

# Supporting Information

## Persistent halogenated compounds in waterbirds from an e-waste recycling region in South China

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## Sampling Site

E-waste recycling activities in Qingyuan County began in the mid 1990s. Nowadays, more than 1300 recycling workshops and 80,000 workers are involved in the business of e-waste recycling, and approximately 1.7 million tons of e-wastes (computers, printers, cables, TV-sets, electromotor, electrical machines, and transformers etc.) are dismantled annually in this region (<http://www.21class.com/ccer/html/14050-1.shtml>). The traditional agricultural practices (such as rice-growing, vegetable planting, and fish-farming) around the recycling workshops may accelerate the transport of e-waste contaminants to wildlife.

**Chemical Analysis.** PBDEs, DBDPE, polybrominated biphenyl 153 (PBB 153) was analyzed with a Shimadzu 2010 gas chromatograph coupled with a QP2010 mass spectrometer (Shimadzu, Japan) using electron capture negative ionization (ECNI) in the selective ion-monitoring (SIM) mode. A DB-XLB (30 m × 0.25 mm × 0.25 μm) capillary column was used for the determination of mono- to hepta-BDE congeners and PBB 153. For octa- to deca-BDE congeners and DBDPE, a DB-5HT (15 m × 0.25 mm × 0.10 μm) capillary column was used. PCBs and OCPs were analyzed with an Agilent 6890 GC/5975B MSD in electron impact (EI) and SIM mode, equipped with a DB-5ms capillary column (60 m × 0.25 mm × 0.25 μm). Details of the GC temperature program and monitored ions for all the analytes are given in our previous publication (*1*). In all samples, 13 PBDE congeners, PBB 153, DBDPE, 51 PCB congeners, four HCH isomers, *p,p'*-DDT and its metabolites (*p,p'*-DDE and *p,p'*-DDD) were measured. The target analytes were quantified using the internal calibration method based on five-point calibration curves for individual compounds. The limit of detection (LOD), defined as a signal/noise ratio (S/N) = 3, ranged from 0.05–2 ng/g lipid weight for PBDEs, 0.12–4.16 ng/g for PCBs, and 0.34–2.4 ng/g for OCPs, respectively.

**Quality Assurance and Control (QA/QC).** QA/QC measures used in sample analyses include spiking of surrogate standards into all the samples and analyses of procedural blanks, spiked blanks, matrix spiked samples and sample triplicates. Only trace levels of BDE 47, 99, 153, and 209 and PCB 153 and 138 were detected in blanks and the mean concentrations were subtracted from those in the samples. The mean recoveries of eight individual PBDE congeners (BDE 28, 47, 100, 99, 154, 153, 183, and 209) ranged from 77% to 93% in spiked blanks and from 70% to 89% in matrix spiked samples. The mean recoveries of 21 individual PCB congeners (PCB 18 to PCB 209) in spiked blanks ranged from 55% to 109% and ranged from 66% to 110% in matrix spiked samples. The surrogate standard recoveries in all samples were 72% to 92% for PCB 65, 64% to 101% for PCB 204, 77% to 110% for <sup>13</sup>C-PCB 141, 87% to 113% for CDE 99, and 86% to 105% for <sup>13</sup>C-BDE 209. The relative standard deviations of all PBDEs and OCPs in triplicate samples were less than 15% except for BDE 99 which was 17%, and were less than 20% for PCBs except for PCB 205, 206, and 110 which were less than 25%. Reported concentrations were not surrogate recovery corrected in the present study.

Table S1 Information on bird species used in this study

Sample ID	Growth state	Sex	Body weight	Body length	Food habit	Habitat
White-breasted waterhen ( <i>Amaurornis phoenicurus</i> )						
W1	Adult	female	124	24	Mainly insects, worms, march plant shoots, paddy grains and fish	Moist ground overgrowth with bushes; also seen in waterlogged low lying areas
W2	Adult	male	158	29		
W3	Adult	female	154	28		
W4	Adult	male	152	28		
W5	Adult	male	166	30		
W6	Adult	male	133	25		
W7	Adult	male	146	27		
W8	Adult	female	157	26.5		
W9	Subadult	male	87.5	19		
W10	Sunadult	female	113	26		
W11	Subadult	male	69.4	17		
Slaty-breasted rail ( <i>Gallirallus striatus</i> )						
S1	Adult	female	95.4	25	Shrimp, crab, and insect	Paddy fields, wetland
S2	Adult	male	125	22		
S3	Adult	female	74	23		
S4	Adult	female	84.9	23		
S5	Adult	female	111	20		
Ruddy-breasted crake ( <i>Porzana fusca</i> )						
R1	Adult	female	91	16	Mainly tender shoots, berries, aquatic insects mollusks	Swamps and similar wet areas
R2	Adult	female	64	19		
R3	Adult	female	49	17		
R4	Adult	female	51	20		
R5	Adult	male	71	20		
Chinese-pond heron ( <i>Ardeola bacchus</i> )						
H1	Adult	female	95	32	Fish, crab, and insect	Live near water bodies such as ponds, rivers, marshes and swamps
H2	Adult	male	97	31		
H3	Adult	male	79	30		
H4	Adult	male	91	31		
H5	Adult	male	112	30		
Common snipe ( <i>Gallinago gallinago</i> )						
C1	Adult	male	89	32	larval insects and aquatic invertebrates	Freshwater marshes ponds, flooded meadows, field
C2	Adult	male	83	28		
C3	Adult	male	67	18		

Table S2 Concentration of analyzed compounds in each sample

Compound	White-breasted waterhen											Slaty-breasted rail				
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	S1	S2	S3	S4	S5
PCB28/31	147	nd	6	nd	80	nd	1	45	nd	9	nd	31	10	60	17	11
PCB52	177	nd	1	nd	3	nd	2	10	nd	nd	nd	nd	1	nd	nd	nd
PCB60	30751	88	733	156	138	nd	1384	70	17	175	37	180	34	77	113	34
PCB66	10835	67	358	119	187	38	345	91	11	157	32	227	51	146	127	50
PCB74	485	nd	24	22	60	5	12	36	2	18	11	56	24	104	44	24
PCB85	6679	8	96	19	29	3	118	19	2	11	nd	nd	9	34	36	13
PCB90	5410	25	129	27	38	9	432	10	6	34	7	nd	13	20	26	8
PCB92	4517	6	58	nd	27	2	69	13	2	12	nd	20	8	8	16	9
PCB99	71381	94	1042	163	216	52	2389	98	35	211	42	495	185	377	445	134
PCB101	3734	nd	138	nd	24	9	503	34	nd	nd	nd	5	nd	4	14	nd
PCB105	3716	680	2727	689	751	244	6300	162	104	1026	150	613	292	442	587	162
PCB107	9402	85	456	nd	87	nd	nd	8	nd	nd	nd	nd	8	nd	3	6
PCB110	220	nd	2	nd	5	nd	3	10	nd	nd	nd	nd	1	nd	nd	nd
PCB114	7555	173	432	104	126	52	1095	17	18	165	23	66	34	51	66	22
PCB115/87	6945	nd	120	nd	41	9	342	19	2	nd	10	46	15	35	42	11
PCB117	7206	63	233	55	70	17	728	14	10	69	14	44	24	34	41	12
PCB118	106290	1118	4526	1148	1608	569	6648	348	215	1761	245	1115	610	1127	1154	371
PCB119	191	nd	2	nd	nd	nd	3	1	nd	nd	nd	nd	nd	2	nd	nd
PCB123	4631	75	239	60	79	28	577	12	11	87	14	46	19	24	39	13
PCB128	48572	323	1628	384	487	106	5033	72	77	389	76	327	174	267	364	95
PCB130	12285	89	451	145	135	39	1341	20	20	130	20	82	46	71	89	28
PCB137	18548	136	783	139	167	48	2219	26	26	153	26	97	47	89	134	37
PCB138	118672	1093	6972	1600	1856	399	20675	301	256	1253	236	1401	878	1389	1628	494
PCB141	9654	8	113	nd	34	nd	115	13	5	10	nd	nd	8	nd	24	10
PCB146	43343	578	2138	665	599	240	6610	63	88	487	90	331	186	292	332	127
PCB147	3905	33	152	37	48	12	435	7	7	30	7	26	8	16	24	9
PCB149/139	14548	27	289	41	98	nd	699	28	14	33	nd	nd	9	nd	40	10
PCB153	276053	4221	14858	4344	3765	1310	41236	421	569	3035	502	2015	1508	1939	2230	769
PCB154	733	2	17	nd	7	nd	39	1	nd	3	nd	nd	2	nd	nd	2
PCB158	95630	nd	nd	nd	nd	21	1006	nd	221	nd	18	152	nd	1223	141	nd
PCB164/163	109457	948	6231	1137	1045	478	19256	119	143	829	143	733	257	733	523	188
PCB166	2968	74	165	42	56	17	568	5	4	55	9	23	15	23	29	10
PCB167	14605	416	1021	330	312	140	2345	30	50	337	45	151	95	126	151	54
PCB171	14475	78	455	79	167	nd	1304	11	10	77	nd	38	65	38	111	47

PCB174	1314	17	68	6	nd	5	187	5	2	nd	nd	9	nd	8	11	nd
PCB175	1242	23	70	39	28	9	183	nd	68	28	nd	nd	10	225	nd	5
PCB177	5530	93	345	133	194	54	817	15	28	116	20	44	30	69	64	35
PCB178	3757	83	326	82	194	30	489	4	11	135	16	nd	36	9	42	40
PCB183	49768	377	2624	435	411	160	7623	36	64	321	53	196	106	148	185	87
PCB187/182	33146	718	2327	832	834	305	5176	68	129	651	113	585	225	354	361	213
PCB190/170	40445	840	2362	634	740	207	6924	61	117	657	102	315	248	402	384	137
PCB191	2383	59	147	43	52	27	462	4	4	47	8	23	14	25	26	12
PCB193/180	95110	2327	6697	2111	1866	770	15519	138	285	1492	247	747	610	801	861	369
PCB194	20403	752	1586	568	439	195	3874	25	73	370	94	178	110	250	197	91
PCB195	6224	152	355	110	104	30	1176	7	9	68	19	46	31	57	55	24
PCB202	316	26	45	nd	81	25	63	4	14	70	8	nd	28	16	13	17
PCB205	10762	284	580	202	144	17	3062	4	22	97	28	51	24	nd	59	27
PCB206	20396	821	1274	466	325	153	4626	15	56	264	79	159	61	201	178	66
PCB207	4682	178	276	78	73	28	1182	3	11	73	13	47	12	32	40	14
PCB208	1760	123	168	54	93	43	436	3	15	106	15	30	8	29	26	18
PCB209	12245	586	670	337	217	83	3225	8	27	148	57	141	30	138	111	32
ΣPCBs	1373203	17963	66517	17637	18138	5987	178855	2532	2861	15198	2629	10891	6215	11516	11200	3946
BDE28	2	nd	nd	nd	nd	nd	nd	2	nd	nd	2	nd	nd	nd	nd	nd
BDE47	1569	22	89	12	10	10	169	71	39	43	13	10	9	11	17	10
BDE100	641	18	52	18	7	6	89	11	19	23	9	18	7	4	13	12
BDE99	1607	39	266	56	28	26	483	64	85	142	19	19	17	12	15	23
BDE154	2751	81	258	117	29	17	563	16	64	95	14	14	11	7	22	16
BDE153	4480	174	545	216	85	42	1268	36	165	321	24	45	60	38	53	54
BDE183	1886	74	756	80	61	17	1144	30	71	172	12	14	13	11	11	19
BDE203	98	25	56	17	16	18	53	6	nd	25	nd	20	4	34	4	4
BDE196	124	28	86	15	60	20	97	9	2	36	nd	9	1	7	3	4
BDE208	32	5	48	29	7	nd	44	7	9	8	nd	72	2	69	31	27
BDE207	141	25	129	80	30	nd	134	23	38	76	16	137	4	91	85	61
BDE206	nd	nd	nd	23	5	nd	nd	4	18	3	5	140	nd	98	80	56
BDE209	nd	nd	nd	136	nd	nd	nd	30	94	186	35	895	nd	934	492	330
ΣPBDEs	13529	497	2370	798	349	156	4177	314	605	1155	148	1395	128	1316	824	616
DBDPE	nd	5	16	13	1	1	20	13	35	218	5	62	5	43	22	10
PBB153	2780	248	409	140	38	36	477	22	66	191	nd	62	nd	94	55	24
β-HCH	566	94	45	228	447	69	129	124	126	53	87	178	96	159	221	106
γ-HCH	319	45	nd	154	76	46	43	55	148	39	87	277	34	190	210	122

δ-HCH	317	nd	33	nd	95	63	59	30	63	nd	nd	nd	17	176	197	106
p,p'-DDE	3692	463	423	1552	503	62	720	596	71	168	149	353	323	527	640	171
p,p'-DDD	nd	nd	nd	nd	29	19	20	13	10	nd	nd	31	18.2	28.0	nd	14.3
p,p'-DDT	nd	nd	nd	nd	51	42	52	nd	nd	nd	nd	122	21.2	nd	nd	nd
<u>ΣOCPs</u>	<u>4894</u>	<u>601</u>	<u>501</u>	<u>1934</u>	<u>1200</u>	<u>300</u>	<u>1022</u>	<u>817</u>	<u>418</u>	<u>261</u>	<u>323</u>	<u>961</u>	<u>510</u>	<u>1077</u>	<u>1267</u>	<u>520</u>

Table S2 Concentration of analyzed compounds in each sample (continued).

Compound	Ruddy-breasted crane					Chinese-pond Heron					Common snipe		
	R1	R2	R3	R4	R5	H1	H2	H3	H4	H5	C1	C2	C3
PCB28/31	6	13	11	128	19	3469	2262	1884	2772	24	295	8	74
PCB52	1	1	2	11	nd	120	1253	720	1614	17	55	nd	60
PCB60	15	29	42	190	13	2704	2349	3546	1399	14	411	45	42
PCB66	19	36	24	315	25	3486	3347	5144	3347	47	480	45	142
PCB74	12	17	20	135	19	3431	2519	3674	2507	34	614	11	104
PCB85	4	11	nd	74	6	904	1552	2724	1287	10	31	5	33
PCB90	3	10	nd	33	3	165	136	384	149	8	80	17	25
PCB92	2	3	nd	11	3	434	1046	2007	577	8	20	5	25
PCB99	36	114	28	439	37	5872	4696	10061	3785	140	1271	50	431
PCB101	4	5	3	26	6	891	2879	5581	3675	136	921	nd	426
PCB105	61	146	117	591	42	4936	5464	8916	3151	143	1663	327	430
PCB107	nd	4	3	34	9	807	1823	2763	674	84	650	nd	152
PCB110	2	2	4	17	4	385	2290	3231	2338	7	11	nd	23
PCB114	9	16	14	55	4	578	409	778	275	13	262	71	39
PCB115/87	4	9	nd	39	6	960	1111	4073	1406	32	196	12	95
PCB117	7	17	11	42	4	282	241	523	215	13	126	42	41
PCB118	134	403	263	1521	126	16873	15664	23047	9049	350	3526	548	1070
PCB119	nd	nd	nd	nd	nd	77	117	192	105	nd	nd	nd	2
PCB123	4	8	nd	34	4	269	513	418	233	48	87	34	29
PCB128	37	93	21	235	27	2947	3161	6808	1872	115	841	218	324
PCB130	11	33	16	100	10	649	729	1593	435	36	302	51	110
PCB137	12	21	0	95	8	986	1087	2481	564	36	324	86	109
PCB138	142	387	128	1272	110	14706	10961	33311	7225	475	3644	656	1431
PCB141	4	4	nd	23	8	1230	3266	8920	1085	62	472	4	127
PCB146	44	111	79	334	27	2632	2310	5291	1342	95	871	304	293
PCB147	3	10	nd	27	3	158	202	515	146	10	81	19	32
PCB149/139	6	11	7	59	9	1287	2894	12258	1745	141	456	20	257
PCB153	236	535	209	1707	141	18844	15498	37172	9433	623	5333	2193	1894
PCB154	nd	1	nd	nd	nd	58	68	106	46	2	10	1	6
PCB158	115	nd	7	nd	96	1512	nd	3990	nd	373	147	nd	nd
PCB164/163	89	246	110	568	50	7093	7657	17103	2754	328	2846	497	610
PCB166	4	7	5	20	2	201	136	323	98	6	108	35	19
PCB167	24	49	45	126	10	1022	924	1360	492	28	252	165	83

PCB171	4	9	nd	67	5	1036	1049	3744	741	34	297	47	130
PCB174	nd	nd	nd	19	2	214	488	1911	304	22	137	9	67
PCB175	1	1	nd	238	nd	90	73	216	50	5	63	nd	14
PCB177	11	19	15	100	7	582	536	1948	411	47	337	47	139
PCB178	8	12	18	91	4	739	762	2140	296	42	427	30	93
PCB183	19	24	25	143	10	2902	2527	8360	872	123	1129	191	227
PCB187/182	56	72	88	411	21	2394	2516	6809	1417	132	1047	263	400
PCB190/170	54	80	63	277	18	2463	2085	6375	1254	105	964	407	317
PCB191	7	3	nd	16	nd	157	101	336	84	6	90	24	16
PCB193/180	110	127	158	672	39	5790	5187	16537	2895	234	1965	911	685
PCB194	39	31	82	158	9	1141	967	3364	479	41	452	267	114
PCB195	8	7	10	38	2	306	268	1056	156	17	179	66	46
PCB202	4	3	nd	45	1	152	201	448	96	12	98	10	35
PCB205	8	7	21	32	2	357	107	946	112	1	243	106	19
PCB206	30	20	60	104	6	829	595	2118	314	26	420	292	68
PCB207	4	1	3	17	nd	235	101	447	79	10	217	75	30
PCB208	6	2	8	34	1	257	184	538	88	12	176	37	36
PCB209	15	12	53	40	2	507	136	847	150	8	269	180	20
∑PCBs	1429	2782	1772	10765	956	120121	116446	269034	75596	4335	34898	8432	10994
BDE28	nd	nd	nd	nd	nd	3	26	2	20	1	1	nd	1
BDE47	9	10	3	53	10	606	619	413	712	188	218	13	97
BDE100	2	2	1	6	2	170	167	224	204	68	76	8	29
BDE99	9	7	2	27	5	124	371	231	647	43	212	22	66
BDE154	4	3	1	8	2	321	402	468	247	126	166	39	36
BDE153	8	7	3	20	3	667	464	364	319	70	360	99	71
BDE183	2	2	5	13	1	208	251	169	188	19	296	24	37
BDE203	nd	nd	5	3	nd	20	23	20	11	2	25	3	1
BDE196	nd	1	1	1	nd	22	33	16	19	2	39	5	4
BDE208	nd	nd	nd	nd	nd	nd	14	7	5	nd	28	6	nd
BDE207	2	6	6	nd	nd	7	39	20	27	3	75	18	nd
BDE206	1	3	1	nd	nd	15	nd	nd	nd	nd	3	8	nd
BDE209	nd	60	nd	nd	nd	nd	nd	nd	nd	nd	116	23	nd
∑PBDEs	37	100	28	132	23	2205	2462	1964	2440	526	1653	273	341
DBDPE	4	11	16	10	10	482	804	176	145	33	7	29	6
PBB153	19	9	10	39	2	1	3	3	86	1	188	96	43

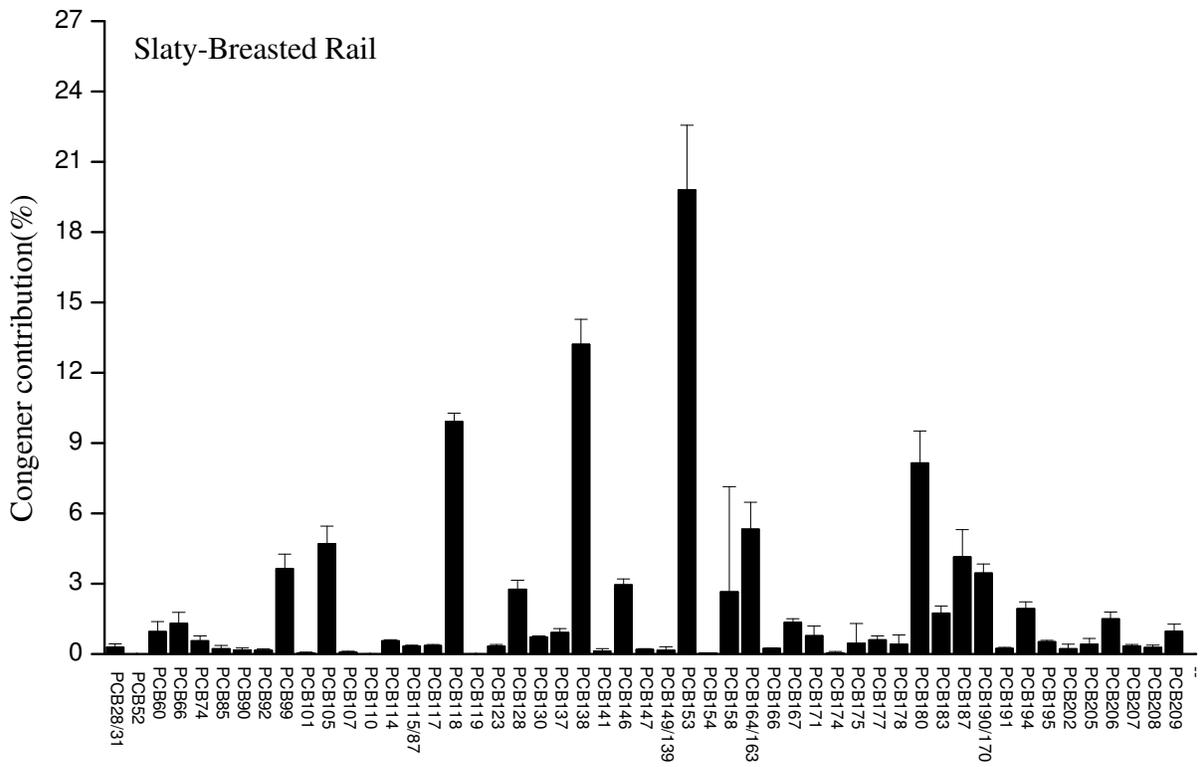
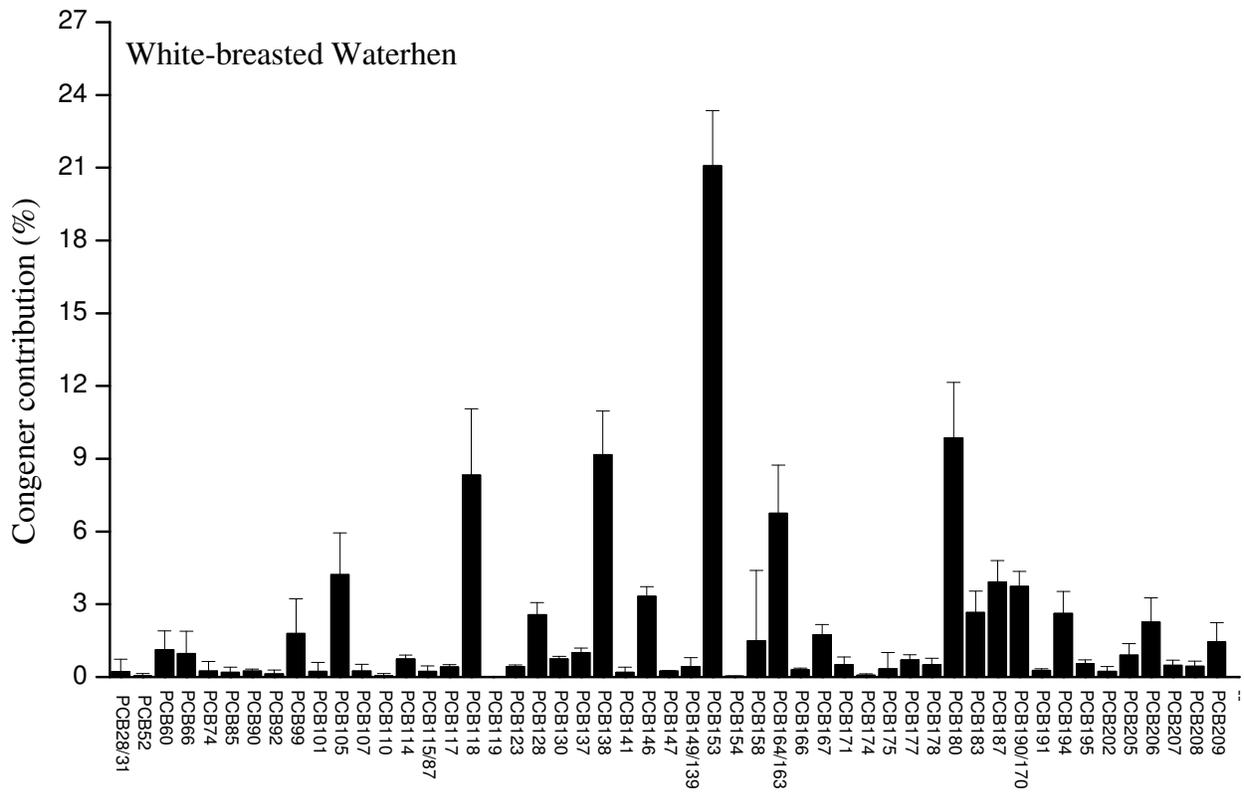
$\beta$ -HCH	47	173	90	301	30	1714	185	1796	1462	25	707	28	64
$\gamma$ -HCH	21	22	58	119	26	39	38	56	62	12	63	11	22
$\delta$ -HCH	nd	nd	nd	nd	nd	46	536	10186	287	44	71	nd	108
p,p'-DDE	172	512	405	1434	74	6931	1863	5764	2568	106	3435	73	318
p,p'-DDD	nd	6.2	nd	nd	nd	nd	83	80	82	6	nd	nd	14
p,p'-DDT	nd	nd	nd	nd	nd	nd	nd	nd	65	6	nd	nd	nd
$\Sigma$ OCPs	240	712	553	1853	129	8730	2222	8714	4526	198	4276	112	525

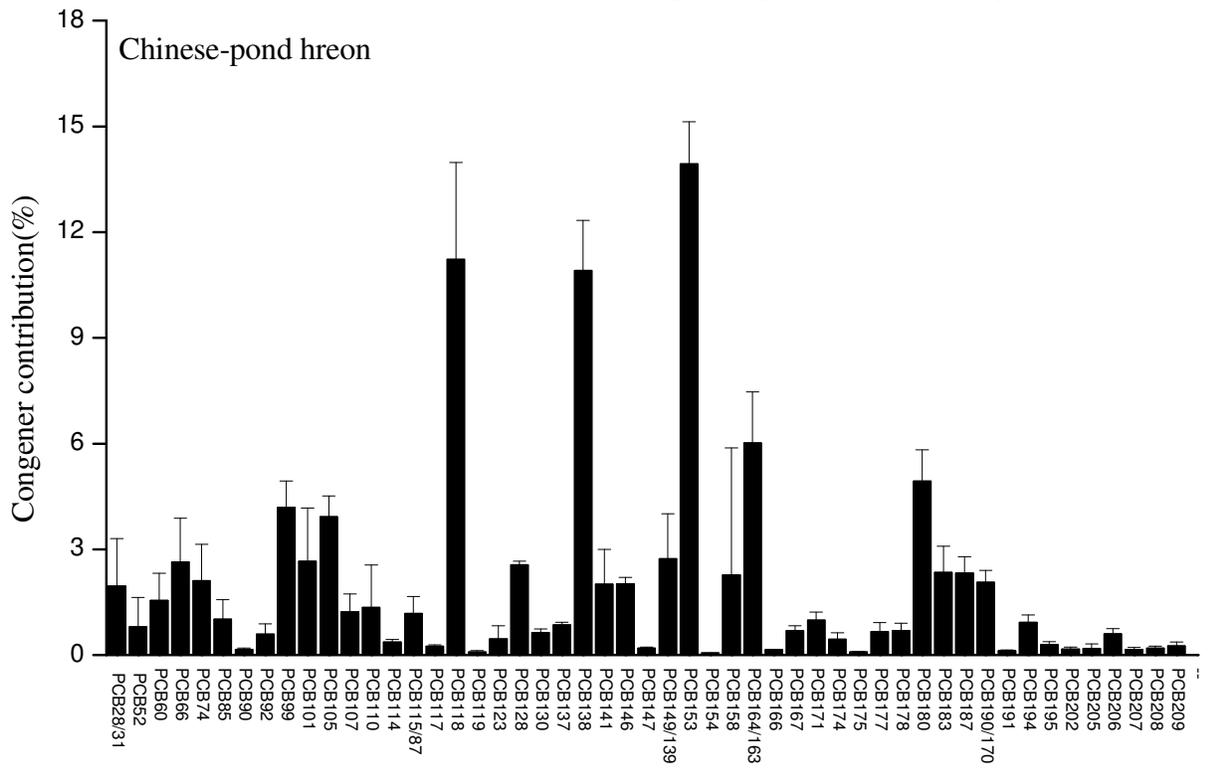
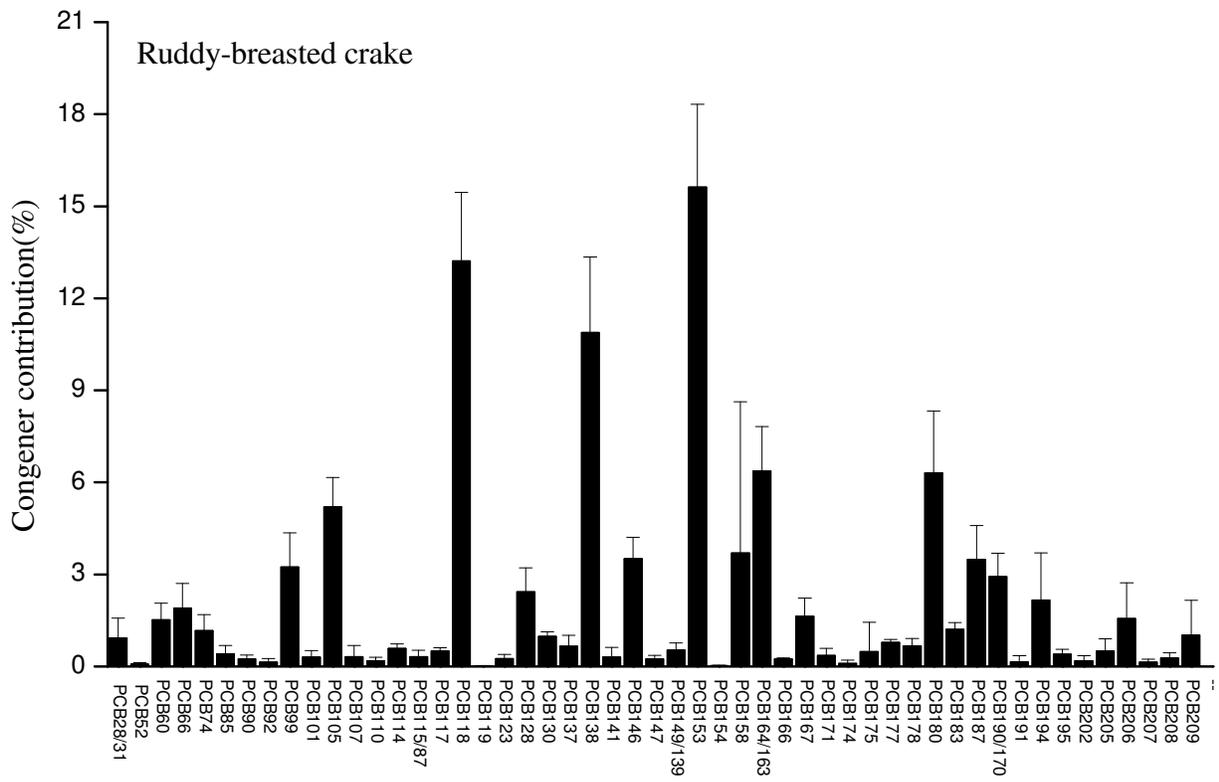
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**Table S3 Comparison with other studies**

Bird specie	Time	Location	Tissue	PBDEs	PCBs	DDTs	HCHs	BB-153	References
Chinese pond heron	2006-2007	Guangdong Qingyuan, China	muscle	2205(526-2462)	116446(4335-269034)	2715(118-6931)	1799(80-2780)	3(1-86)	this study
Black-footed albatross	1998-1999	open sea Japan	muscle	100(60-210)	54000(37000-210000)				(2)
Laysan albatross	1998	open sea Japan	muscle	10(6.2-73)	9500(4300-34000)				(2)
Black tail gull	1999-2001	Rishiri Is., Hokkaido, Japan	muscle	290(220-530)	6700(2700-11000)				(2)
Common cormorant	2001	Lake Biwa, Shiga Japan	muscle	530(230-820)	3100000(63000-7700000)				(2)
Little egret, Night heron	2004	coastal area South China	egg	30-1000					(3)
Cattle egret, Chinese pond heron									
Grey heron	2003-2004	Belgium	muscle	900(130-6500)	90000(5000-200000)	7200(1200-208000)	150(32-160)		(4)
			Liver	1200(58-12000)	82000(3900-310000)	15000(710-220000)	150(23-1100)		(4)
Guillemot	2000	Baltic Sea	muscle	96.9(f),66.5(m) <sup>a</sup>	7370(f), 6290(m)	13400(f), 12400(m)	305(f), 272(m)		(5)
Northern Fulmar	2003	Viðareiði, Faroe Islands	egg	24.9					(6)
Herring gull	2000	Great Lakes	egg	662(192-1400) <sup>b</sup>					(7)
Great blue heron	2002	University of British Columbia	egg	455 <sup>c</sup>					(8)
Ivory gull	2004	Canadian Arctic	egg	44.5	4877	10744	175		(9)
Yellow-legged herring	1998-2002	Coastal areas of Campania, Italy	liver		3343(120-8431) <sup>d</sup>	810(34-2434)			(10)
Black-headed gull	1998-2002	Coastal areas of Campania, Italy	liver		2079(494-5520) <sup>e</sup>	632(92-2216)			(10)
Black-headed gull	1992-1994	Nakdong River Estuary, Korea	fat		6005(1570-17000)	2037(1107-4198)	229(104-573)		(11)
Herring gull	1992-1994	Nakdong River Estuary, Korea	fat		7818(1800-24000)	2675(1136-5100)	231(81-517)		(11)
Common gull	1992-1994	Nakdong River Estuary, Korea	fat		3744(1740-5600)	2564(479-4507)	331(83-667)		(11)
Black-tailed gull	1992-1994	Nakdong River Estuary, Korea	fat		14510(6700-27000)	2578(1236-6688)	255(86-458)		(11)
Fulmar	2000-2001	Faroe Islands	muscle	16(11-24)	13000(5800-24000)	7340(1751-21200)		17(6.2-44)	(12)
Owls	2001-2003	Flanders, Belgium	muscle	250(17-480)				3(0.56-28)	(13)
Buzzard	2001-2003	Flanders, Belgium	muscle	70(12-4800)				2(0.25-95)	(13)
Sparrowhawk	2001-2003	Flanders, Belgium	muscle	1300(280-26000)				18(0.73-310)	(13)
Peregrine Falcons	1991-1999	Northern Sweden	egg					110(27-370)	(14)
Little owls	1998-2000	Charleroi, Belgium	egg	110(29-570)	2600(790-23000)	830(200-7300)	27(6-330)	1(1-6)	(15)

<sup>a</sup> f, female; m, male, <sup>b</sup> wet weight, lipid content 8.5-11.3%, <sup>c</sup> wet weight, lipid content 5.9%, <sup>d</sup> wet weight, lipid content 5.9%, <sup>e</sup> wet weight, lipid content 5%.





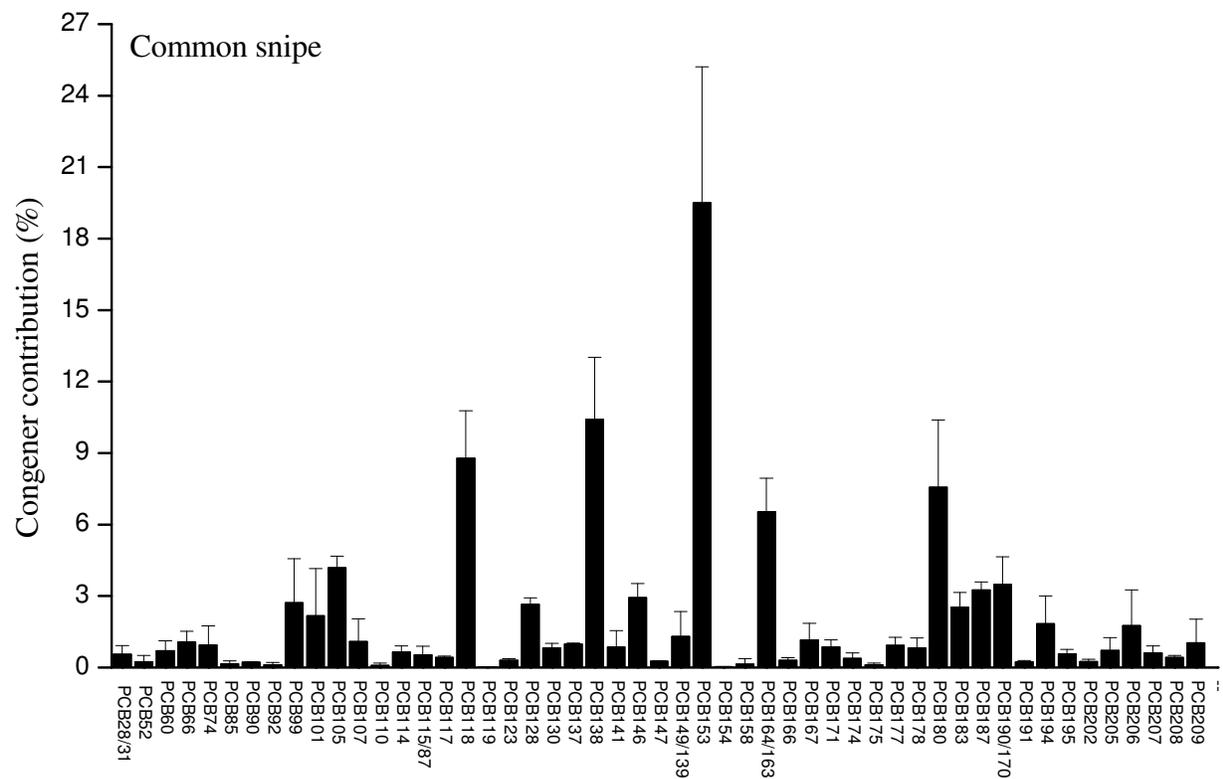


Figure S1 Congener profiles of PCBs in muscle of five bird species

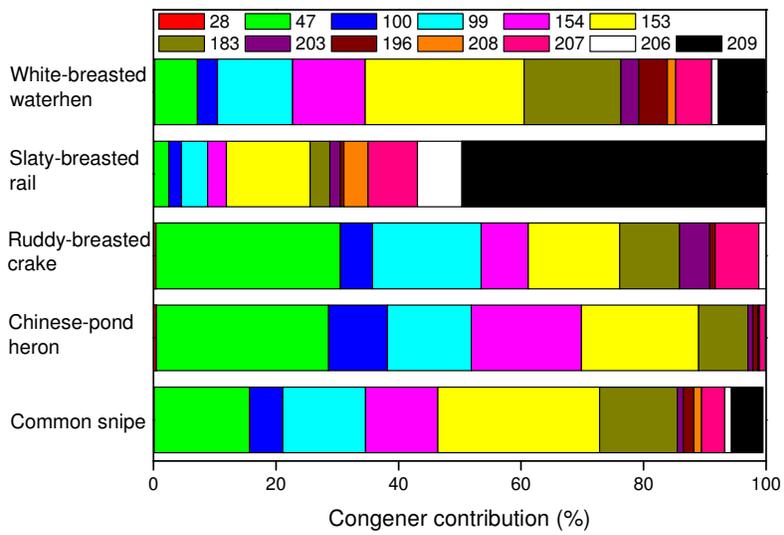


Figure S2 Congener profile of PBDEs in muscle of five birds

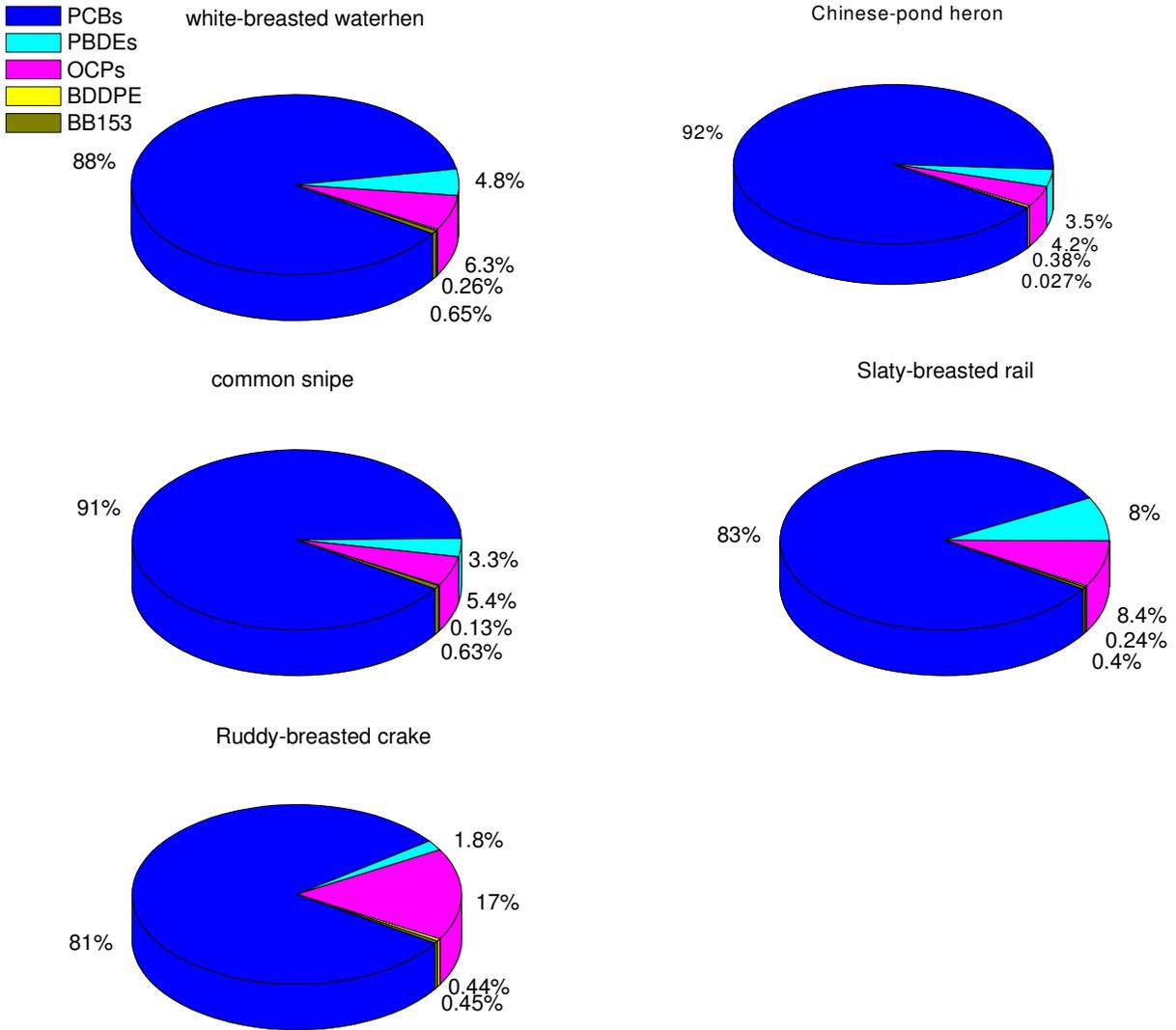


Figure S3 Contribution of each class contaminant to all PHCs

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