

Analysis of Pentachlorophenol from Water, Sediments, and Fish Bile of Dongting Lake in China

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Dongting lake is located in the south of China. The total area of the lake is about 2,740 km². The average of the lake depth is about 6-7 m, and the deepest of the lake is about 31 m. It is an important source of freshwater fish in China. However *Schistosoma japonica* prevailed in this region for a long time and sodium pentachlorophenate (Na-PCP) has been sprayed since the 1960s to control the spread of snailborne schistosomiasis. It has been estimated that at least 9.8x 10⁶ kg Na-PCP was used in this region. Although Na-PCP has been replaced by some new molluscicides in this region since 1996, the free phenol of Na-PCP, pentachlorophenol (PCP) distributes in the lake environment and accumulates in sediments. The persistence of PCP and its derivatives has resulted in serious pollution of the lake.

MATERIALS AND METHODS

Samples were taken in April 1998. The sampling locations for the study are indicated in Fig. 1. These locations are on the profiles of national or the province key monitoring areas, which can represent conditions of lake pollution. Each sample was an aliquot of the mixture from at least 3 sites of each location.

Acetylation of PCP from water was performed *in situ*. A 100-ml volume of water was transferred into a separating funnel and 1.0 g of Na₂CO₃ was added. After alkalization, 0.5 ml of acetic anhydride was added. The sample was shaken for 2 min and let stand for 10 min. Two 7.5-ml portion of hexane were used to extract the derivative. The extract was eluted through a Na₂SO₄ column to remove water. Samples were centrifuged and adjusted to an appropriate volume for injection into GC-ECD.

Sediments were collected with a grab sampler from shipboard. Samples were wrapped in aluminium foil and deep frozen until analysis, which was performed within 2 weeks. PCP in sediments were analyzed according to Eder et al. (1980).

Fish ranging from in weight between 350 g and 2,350 g were caught with gill nets on board. Bile samples were drawn from the gallbladder into syringes. All

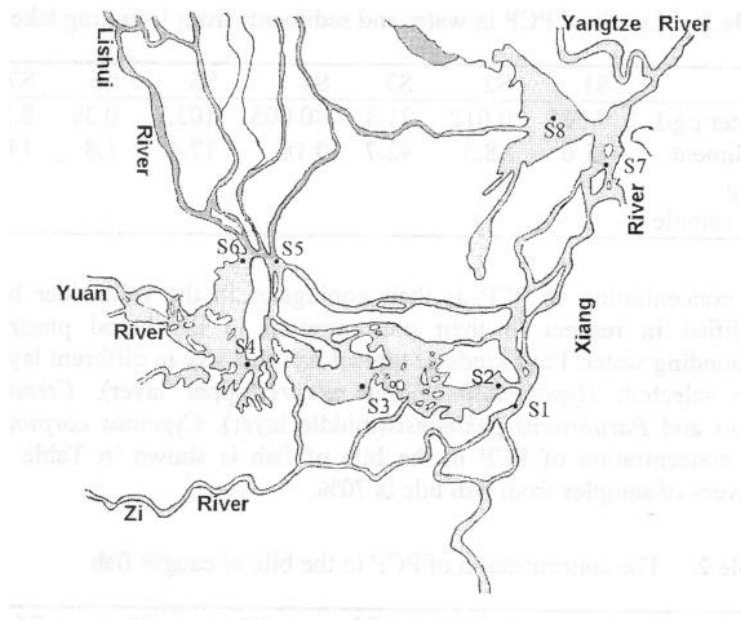


Figure 1. Locations of sampling sites at Dongting lake.

samples were stored at -20°C until analysis, which was performed within 2 weeks. PCP from fish bile was analyzed after acid hydrolysis according to Söderström et al.(1994). Before hydrolysis the internal standard(2,4,6-tribromophenol) was added.

Hitachi 663-50 GC equipped with ECD, and DB-5 fused silica capillary column(30 mx0.25 mm i.d., J&W) was used. Carrier gas was nitrogen at 20 ml/min. The column temperature was 200°C .

RESULTS AND DISCUSSION

The results of analysis of water and sediments from Dongting lake for PCP are shown in Table 1. The mean recoveries of samples from water and sediments are 94% and 87% respectively.

From Table 1, it can be see that the levels of PCP in sediments from different locations at the lake are very high. Loaded sediments may provide a source of long term pollution of the lake due to remobilization processes even after the original discharge has declined. Owing to different current velocities at different locations, the levels of PCP in water are not always proportional to that in the sediments.

Table 1. Levels of PCP in water and sediments from Dongting lake in China

	S1	S2	S3	S4	S5	S6	S7	S8
Water µg/L	0.005	0.012	71.3	<0.005	103.7	0.39	8.3	7.12
Sediment µg/g dry sample	11.6	48.3	42.7	0.18	17.4	1.8	14.3	24.8

The concentration of PCP as their conjugates in the gallbadder bile is greatly amplified in respect to their concentration in the blood plasma or in the surrounding water. Four kinds of typical fish that live in different layer of the lake were selected: *Hypophthalmichthys molitrix*(upper layer), *Ctenopharyngodon idellus* and *Parabramis pekinensis* (middle layer), *Cyprinus carpio*(lower layer). The concentration of PCP in the bile of fish is shown in Table 2. The mean recovery of samples from fish bile is 70%.

Table 2. The concentration of PCP in the bile of caught fish

	S1	S3	S4	S5	S6	S8
<i>Hypophthalmichthys molitrix</i>	ND (1.1, 3)	ND (0.8, 2)	ND (0.8, 1)	0.55 (0.8, 3)		ND (0.9, 3)
<i>Ctenopharyngodon idellus</i>	ND (1.1, 2)					0.63 (2.4, 1)
<i>Parabramis pekinensis</i>		0.34 (0.4, 3)	0.04 (0.4, 3)	0.05 (0.4, 3)		
<i>Cyprinus carpio</i>	ND (0.7, 3)	0.06 (1.0, 2)	ND (0.9, 2)	ND (0.9, 2)	ND (0.8, 2)	ND (0.9, 2)

[average weigh(kg), number of specimens]

ND: not detectable(<0.01 ng/mg).

At first sight, PCP levels in the bile appear quite arbitrary. However, there exists a positive correlation between the PCP content in the bile and in the water. PCP content in *Ctenopharyngodon idellus* bile at S8 is the highest. This can be explained by the fact that this caught fish at least lived three years long in the lake and it is the biggest and eldest one. Owing to the highest level of PCP in water at S5, the level of PCP in *Hypophthalmichthys molitrix* at S5 is much higher. Since lower PCP levels have detected in *Cyprinus carpio* bile, it is seems that PCP in sediments has little direct effects on fish.

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REFERENCES

Eder G, Weder K (1980) Chlorinated phenols in sediments and suspend matter of

weser estuary. Chemosphere 9:111-118

Soderstrom M, Wachtmeister CA, Forlin L (1994) Analysis of chlorophenolics from bleach kraft mill effluents(BKME) in bile of perch(*perca fluviatilis*) from the Baltic Sea and development of an analytical procedure also measuring chlorocatechols. Chemosphere 28:1701-1719