

PRELIMINARY HAZARD ASSESSMENT OF POLYCHLORINATED BIPHENYLS,
POLYBROMINATED DIPHENYL ETHERS, AND POLYCHLORINATED
DIBENZO-*p*-DIOXINS AND DIBENZOFURANS TO YANGTZE FINLESS PORPOISE
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Abstract—Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*), a protected endangered species, is the sole freshwater subspecies of finless porpoise, living only in the middle and lower reaches of the Yangtze River, China, and its appended lakes. Its population has decreased sharply to 1,400 because of human activities, including environmental contamination. In the present study, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) were determined in the blubber, liver, kidney, stomach, small intestine, and brains of five individual Yangtze finless porpoises collected from 1998 to 2004. The results showed PCB concentrations ranged from 0.06 to 1.89 $\mu\text{g/g}$ lipid weight in the organs and consisted mainly of penta-, hexa-, and decachlorinated biphenyls. The PBDE concentrations were between 5.32 and 72.76 ng/g lipid weight. Tetra-, penta-, and hexabrominated diphenyl ethers were the major homologues. The PCDD/F concentrations ranged from 65 to 1,563 pg/g lipid weight, and their predominant homologues were penta- and hexachlorinated dibenzofurans and hepta- and octachlorinated dibenzo-*p*-dioxins. The hazard quotients (HQs) based on toxic equivalency were determined to be greater than one in all individuals for PCBs, for PCDD/Fs, and for PCBs and PCDD/Fs. In addition, HQs would be higher if PBDEs were included. The results suggest that reduction of environmental contamination may contribute greatly to protecting this highly endangered species.

Keywords—Hazard assessment Polychlorinated biphenyls Polybrominated diphenyl ethers Polychlorinated dibenzo-*p*-dioxins/dibenzofurans Yangtze finless porpoise

INTRODUCTION

River dolphins are unique species among cetaceans in that they inhabit freshwaters. They have been threatened, however, by degradation and destruction of riverine habitat [1]. The populations of some river dolphins are rapidly declining and endangered [1]. Apart from habitat destruction, chemical pollution also has been a serious threat to the health of river dolphin populations ([2,3]; <http://www.onefish.org/servlet/CDSServlet?status=ND02NDA1LjgzODMmNj11biYzMz1kb2N1bWVudHMmc2hvd0NoaWxkcmVudXRYdWUuMzc9aW5mbw~#koinfo>). Some river dolphins are regarded as vulnerable and protected species by the International Union for Conservation of Nature and Natural Resources [4,5].

The sole freshwater subspecies of finless porpoise, the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) lives only in the middle and lower reaches of the Yangtze River and its appended Poyang and Dongting Lakes in China. In recent decades, the population has decreased sharply each year by approximately 7.3% because of human activities on the river, including fishing, pollution, transportation, and dam construction [6]. A recent survey estimated a total population of, at most, 1,400 in 2006 [7]. A population viability analysis also suggested that the Yangtze finless porpoise will become extinct within 24 to 94 years if no protective measures are taken [5]. Fortunately, the species is now listed

in the Second Order of Protected Animals in China and as an endangered species in the International Union for Conservation of Nature and Natural Resources Red Data Book [5].

Dongting Lake is the second-largest lake in China and has been one of the most important habitats for the Yangtze finless porpoise. The local agriculture and industry, including paper mills and oil refineries, have increased dramatically around the lake in the past few decades. It is estimated that approximately 800 million tons of wastewater are discharged into the lake each year [8]. Contamination of the aquatic environment would result in adverse effects on the ecosystem in the lake. Declines of aquatic animal populations and of species diversity in Dongting Lake have been observed, possibly because of the released pollutants [8]. The population of Yangtze finless porpoise also has been greatly reduced in the lake. In 1999, only approximately 150 individuals were left in Dongting Lake, and most of these animals resided in the eastern area of the lake [9].

Polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) have been reported to accumulate in cetaceans [10–15]. To our knowledge, however, no studies have investigated these persistent organic pollutants and their hazards to the Yangtze finless porpoise because of the limited availability of samples. In the present study, we collected stranded Yangtze finless porpoises and sampled organs to study the accumulation levels and preliminary hazard

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Table 1. Sampling information and biological characteristics of Yangtze finless porpoises

	Porpoise 1	Porpoise 2	Porpoise 3	Porpoise 4	Porpoise 5
Collection time	April 4, 2004	March 31, 2001	2000	July, 1998-2007	June 5, 2004
Gender	Male	Male	Female	Female	Female/pregnant
Age	9.4	7.1	6.6	0.2	11.1
Body length (cm)	157.0	151.0	139.0	101.0	146.0
Body weight (kg)	61.0	42.5	27.5	19.5	63.5
Blubber ^a (kg)	20.5	18.3	10	12.3	22
Liver (kg)	2.3	0.7	0.865	0.35	1.35
Kidney (kg)	0.21	0.2	0.182 ^b	0.129 ^b	0.42
Stomach (kg)	0.88	0.55	0.64	0.185	0.65
Small intestine (kg)	1.2	0.85	0.95	0.38	1.34
Brain (kg)	0.5	0.29	0.173 ^b	— ^c	0.4

^a Including the skin.

^b The weight of the organ was not determined and, thus, was calculated according to the ratio of the same organ in the whole body weight of porpoise 5.

^c — = no sample collected.

of PCBs, PBDEs, and PCDD/Fs in the porpoises. To our knowledge, the present study is the first regarding exposure of the Yangtze finless porpoise to PCBs, PBDEs, and PCDD/Fs.

MATERIALS AND METHODS

Sample collection

Five stranded Yangtze finless porpoises were found in the channel of eastern Dongting Lake near the Yangtze River between 1998 and 2004. After determining gender, body weight, body length, age, and maturity, samples of blubber, liver, kidney, stomach, small intestine, and brain tissues were collected and weighed. The brain of porpoise 4 was not collected because of disaggregation of the tissue. Detailed information about sampling and the biological character of these individuals is shown in Table 1. The collected tissues were divided into small portions and stored at -80°C for later analysis.

Chemical analysis

Standards complying with U.S. Environmental Protection Agency (EPA) methods 1668A for PCB analysis ([16,17]; <http://www.epa.gov/region03/1668a.pdf>) and 1613B for PCDD/F analysis ([17]; <http://www.epa.gov/waterscience/methods/method/dioxins/1613.pdf>) were obtained from Wellington Laboratories (Guelph, ON, Canada) and Cambridge Isotope Laboratories (Andover, MA, USA), respectively. A mixture solution of PBDEs, including brominated diphenyl ethers (BDEs) 17, 28, 47, 66, 71, 85, 99, 100, 138, 153, 154, 183, and 190, and the [¹³C]PBDE surrogate, including BDEs 47, 99, and 153, were purchased from Wellington Laboratories. All solvents were of pesticide residue grade and were purchased from Fisher Scientific (Fair Lawn, NJ, USA).

Approximately 2 g of each tissue were ground in anhydrous sodium sulfate and placed in a flask overnight at room temperature. Then, the samples were Soxhlet extracted with dichloromethane:hexane (1:1, v/v) for 24 h. Half the extract was transferred to a new flask. The ¹³C-labeled surrogates for PCBs, PBDEs, and PCDD/Fs were added into the extract. After gravimetrically determining the lipid content, approximately 50 ml of hexane and 15 g of acidified silica (30%, w/w) were added to remove lipid. Then, the extract was passed through a multilayered silica gel column packed, from bottom to top, with 1 g of activated silica, 4 g of basic silica (1.2%, w/w), 1 g of activated silica, 8 g of acidified silica (30% w/w), 1 g of

activated silica, and 2 g of AgNO₃ silica (10%, w/w); silica was purchased from Merck (Darmstadt, Germany).

The extract was eluted by 100 ml of dichloromethane/hexane (1:1, v/v). Then, the extract was passed through a column with 6 g of activated basic alumina and eluted with 30 ml of dichloromethane/hexane (1:1, v/v). The extract was concentrated and loaded onto the column with 1 g of activated Florisil® (U.S. Silica, Berkeley Springs, WV, USA) and eluted with 40 ml of dichloromethane. After that, the extract was loaded onto a gel permeation chromatographic column. The first fraction of 70 ml of hexane for PCDD/F and PCB analyses and the following fraction of 70 ml of dichloromethane/hexane (1:1, v/v) for PBDE analysis were collected. Afterward, the extracts were concentrated with a gentle nitrogen flow, and the solvent was changed to 10 μl of nonane in a minivial. Before instrumental analysis, ¹³C-labeled injection standards were added (¹³C-labeled injection standards of PCBs also were used to quantify PBDEs).

The quantification of PCB, PBDE, and PCDD/F homologues was performed on an Agilent 6890 gas chromatograph (Agilent Technologies, Santa Clara, CA, USA) coupled with an Autospec Ultima mass spectrometer (Waters Micromass, Manchester, UK) operating in electron-impact ionization and selected-ion monitoring mode. The quantification was based on the isotope dilution method. The details of the mass spectrometer analysis and quality control are described in U.S. EPA methods 1613B, 1668A, and 1614 [18] (<http://www.epa.gov/waterscience/methods/method/files/1614.pdf>). The inlet temperatures of the gas chromatograph were 290, 300, and 300°C for PCBs, PBDEs and PCDD/Fs, respectively. A sample of 1 μl was injected in splitless mode. Helium was used as carrier gas at a constant flow rate of 1 ml/min. Polychlorinated biphenyl and PCDD/F analysis was performed with a DB-5MS fused silica capillary column (length, 60 m; inner diameter, 250 μm ; film thickness, 0.25 μm ; J&W Scientific, Folsom, CA, USA). Polybrominated diphenyl ether analysis was performed with a DM-5MS fused silica capillary column (length, 30 m; inner diameter, 250 μm ; film thickness, 0.1 μm ; J&W Scientific). The oven temperature programs were as follows: For PCBs, start at 120°C, hold for 1 min, ramp from 120 to 150°C at 30°C/min, ramp from 150 to 300°C at 2.5°C/min, and hold at 300°C for 1 min; for PBDEs, start at 100°C, hold for 3 min, ramp from 100 to 320°C at 5°C/min, and hold at 320°C for 10 min; for PCDD/Fs, start at 150°C, hold for 3 min, ramp

Table 2. Polychlorinated biphenyl (PCB), polybrominated diphenyl ether (PBDE), and polychlorinated dibenzo-*p*-dioxin and dibenzofuran (PCDD/F) concentrations in Yangtze finless porpoise organs and their total amounts and body burdens

Porpoise	Blubber	Liver	Kidney	Stomach	Small intestine	Brain	Total amount ^a	Burden ^b
PCBs ($\mu\text{g/g}$ lipid wt)								
1	1.89	0.29	0.28	0.49	0.21	0.18	28.0	1,094
2	0.12	0.25	0.12	0.38	0.06	0.11	1.83	87.6
3	0.30	0.29	0.32	0.82	0.17	0.11	2.62	210
4	1.19	1.47	1.17	0.25	0.38	— ^c	13.6	1,029
5	0.17	0.20	0.20	0.47	0.06	0.13	3.63	139
PBDEs (ng/g lipid wt)								
1	45.9	10.3	12.7	22.4	13.4	7.40	6,829	267
2	12.2	14.1	10.2	24.5	5.45	—	186	8.90
3	19.0	16.6	17.0	41.0	11.3	9.60	167	13.4
4	72.8	70.8	60.0	13.6	17.9	—	832	62.9
5	20.3	32.1	27.1	38.6	5.32	24.6	433	16.6
PCDD/Fs (pg/g lipid wt)								
1	287	535	1,094	1,564	735	872	4.47	175
2	65.3	597	518	475	572	674	1.07	51.2
3	140	440	526	753	1,340	831	1.30	104
4	108	1,003	1,244	1,046	826	—	1.27	96.1
5	134	210	362	618	396	464	2.89	110

^a Concentrations of total amount are in milligrams for PCBs and micrograms for both PBDEs and PCDD/Fs.

^b Burdens were calculated based on the total weight of six (or five) organs. Concentrations of burden are in $\mu\text{g/kg}$ for both PCBs and PBDEs and in pg/kg for PCDD/Fs.

^c — = not determined.

from 150 to 230°C at 20°C/min, hold at 230°C for 18 min, ramp from 230 to 235°C at 5°C/min, hold at 235°C for 10 min, ramp from 235 to 330°C at 4°C/min, and hold at 330°C for 3 min.

Total amounts and body burdens of PCBs, PBDEs, and PCDD/Fs

The total amounts and body burdens of PCBs, PBDEs, and PCDD/Fs were calculated according to the following formulation based on organ weight:

$$\text{total amount} = \sum (\text{concentration} \times \text{organ wt}) \quad (1)$$

$$\text{body burden} = \frac{\text{total amount}}{\text{sum weight of the organs}} \quad (2)$$

Hazard assessment

The hazard of PCDD/Fs and dioxin-like PCBs to the Yangtze finless porpoise also was preliminarily assessed based on the toxic equivalents (TEQs) in the porpoises. Toxic equivalents were calculated according to toxic equivalency factors suggested by World Health Organization (Geneva, Switzerland) in 2005 [19]. The intake of TEQs was then calculated using the following equation [20] (<http://www.who.int/ipcs/publications/en/exe-sum-final.pdf>):

$$\text{intake (pg TEQ/kg/d)} = \text{body burden (ng TEQ/kg)} \cdot 1,000 \cdot \{[\ln(2)/\text{half-life}]/f\} \quad (3)$$

where f is the fraction of dose absorbed (assumed to be 50% for absorption from food) and the estimated half-life for tetrachlorodibenzo-*p*-dioxin (TCDD) was assumed to be 7.5 years.

The hazard quotient (HQ) was then derived as follows to indicate hazard level in the individual porpoises based on toxicity reference value (TRV) according to the method described by Hung et al. [21] for the assessment of PCBs in the Yangtze finless porpoise:

$$\text{HQ} = \frac{\text{intake (pg TEQ/kg/d)}}{\text{TRV (pg TEQ/kg/d)}} \quad (4)$$

Quality assurance and quality control

All samples were spiked with labeled compounds to monitor method performance. A method blank with each sample batch (12 samples) was checked. One certified reference material of fish (EDF-2526; Cambridge Isotope Laboratories) also was analyzed. The recoveries of labeled compounds were from 45 to 110% for PCDD/Fs, from 62 to 105% for PCBs, and from 59 to 101% for PBDEs, which all met the limits of the U.S. EPA methods. The concentrations determined for the 17 congeners of PCDD/Fs were in excellent agreement with the reference fish certified values.

RESULTS

Concentrations of PCBs, PBDEs, and PCDD/Fs

Polychlorinated biphenyls, PBDEs, and PCDD/Fs were detected in all samples. Their concentrations in the organs are shown in Table 2. Polychlorinated biphenyl concentrations were between 0.06 $\mu\text{g/g}$ lipid weight (in small intestine) and 1.89 $\mu\text{g/g}$ lipid weight (in blubber). The concentrations of PBDEs in the organs were approximately one to two orders of magnitude lower than those of PCBs and ranged from 5.32 ng/g lipid weight (in small intestine) to 72.76 ng/g lipid weight (in blubber). Polychlorinated dibenzo-*p*-dioxins and dibenzofuran concentrations ranged from 65.28 pg/g lipid weight (in blubber) to 1,563.53 pg/g lipid weight (in stomach).

Penta-, hexa-, and decachlorinated biphenyls were the predominant homologues of PCBs in each organ (Fig. 1). The three homologues together contributed 76 to 83% of the sum of PCBs (ΣPCBs) in the organs. Among the 25 congeners determined, PCBs 138, 153, and 209 were the most abundant, together making up more than 50% of ΣPCBs . In particular, PCB 209 constituted, on average, 18.1% of ΣPCBs in blubber, 37.1% in liver, 40.0% in kidney, 46.2% in stomach, 37.7% in

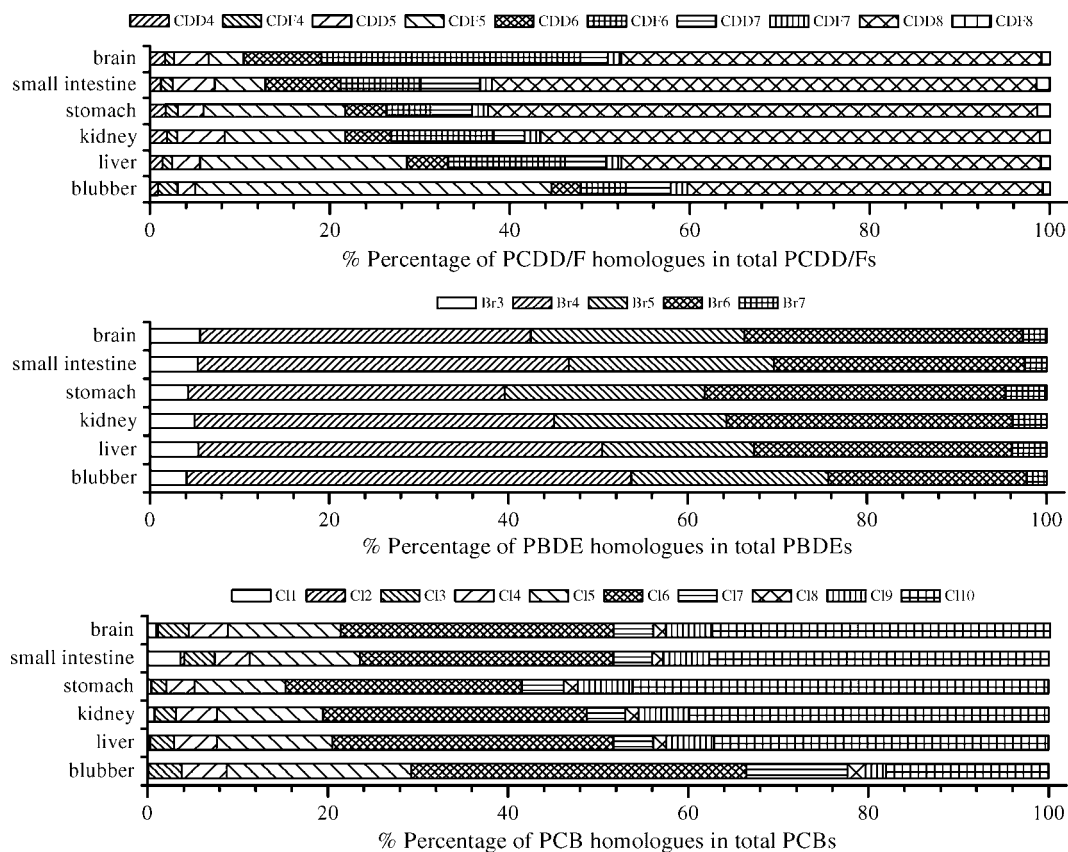


Fig. 1. Homologue patterns of polychlorinated biphenyl (PCB), polybrominated diphenyl ether (PBDE), and polychlorinated dibenzo-*p*-dioxin and dibenzofuran (PCDD/F) in the organs of Yangtze finless porpoise (average \pm standard deviation).

small intestine, and 37.4% in brain. Other large contributors were PCBs 101, 180, and 208.

For PBDEs, tetra-, penta-, and hexabrominated diphenyl ethers were the major homologues in the porpoise (Fig. 1). The abundance was in the following order: Tetrabrominated diphenyl ethers > hexabrominated diphenyl ethers > pentabrominated diphenyl ethers. Among the congeners determined, BDE 47 was the most abundant congener, constituting from 33.8 to 49.5% of the sum of PBDEs (Σ PBDEs) in the six organs. Other major contributors were BDEs 99, 100, 153, and 154. Along with BDE 47, the five congeners together constituted $93.5\% \pm 4.6\%$ (mean \pm standard error throughout) of Σ PBDEs in blubber, $88.5\% \pm 2.5\%$ in liver, $87.4\% \pm 2.1\%$ in kidney, $87.9\% \pm 3.8\%$ in stomach, $83.7\% \pm 6.1\%$ in small intestine, and $83.4\% \pm 7.8\%$ in brain.

Polychlorinated dibenzo-*p*-dioxins and dibenzofurans mainly consisted of penta- and hexachlorinated dibenzofurans as well as hepta- and octachlorinated dibenzo-*p*-dioxins (Fig. 1). Among the homologues, octachlorinated dibenzo-*p*-dioxin constituted more than 50% of PCDD/Fs in most of the samples. Two other major congeners were 1,2,3,7,8-pentachlorinated dibenzo-*p*-dioxin and 1,2,3,4,6,7,8-heptachlorinated dibenzo-*p*-dioxin.

Total amounts and burdens of PCBs, PBDEs, and PCDD/Fs

The total amounts and burdens of PCBs, PBDEs, and PCDD/Fs were also shown in Table 2. The results indicated that the total amounts and burdens of PBDEs in the porpoises were approximately one order of magnitude lower than those

of PCBs and two to three orders of magnitude higher than those of PCDD/Fs. The highest total amounts and burdens for all three pollutants were found in porpoise 1. Furthermore, the total amounts and burdens in the calf (porpoise 4) were relatively high among the individuals.

TEQ of PCBs and PCDD/Fs

In the present study, the TEQs of PCBs ranged from 1.29 to 87.46 pg TEQ/g lipid weight in the organs. Among the congeners, PCB 126 was the predominant contributor to TEQs. The other major congeners were PCBs 118 and 156. Meanwhile, the TEQs of PCDD/Fs were determined to be between 5.70 and 151.36 pg TEQ/g lipid weight in the organs. 1,2,3,7,8-Pentachlorinated dibenzo-*p*-dioxin, 2,3,4,7,8-pentachlorinated dibenzo-*p*-dioxin, and 2,3,7,8-TCDD were the major contributors to TEQs.

Hazard assessment

The intake and HQs of PCBs, of PCDD/Fs, and of PCBs and PCDD/Fs were calculated. These values are shown in Table 3. The intake and HQs of porpoises 1 and 4 were more than 9 and 37 pg TEQ/kg/d, respectively, for PCBs. The values in the two individuals were much higher than those in the others. A similar trend was found in the results of PCBs and PCDD/Fs. For PCDD/Fs, only porpoise 1 had the much higher intake and HQ. In addition, all the HQs exceeded the threshold of one in five individuals for both PCBs and PCDD/Fs. When PCBs and PCDD/Fs were calculated together, all the HQs were greater than the values for each kind of contaminant in the individuals.

Table 3. Intake^a and hazard quotient (HQ)^b calculated for polychlorinated biphenyls (PCBs), polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), and PCBs and PCDD/Fs in Yangtze finless porpoises^c

	PCBs		PCDD/Fs		PCBs and PCDD/Fs ^d	
	Intake	HQ	Intake	HQ	Intake	HQ
Porpoise 1	9.92	9.92	7.41	7.41	17.33	17.33
Porpoise 2	1.86	1.86	2.28	2.28	4.14	4.14
Porpoise 3	1.85	1.85	2.43	2.43	4.28	4.28
Porpoise 4	37.89	37.89	3.15	3.15	41.04	41.04
Porpoise 5	2.17	2.17	3.71	3.71	5.88	5.88

^a Intake (pg toxic equivalents [TEQ]/kg/d) was calculated based on the total weight of six organs with an exception of porpoise 4, for which intake was calculated based on the total weight of five organs because of the absence of brain.

^b The toxicity reference value used was 1 pg TEQ/kg/d, as suggested by Hung et al. [21] for finless porpoise in calculation of the HQ.

^c PBDEs were not calculated because of the absence of their TEQs.

^d Values represent the total of PCBs and PCDD/Fs.

DISCUSSION

Polychlorinated biphenyls, PBDEs, and PCDD/Fs have been reported in cetaceans. Concentrations of PCBs have been found ranging from several to hundreds of $\mu\text{g/g}$ lipid weight in the oceanic and river cetaceans [1,10,14,22–24]. The range of PBDE concentrations was reported from the ng/g to $\mu\text{g/g}$ level in the cetaceans studied [15,25–27]. The concentrations of PCBs and PBDEs in the Yangtze finless porpoise were comparable or even lower than those reported in the other cetaceans from various regions. The observation may be a consequence of the low level of these pollutants in Dongting Lake. Chen et al. [28] have reported that the PCB concentrations in the sediments of Dongting Lake were as low as approximately 20 ng/g dry weight. The concentrations of PCDD/F in the Yangtze finless porpoise, however, were higher than those reported in the other cetaceans [11,13,22]. The high levels of PCDD/Fs found in the porpoise may be caused by the wide use of sodium pentachlorophenol that contained PCDD/Fs as by-products or impurities to control schistosome abundance around the lake in the middle of the last century.

Because of the great amounts in use and their persistence in the environment, penta- and hexachlorinated biphenyls have been found to dominate PCB residues in cetaceans [13,29,30]. The present results were consistent with this previous observation. In the present study, however, PCB 209 was found as a major PCB congener the Yangtze finless porpoise. The congener PCB 209 was seldom investigated or not detected in the past studies because of its absence in most commercial PCB mixtures [30–32]. Even so, PCB 209 can still be found in the other commercial mixtures, such as Aroclor 1268, Chlorofen, and Clophen A60 [33]. Weisbrod et al. [34] have reported PCB 209 at the level of ng/g fresh weight in the organs of white-side dolphins and pilot whales. Besides, higher concentrations of PCB 209 (several hundreds of ng/g lipid wt in blubber) also were found in bottlenose dolphins from the U.S. Atlantic coast [35]. A possible reason for the high concentration of PCB 209 in the Yangtze finless porpoise is that the porpoise has a higher potential to accumulate this congener. Species-specific differences in accumulation of PCBs congeners have been reported by Chou et al. [29] in 13 species of cetaceans from Taiwanese waters. Although to our knowledge no evidence currently suggests that the Yangtze finless porpoise preferentially accu-

mulates PCB 209, further investigation of the abnormally high accumulation of this congener in the porpoise is warranted.

In many studies of PBDEs in cetaceans, BDE 47 usually is the most dominant congener, with BDEs 99, 100, 153, and 154 representing other major constituents [12,25,27]. The present results are consistent with these previous studies and suggest common sources originating from use of the pentabrominated diphenyl ether mixture [12]. In the present study, the congener profile of PCDD/Fs in the Yangtze finless porpoise indicated multiple sources, including pentachlorophenol.

To our knowledge, the hazard of these pollutants to the Yangtze finless porpoise was assessed for the first time in the present study. Although the PCB concentrations in the porpoise were only comparable or even lower than those in some cetaceans studied previously, the HQs for PCBs of greater than one in the individuals suggested a high probable hazard of PCBs to the Yangtze finless porpoise from PCB exposure. Also, the HQs for PCDD/Fs were all greater than one in the finless porpoises and suggested a high probable hazard of PCDD/Fs to the animals from PCDD/F exposure. When PCBs and PCDD/Fs were considered together, a higher HQ was obtained compared with the value for each kind of contaminants. In the present study, PBDEs have been excluded from the calculation of intake and HQ because of the absence of their toxic equivalency factors. It has been reported, however, that some PBDE congeners also have a mode of action similar to that of TCDD and have induced ethoxyresorufin-*O*-deethylase activity [36]. Therefore, the HQs likely would increase in the porpoises if PBDEs were included.

Furthermore, the calf (porpoise 4) had one of the highest total amounts and burdens of PCBs, PBDEs, and PCDD/Fs. Consequently, the intake and HQs in the calf also were relatively high among the individuals, especially for PCBs and for PCBs and PCDD/Fs. These findings were consistent with other studies that reported higher pollutants in juveniles of cetaceans [15,26,37]. A mother–offspring transfer has been suggested to result in higher concentrations in young animals during lactation [15]. The present results further indicated that there may be a greater probable hazard to Yangtze finless porpoise calves from these pollutants compared to those hazards to adults, because calves may experience greater exposure at a developmentally critical age and be more threatened by exposure to persistent organic pollutants than adult porpoises.

CONCLUSION

With economic development and a growing human population, the Yangtze finless porpoise population has decreased sharply in past decades. Environmental pollution is believed to be one of most important causes. Although the number of porpoises collected for the present study was limited, the HQs indicated a higher probable hazard to the species from PCBs, PBDEs, and PCDD/Fs. The present results suggest that reduction of environmental contamination may contribute greatly to protecting this highly endangered species.

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