

Comparison of the Toxicokinetics and Bioaccumulation Potential of Mercury and Polychlorinated Biphenyls in Goldfish (*Carassius auratus*)

Jiajia Li^{†}, Ken G. Drouillard[†], Brian Branfireun[‡], and G. Douglas Haffner[†]*

Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Avenue,
Windsor, Ontario, Canada N9B 3P4

Department of Biology, Western University, 1151 Richmond Street, London, Ontario, Canada,
N6A 5B7

This supporting information is in total 10 pages, including 1 paragraph of text, 1 figure and 6 tables.

* Corresponding author e-mail: li111137@uwindsor.ca; phone: (519) 253-3000 ext 4244; fax: (519) 971-3616

[†] University of Windsor.

[‡] Western University.

Fish Food Preparation

Contaminated food pellets were prepared using a recipe consisting of 0.5L homogenized fish muscle, 16g yeast, 4g Vitamin C, 5.5g Vitamin B, 5g spirulina, 75cc cod liver oil, 120g seaweed flour, and 25g chitin powder (<http://koivet.com/>). The fish muscle used was obtained from a 2.8kg catfish (*Ictalurus punctatus*) and a 3.7kg walleye (*Sander vitreus*) collected in the Detroit River (Szalinska et al. 2006). THg levels in dorsal muscle from these fish were 1.01 and 0.25 $\mu\text{g}\cdot\text{g}^{-1}$ wet wt. respectively. High-contaminated fish food was prepared using catfish muscle, low-contaminated food used walleye muscle, and the medium-contaminated fish diet was prepared by combining catfish and walleye muscle in a 1:1 ratio. After mixing, the material was dried in a conventional food dehydrator, broken apart and put through a 2 mm sieve to generate fish pellets.

Supplemental Table 1: Lipid, moisture and lean dry weight fractions from control and dosed fish food

Fish food type	Lipid (%)	Moisture (%)	Lean dry weight (%)
Control	17.63	8.83	73.54
Low	19.80	9.18	71.04
Medium	20.50	9.16	70.34
High	20.24	12.05	67.71

Supplemental Table 2: PCB congener concentrations from control and dosed fish food

Treatment	Control (ng·g ⁻¹ lipid)	Low (ng·g ⁻¹ lipid)	Medium (ng·g ⁻¹ lipid)	High (ng·g ⁻¹ lipid)
PCB 18/17	0.00	0.00	0.00	1.42
PCB 31/28	0.00	0.00	2.37	19.74
PCB 33	0.00	0.00	0.00	0.00
PCB 52	0.00	9.72	22.12	25.81
PCB 49	0.00	4.91	15.07	30.17
PCB 44	0.00	5.41	14.07	14.05
PCB 74	0.00	0.00	0.00	15.10
PCB 70	0.00	4.48	10.18	5.28
PCB 95	0.91	17.17	22.62	53.42
PCB 101	2.26	30.43	48.26	135.55
PCB 99	0.00	9.28	20.59	100.41
PCB 87	0.00	7.51	12.97	45.95
PCB 110	1.14	23.51	38.73	139.05
PCB 151/82	0.00	13.30	17.52	47.96
PCB 149	0.00	35.19	57.23	173.83
PCB 118	1.45	13.35	32.01	163.90
PCB 153	2.73	53.44	112.39	434.38
PCB 105/132	0.00	15.58	22.75	55.87
PCB 138	2.12	42.74	87.15	359.54
PCB 158	0.00	3.81	7.60	34.14
PCB 187	0.00	24.93	46.96	175.80
PCB 183	0.00	11.42	21.27	81.33
PCB 128	0.00	8.50	14.56	56.09
PCB 177	0.00	9.44	12.86	49.28
PCB 156/171	0.00	7.34	13.85	62.39
PCB 180	0.00	36.12	72.61	275.57
PCB 191	0.00	0.00	0.45	4.72
PCB 169	0.00	0.00	0.00	0.00
PCB 170	0.00	13.54	27.40	87.69
PCB 199	0.00	9.46	15.71	59.28
PCB 195/208	0.00	2.18	6.52	25.68
PCB 194	0.00	6.19	12.85	54.58
PCB 205	0.00	0.00	0.00	4.25
PCB 206	0.00	2.73	4.96	20.93
PCB 209	0.00	0.00	3.43	23.74
sum PCB	10.61	421.70	797.05	2836.92

Supplemental Table 3: Growth rate calculations based on lipid and lean dry weight of the fish during dosing

Treatment	Days of dosing	Wet weight(g)	Lipid	Moisture	Lipid weight(g)	Dry weight(g)	Lean dry weight(g)
k_g(±SE) from linear model					0.000		0.000
R square (probability)					0.012 (0.717)		0.015 (0.694)
k_g(±SE) from logarithm model					0.000		0.000
R square (probability)					0.002 (0.874)		0.002 (0.880)
Low	0	2.1	1.80%	77.60%	0.038	0.470	0.432
Low	0	1.9	1.60%	82.70%	0.030	0.328	0.298
Low	0	2.6	1.00%	80.50%	0.026	0.508	0.481
Low	7	3.3	3.00%	78.60%	0.098	0.707	0.609
Low	7	3.8	5.50%	74.10%	0.208	0.984	0.776
Low	7	2.1	2.20%	79.30%	0.047	0.436	0.389
Low	7	2	2.60%	77.60%	0.052	0.449	0.396
Low	7	2.4	3.20%	77.80%	0.076	0.533	0.458
Low	14	3	2.60%	78.50%	0.078	0.645	0.567
Low	14	4.6	3.10%	77.20%	0.144	1.049	0.905
Low	14	1.5	1.60%	78.70%	0.024	0.320	0.296
Low	14	1.6	1.00%	79.90%	0.016	0.321	0.305
Low	14	1.6	1.60%	78.60%	0.026	0.343	0.317
k_g(±SE) from linear model					0.003 (±0.001)		0.000
R square (probability)					0.330 (0.040)		0.076 (0.203)
k_g(±SE) from logarithm model					0.034 (±0.015)		0.000
R square (probability)					0.318 (0.045)		0.043 (0.341)
Medium	0	2.4	0.80%	80.30%	0.019	0.472	0.453
Medium	0	1.7	2.00%	79.40%	0.034	0.351	0.317
Medium	0	1.6	2.40%	77.50%	0.038	0.360	0.322
Medium	7	2	3.70%	76.40%	0.075	0.472	0.398
Medium	7	3.1	3.40%	75.80%	0.107	0.751	0.645
Medium	7	2.2	1.60%	80.30%	0.036	0.434	0.398
Medium	7	2.3	1.40%	78.00%	0.033	0.506	0.473
Medium	7	1.9	3.40%	77.70%	0.065	0.423	0.359
Medium	14	3.8	--	77.40%	--	0.859	0.859
Medium	14	2.8	--	77.40%	--	0.633	0.633
Medium	14	1.9	--	77.40%	--	0.429	0.429
Medium	14	2.2	--	77.40%	--	0.497	0.497

Medium	14	2.7	--	77.40%	--	0.610	0.610
Medium	21	4.2	--	76.80%	--	0.974	0.974
Medium	21	2.7	--	76.80%	--	0.626	0.626
Medium	21	2.2	--	76.80%	--	0.510	0.510
Medium	21	1.7	--	76.80%	--	0.394	0.394
Medium	21	2.1	--	76.80%	--	0.487	0.487
Medium	28	1.5	2.40%	83.60%	0.037	0.246	0.210
Medium	28	1.5	2.60%	77.90%	0.039	0.332	0.293
Medium	28	2.8	4.40%	77.50%	0.122	0.629	0.507
Medium	28	3.7	6.10%	73.90%	0.225	0.966	0.740
Medium	28	4.2	3.80%	76.50%	0.158	0.987	0.829
k_g(±SE) from linear model					0.003 (±0.001)	0.005 (±0.002)	
R square (probability)					0.327 (0.004)	0.173 (0.048)	
k_g(±SE) from logarithm model					0.031 (±0.01)	0.000	
R square (probability)					0.323 (0.005)	0.140 (0.079)	
High	0	2.5	4.40%	77.90%	0.111	0.552	0.441
High	0	2.1	2.60%	80.40%	0.055	0.412	0.356
High	0	2	2.40%	81.20%	0.048	0.376	0.328
High	7	2	1.00%	73.60%	0.020	0.529	0.509
High	7	1.4	1.40%	78.10%	0.020	0.306	0.287
High	7	2.9	1.60%	79.20%	0.047	0.603	0.556
High	7	1.9	1.60%	77.80%	0.030	0.423	0.392
High	7	1.6	1.20%	79.40%	0.019	0.330	0.312
High	14	3.5	4.40%	77.10%	0.154	0.803	0.649
High	14	2.6	1.60%	78.80%	0.042	0.553	0.511
High	14	2.4	2.70%	74.80%	0.066	0.606	0.540
High	14	2.2	2.00%	77.40%	0.044	0.497	0.454
High	14	1.9	1.80%	78.00%	0.034	0.418	0.384
High	21	3.2	2.50%	77.20%	0.079	0.731	0.652
High	21	2.5	1.70%	76.60%	0.041	0.585	0.544
High	21	1.8	3.50%	75.40%	0.063	0.443	0.380
High	21	1.7	3.40%	77.80%	0.057	0.377	0.320
High	21	1.5	1.20%	78.40%	0.018	0.324	0.306
High	42	2	3.60%	77.40%	0.072	0.452	0.380
High	42	2	5.30%	73.70%	0.106	0.526	0.420
High	42	2	4.20%	76.40%	0.083	0.472	0.388
High	42	4.4	7.60%	72.20%	0.335	1.223	0.887
High	42	4.5	5.50%	74.30%	0.245	1.159	0.914

Supplemental Table 4: Growth rate calculations based on lipid and lean dry weight of the fish during elimination phase of the study

Treatment	Days of elimination	Wet weight(g)	Lipid percentage	Moisture	Lipid weight(g)	Dry weight(g)	Lean dry weight(g)
$k_g(\pm SE)$ from linear model					0.000		0.000
R square (probability)					0.027 (0.307)		0.016 (0.441)
$k_g(\pm SE)$ from logarithm model					0.000		0.000
R square (probability)					0.035 (0.245)		0.018 (0.409)
Low	0	3	2.59%	78.50%	0.078	0.645	0.567
Low	0	4.6	3.14%	77.20%	0.144	1.049	0.905
Low	0	1.5	1.59%	78.66%	0.024	0.320	0.296
Low	0	1.6	1.00%	79.93%	0.016	0.321	0.305
Low	0	1.6	1.60%	78.57%	0.026	0.343	0.317
Low	7	2.9	2.96%	79.52%	0.086	0.594	0.508
Low	7	3.4	5.66%	74.28%	0.193	0.875	0.682
Low	7	2.9	1.99%	78.84%	0.058	0.614	0.556
Low	7	4.4	3.84%	76.05%	0.169	1.054	0.885
Low	7	1.7	1.01%	78.07%	0.017	0.373	0.356
Low	14	1.8	2.85%	78.33%	0.051	0.390	0.339
Low	14	1.5	3.39%	76.90%	0.051	0.346	0.296
Low	14	3.4	7.48%	72.71%	0.254	0.928	0.674
Low	14	4.3	5.81%	75.63%	0.250	1.048	0.798
Low	14	4.7	7.05%	74.04%	0.331	1.220	0.889
Low	21	1.9	1.60%	81.24%	0.031	0.357	0.326
Low	21	3.8	2.99%	78.00%	0.114	0.836	0.722
Low	21	2.9	4.91%	76.31%	0.143	0.687	0.545
Low	21	4.4	3.59%	76.98%	0.158	1.013	0.855
Low	21	4.1	5.26%	77.71%	0.216	0.914	0.698
Low	28	0.9	2.49%	76.85%	0.022	0.208	0.186
Low	28	1.9	1.21%	81.09%	0.023	0.359	0.336
Low	28	2.7	2.84%	77.58%	0.077	0.605	0.529
Low	28	4.2	5.77%	73.24%	0.242	1.124	0.882
Low	28	4.4	5.54%	75.49%	0.244	1.079	0.835
Low	42	1.6	1.18%	81.19%	0.019	0.301	0.282
Low	42	1.7	1.61%	80.05%	0.027	0.339	0.312
Low	42	3.6	5.22%	76.30%	0.188	0.853	0.665
Low	42	3.3	3.82%	78.49%	0.126	0.710	0.584
Low	42	4.6	5.99%	74.76%	0.276	1.161	0.885
Low	56	1.9	2.57%	77.55%	0.049	0.427	0.378

Low	56	2.2	1.63%	78.95%	0.036	0.463	0.427
Low	56	1.8	2.18%	76.93%	0.039	0.415	0.376
Low	56	4.8	3.82%	75.59%	0.184	1.172	0.988
Low	56	4.5	3.39%	76.23%	0.153	1.070	0.917
Low	70	2.4	1.99%	77.76%	0.048	0.534	0.486
Low	70	2.9	5.26%	76.10%	0.153	0.693	0.541
Low	70	2.6	5.75%	74.95%	0.150	0.651	0.502
Low	70	4.3	8.06%	71.65%	0.347	1.219	0.873
Low	70	4.3	4.81%	75.47%	0.207	1.055	0.848
k_g(±SE) from linear model					0.000		0.000
R square (probability)					0.011 (0.506)		0.056 (0.131)
k_g(±SE) from logarithm model					0.000		0.000
R square (probability)					0.034 (0.241)		0.093 (0.053)
Medium	0	1.5	2.44%	83.58%	0.037	0.246	0.210
Medium	0	1.5	2.60%	77.88%	0.039	0.332	0.293
Medium	0	2.8	4.37%	77.54%	0.122	0.629	0.507
Medium	0	3.7	6.09%	73.90%	0.225	0.966	0.740
Medium	0	4.2	3.76%	76.51%	0.158	0.987	0.829
Medium	7	1.7	1.38%	80.23%	0.024	0.336	0.313
Medium	7	1.9	1.41%	80.13%	0.027	0.377	0.351
Medium	7	3.4	6.49%	73.50%	0.221	0.901	0.680
Medium	7	2.4	3.86%	79.05%	0.093	0.503	0.410
Medium	7	3.4	4.78%	76.33%	0.163	0.805	0.642
Medium	14	2.1	4.89%	78.81%	0.103	0.445	0.342
Medium	14	2.5	5.83%	74.74%	0.146	0.632	0.486
Medium	14	2.3	5.06%	75.56%	0.116	0.562	0.446
Medium	14	2.7	4.44%	77.00%	0.120	0.621	0.501
Medium	14	3.9	4.23%	76.84%	0.165	0.903	0.738
Medium	21	2.1	2.44%	78.74%	0.051	0.447	0.395
Medium	21	2.3	3.81%	75.20%	0.088	0.571	0.483
Medium	21	3.1	4.03%	75.88%	0.125	0.748	0.623
Medium	21	5.4	5.60%	74.72%	0.302	1.365	1.063
Medium	21	5	5.76%	74.87%	0.288	1.256	0.969
Medium	28	2.3	4.71%	75.38%	0.108	0.566	0.458
Medium	28	1.9	5.47%	75.95%	0.104	0.457	0.353
Medium	28	4.1	7.07%	74.74%	0.290	1.036	0.746
Medium	28	3.9	5.85%	75.62%	0.228	0.951	0.723
Medium	28	3.8	7.60%	75.76%	0.289	0.921	0.632
Medium	42	1.8	3.01%	77.01%	0.054	0.414	0.360

Medium	42	1.8	3.03%	76.24%	0.055	0.428	0.373
Medium	42	4	5.04%	75.14%	0.202	0.994	0.793
Medium	42	4.2	9.55%	71.88%	0.401	1.181	0.780
Medium	56	2.3	4.57%	74.83%	0.105	0.579	0.474
Medium	56	2.4	3.78%	73.88%	0.091	0.627	0.536
Medium	56	3.6	6.37%	72.72%	0.229	0.982	0.753
Medium	56	3.4	2.96%	76.38%	0.101	0.803	0.703
Medium	70	3.2	5.79%	76.41%	0.185	0.755	0.570
Medium	70	3.1	3.75%	76.98%	0.116	0.714	0.597
Medium	70	3.2	3.53%	77.62%	0.113	0.716	0.603
Medium	70	4	5.26%	75.08%	0.211	0.997	0.786
Medium	84	3.6	4.87%	75.23%	0.175	0.892	0.716
Medium	84	2.9	2.23%	79.61%	0.065	0.591	0.527
Medium	84	3.4	5.69%	75.28%	0.194	0.840	0.647
Medium	84	3	2.61%	78.49%	0.078	0.645	0.567
Medium	84	3.7	6.18%	73.09%	0.229	0.996	0.767
k_g(±SE) from linear model					0.000		0.000
R square (probability)					0.002 (0.798)		0.015 (0.435)
k_g(±SE) from logarithm model					0.000		0.000
R square (probability)					0.011 (0.501)		0.001 (0.867)
High	0	2	3.62%	77.40%	0.072	0.452	0.380
High	0	2	5.29%	73.70%	0.106	0.526	0.420
High	0	2	4.16%	76.43%	0.083	0.472	0.388
High	0	4.4	7.62%	72.22%	0.335	1.223	0.887
High	0	4.5	5.45%	74.25%	0.245	1.159	0.914
High	7	1.9	3.25%	76.41%	0.062	0.448	0.386
High	7	2.1	3.18%	76.89%	0.067	0.485	0.419
High	7	4.4	6.50%	73.25%	0.286	1.177	0.891
High	7	5.3	7.72%	72.58%	0.409	1.453	1.044
High	7	5.4	6.35%	72.75%	0.343	1.471	1.128
High	14	2.3	5.47%	75.99%	0.126	0.552	0.426
High	14	2.1	3.80%	74.31%	0.080	0.540	0.460
High	14	3.7	4.40%	75.64%	0.163	0.901	0.739
High	14	4.7	4.34%	77.01%	0.204	1.080	0.877
High	14	5.6	7.50%	74.49%	0.420	1.429	1.009
High	21	1.8	3.99%	76.59%	0.072	0.421	0.349
High	21	2.6	4.75%	72.26%	0.124	0.721	0.598
High	21	4.1	3.19%	74.29%	0.131	1.054	0.923
High	21	3.6	7.52%	74.33%	0.271	0.924	0.653

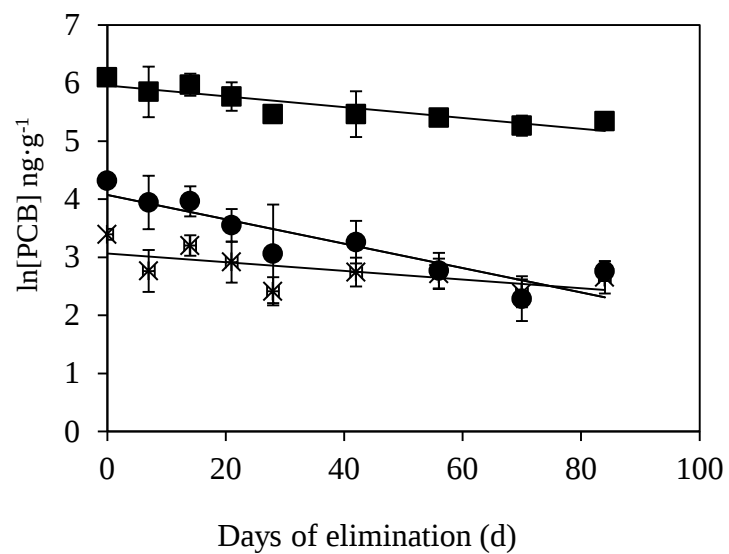
High	21	4.9	5.64%	74.19%	0.277	1.264	0.988
High	28	2.2	4.37%	75.28%	0.096	0.544	0.448
High	28	2.1	2.62%	78.40%	0.055	0.454	0.399
High	28	3.9	8.40%	71.62%	0.328	1.107	0.779
High	28	4.1	9.03%	70.00%	0.370	1.230	0.860
High	42	2.5	2.21%	76.60%	0.055	0.585	0.530
High	42	2.5	8.07%	72.94%	0.202	0.677	0.475
High	42	3.1	5.68%	74.53%	0.176	0.790	0.614
High	42	3.3	4.93%	72.22%	0.163	0.917	0.754
High	56	2.7	5.84%	74.71%	0.158	0.683	0.525
High	56	3.2	7.30%	74.67%	0.234	0.811	0.577
High	56	3.5	5.47%	75.43%	0.191	0.860	0.669
High	56	3.9	3.98%	75.85%	0.155	0.942	0.787
High	70	2.8	6.04%	74.93%	0.169	0.702	0.533
High	70	2.3	4.60%	76.28%	0.106	0.546	0.440
High	70	2.8	7.17%	73.51%	0.201	0.742	0.541
High	70	3.5	7.52%	74.98%	0.263	0.876	0.613
High	70	3	5.27%	74.33%	0.158	0.770	0.612
High	84	3.1	6.93%	72.96%	0.215	0.838	0.623
High	84	2.7	5.26%	71.64%	0.142	0.766	0.624
High	84	4	5.76%	72.56%	0.230	1.098	0.867
High	84	3.1	7.56%	72.45%	0.234	0.854	0.620
High	84	2.8	5.67%	71.27%	0.159	0.804	0.646

Supplemental Table 5: Toxicokinetic parameters (mean±standard deviation) for Hg

Chemical	Treatment	AE (%)	$k_{\text{tot}}(\text{d}^{-1})$	$t_{1/2}$ (d)	BMF (g dry wt food·g ⁻¹ dry wt fish)
THg	low	64±7	0.0124±0.003	56	3.3
	medium	80±5	0.0107±0.002	65	4.5
	high	77±3	0.0068±0.001	102	6.6
MeHg	low	102±14	0.0167±0.006	42	3.9
	medium	106±8	0.0098±0.003	71	6.5
	high	92±4	0.0109±0.002	64	4.9

Supplemental Table 6: Toxicokinetic parameters (mean±standard deviation) for PCB congeners

Congener	log K _{OW}	AE (%)	k _{tot} (d ⁻¹)	t _{1/2} (d)	BMF (g dry wt food·g ⁻¹ dry wt fish)	BMF (g lipid food·g ⁻¹ lipid fish)
PCB 95	6.13	27±4	0.0224±0.006	31	0.7	1.4
PCB 101	6.38	28±3	0.0108±0.002	64	1.5	2.9
PCB 99	6.39	38±3	0.0107±0.002	65	2.1	4.1
PCB 87	6.29	23±3	0.0173±0.002	40	0.8	1.6
PCB 110	6.48	26±3	0.0137±0.002	51	1.1	2.2
PCB 151/82	6.64/6.2	41±4	0.0107±0.002	65	2.2	4.4
PCB 149	6.67	39±3	0.0102±0.002	68	2.3	4.4
PCB 118	6.74	38±4	0.0118±0.002	59	1.9	3.7
PCB 153	6.92	44±4	0.0069±0.001	100	3.8	7.4
PCB 105/132	6.65/6.58	63±6	0.016±0.003	43	2.3	4.5
PCB 138	6.83	46±4	0.0083±0.002	84	3.2	6.3
PCB 158	7.02	44±4	0.0104±0.001	67	2.5	4.8
PCB 187	7.17	44±4	0.0098±0.001	71	2.7	5.2
PCB 183	7.2	42±4	0.0104±0.001	67	2.4	4.7
PCB 128	6.74	23±2	0.0136±0.002	51	1.0	2.0
PCB 177	7.08	40±4	0.0126±0.002	55	1.9	3.7
PCB 156/171	7.18/7.11	41±4	0.0132±0.002	53	1.8	3.6
PCB 180	7.36	44±4	0.0093±0.001	75	2.8	5.4
PCB 170	7.27	45±4	0.0078±0.002	89	3.4	6.6
PCB 199	7.2	46±4	0.0094±0.001	74	2.9	5.6
PCB 195/208	7.56/7.71	46±4	0.0107±0.001	65	2.5	4.9
PCB 194	7.8	43±4	0.009±0.002	77	2.8	5.4
PCB 206	8.09	44±4	0.0088±0.002	79	3.0	5.8
PCB 209	8.18	34±3	0.0077±0.002	90	2.6	5.0



Supplemental Figure 1: PCB elimination by high dosed fish, three congeners covering the K_{OW} range were chosen to represent the PCB elimination. Circles (●) represent PCB 95 with a log K_{OW} of 6.13; squares (■) represent PCB 180 with a log K_{OW} of 7.36; crosses (×) represent PCB 209 with a log K_{OW} of 8.18.