 congeners.

Determination of PCBs levels: Freeze-dried sample was ground, put into a thimble together with an internal standard and Soxhlet extracted in 1:1 mixture of n-hexane/acetone for 16 h. The extract was dehydrated with anhydrous Na₂SO₄ and concentrated by using a rotary evaporator. It was then eluted with 120 mL of n-hexane by passing through an acid-base silica gel column, the eluent was concentrated again, and the final volume was reduced to 1 mL by purging an ultra pure N₂ gas. Identification for PCB congeners was performed by HP6890 gas chromatograph equipped with an electron capture detector (⁶³Ni) using a HP-5 column (60 m length, 0.32 mm i.d. and 0.25 μm film thickness).

Results and Discussion

The recovery rates obtained from the standard reference material CARP-1 was in the range of 84% to 133% with standard deviations ranged from 0.9 to 8.9%. Total PCBs and homolog levels in muscle are listed in Table 1. These are also illustrated in Fig. 2 and 3, respectively. The total PCBs levels ranged from 0.73 to 32 ng/g (wet weight). The average total PCBs level is 8.1±8.9 ng/g which implies large differences in the total PCBs levels by sites. The highest 6 sites show average total PCBs levels as 23±7 ng/g, which occupy 60% of the total PCBs obtained from the 29 sites. On the other hand, the other 23 sites occupy only 40% of the total PCBs with average 4.0±2.8 ng/g.

Penta- and hexa-CBs showed highest levels among the 10 homologs, and occupied 62% of the total PCBs contained in curcians. Most of the PCBs consists of from tri- to hepta-CBs, which is 97% of the total PCBs. This is a general trend of PCBs levels in fishes. Deca-, nona-, octa-, di-, and mono-CBs occupied only 0.05, 0.41, 1.1, 0.43, and 2.0%, respectively.

The Anyanang Stream (site no. 6) which is a tributary of the Han River system and the Hwangku-Tributary (site no. 29) showed the highest contamination level. Total PCBs levels, however, are much lower than that of the caged fish from the Saginaw River, MI, U.S.A., which showed 46-290 ng/g (wet weight).⁴ But it is significantly higher than that of the fresh water fishes from the coastal and riverine area in Cambodia, a developing country, which showed <0.05-1.0 ng/g (wet weight).⁵ Generally, PCBs contamination is more serious in developed nations than in developing countries. Kannan et al reported that PCB concentrations in fish were greater in developed or recently industrialized countries.⁶

Acknowledgements

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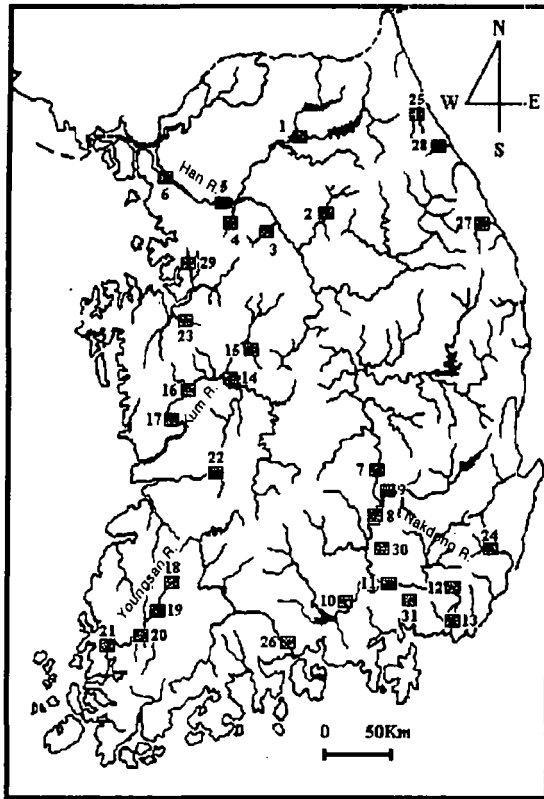


Figure 1. The 31 sampling sites in S. KOREA (126°-130° E; 34°-38° N)

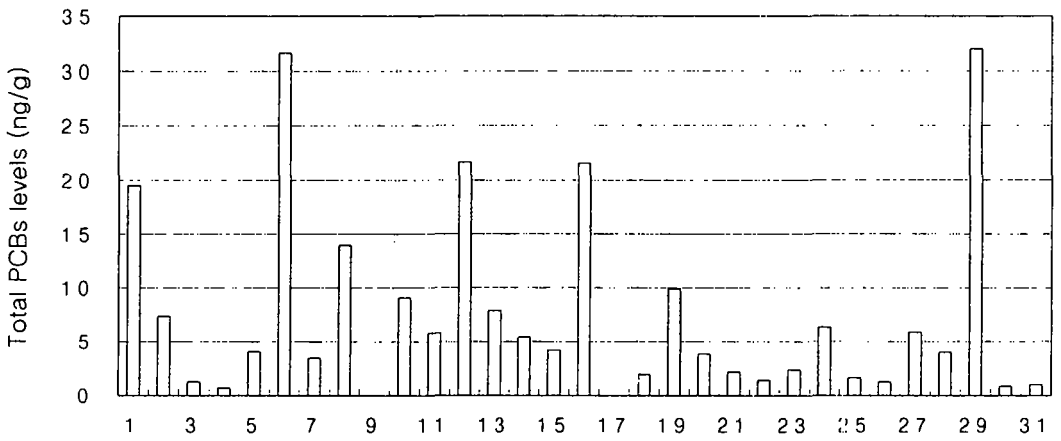


Figure 2. Total PCBs levels in the muscle of crucian. (See the location of each site in Fig. 1 and place name in Table 1.)

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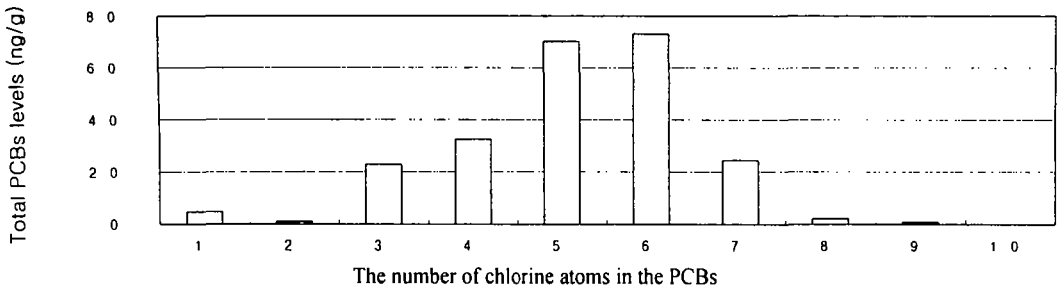


Figure 3. Total homolog levels in muscle of crucian.

Table 1. Total PCBs and homolog levels in muscle of crucian. ng/g (wet weight)

	Site No. and Name	The number of chlorine atoms in the polychlorinated biphenyls										Total PCBs
		1	2	3	4	5	6	7	8	9	10	
Han River	1 Uiam-D	0.06	nd	1.6	3.2	6.7	5.8	1.9	0.26	nd	nd	20
	2 Seom-R	0.19	nd	0.86	2.1	1.6	1.4	0.78	0.17	0.24	0.02	7.4
	3 Bokha-S	0.14	nd	0.12	nd	0.38	0.47	0.14	0.01	nd	nd	1.3
	4 Kyungan-S	nd	nd	0.04	0.01	0.29	0.39	nd	nd	nd	nd	0.73
	5 Paldang-D	0.05	nd	0.26	0.45	1.6	1.4	0.36	0.03	nd	0.02	4.2
	6 Anyang-S	nd	nd	7.8	9.8	5.1	5.8	3.0	0.18	nd	0.02	32
Nakdong River	7 Koomee	nd	nd	1.2	0.37	0.89	1.0	0.41	0.05	nd	nd	3.9
	8 Koryoung	0.20	0.20	1.2	0.88	3.1	5.4	2.8	0.20	nd	nd	14
	9 Kumho-R	* Crucian was not caught.										
	10 Nam-R	nd	nd	0.94	0.75	3.6	3.4	0.40	0.03	nd	nd	9.1
	11 Namji	nd	nd	0.07	0.53	2.0	2.2	0.89	0.10	nd	nd	5.8
	12 Moolgum	0.92	nd	1.7	2.5	4.0	6.6	4.5	0.90	0.51	nd	22
Kum River	13 Nakdong-E	0.07	nd	1.3	1.4	1.9	2.2	0.89	0.10	nd	0.02	7.9
	14 Dachung-D	0.06	nd	0.87	0.74	2.0	1.4	0.37	nd	nd	0.01	5.4
	15 Moosim-S	nd	nd	1.0	0.85	1.2	1.0	0.15	0.01	nd	nd	4.2
	16 Kongjoo	0.52	nd	nd	0.63	7.4	9.9	3.1	nd	nd	nd	22
	17 Booyeo	* Crucian was not caught.										
Youngsa n River	18 Damyang-D	0.11	nd	0.12	nd	0.63	0.89	0.20	nd	0.01	0.01	2.0
	19 Kwangjoo-S	0.07	nd	0.20	0.66	5.4	3.1	0.48	0.04	0.02	0.01	10
	20 Najoo	nd	nd	0.32	0.50	1.5	1.1	0.44	0.02	0.01	nd	3.9
	21 Mooan	nd	nd	nd	0.53	0.77	0.88	nd	nd	nd	nd	2.2
Other small scaled Rivers	22 Kosan	0.08	0.08	0.28	0.16	0.42	0.40	0.04	0.01	nd	nd	1.5
	23 Oncheon-S	0.04	nd	0.19	0.15	1.0	0.86	0.17	0.03	nd	0.01	2.4
	24 Myungchon	0.15	nd	0.05	0.14	1.3	3.0	1.6	0.12	0.01	nd	6.3
	25 Yangyang	0.26	nd	0.04	0.15	0.50	0.60	1.4	nd	nd	nd	1.7
	26 Hadong	0.08	nd	0.70	0.06	0.16	0.14	0.01	0.01	0.13	nd	1.3
	27 Samcheok	0.12	0.20	1.2	1.8	1.5	0.83	0.21	0.02	nd	nd	5.9
	28 Kangnung	0.06	0.15	nd	0.82	1.0	1.7	0.35	nd	nd	nd	4.1
	29 Hwangku-T	1.3	nd	0.66	3.2	14	11	1.7	0.19	nd	0.03	32
	Wet-lands	30 Woopo	0.17	0.33	0.11	0.09	0.14	0.06	nd	nd	nd	nd
31 Joonam		0.13	0.08	0.25	0.09	0.24	0.23	0.04	0.02	nd	nd	1.0
Total Homolog		4.8	1.0	23	33	70	73	25	2.5	0.96	0.12	230

nd: none detected. D: Dam; R: River; S: Stream; E: Estuary; T: Tributary