APPENDIX - Environmental Monitoring and Assessment

Bioaccumulation of essential and toxic elements in natural populations of *Caiman latirostris*: sentinels of pollution in a hypereutrophic urban tropical estuary

Carlos Fernando Rodrigues de Souza Neto[1], Anna Thereza de Oliveira Barbosa[2], George Tadeu Nunes Diniz[3], Caroline Cristine Augusto[4], Bruna Moreira Freire[4], Bruno Lemos Batista[4], Lucas Aparecido Rosa Leite[5], Vanessa Doro Abdallah Kozlowiski[6], Rafael Sá Leitão Barboza[1,2], Paulo Braga Mascarenhas-Junior[2,7,8], Jaqueline Bianque de Oliveira[1], Jozelia Maria de Sousa Correia[1,2*]

[1]Programa de Pós-graduação em Biodiversidade, Universidade Federal Rural de Pernambuco (UFRPE), Recife, Pernambuco, Brazil

[2]Laboratório Interdisciplinar de Anfíbios e Répteis (LIAR), Universidade Federal Rural de Pernambuco (UFRPE), Recife, Pernambuco, Brazil

[3]Fundação Oswaldo Cruz/Instituto Aggeu Magalhães, Recife, Pernambuco, Brazil

[4]Centro de Ciências Naturais e Humana, Universidade Federal do ABC (UFABC), Santo André, São Paulo, Brazil

[5]Instituto de Biociências de Botucatu (IBB), Universidade de São Paulo (UNESP), Botucatu, São Paulo, Brazil

[6]Instituto de Ciências Biológicas e da Saúde (ICBS), Universidade Federal de Alagoas (UFAL), Maceió, Alagoas, Brazil

[7]Programa de Pós-Graduação em Biologia Animal, Universidade Federal de Pernambuco (UFPE), Recife, Pernambuco, Brazil

[8]Laboratório de Ecologia, Conservação e Movimento de Vertebrados (ECOMOV), Universidade Federal de Pernambuco (UFPE), Recife, 50670-901, Pernambuco, Brazil

*Corresponding author: jozelia.mscorreia@ufrpe.br

APPENDIX

Table 3. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, Ni, and Zn in the liver of female and male *Caiman latirostris* captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Variables showing statistically significant differences between sexes ($p < 0.05$) are highlighted. Number of individuals analyzed: females (n = 8) and males (n = 14). SD: Standard Deviation.

Liver	Sex	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	Female	4808.38	38896.67	14438.17	8463.15	11617.67	0.0248	0.6642
	Male	4169.25	64693.64	19000.64	12342.82	18085.04	0.0026	
Cr	Female	70.30	926.26	234.1	106.34	293.24	**0.0002**	0.1450
	Male	10.77	437.93	123.09	90.11	111.42	**0.0029**	
Mn	Female	1236.12	4274.31	2727.73	2631.22	942.11	0.9897	0.4951
	Male	923.20	4784.41	2407.70	2234.46	1183.86	0.2377	
Fe	Female	283935.10	1850171.00	802599.4	580248.94	609208.41	**0.0245**	0.2119
	Male	92535.82	1395459.00	546682.52	384076.3	446160.84	**0.0302**	
Co	Female	10.08	46.12	27.97	22.07	13.62	0.1557	0.6163
	Male	8.68	104.83	27.13	23.6	24.27	**0.0001**	
Cu	Female	9390.57	67757.60	32096.58	28583.89	17698.83	0.4529	0.0936
	Male	6770.93	41153.95	19405.83	16588.78	10234.83	0.1641	
Zn	Female	30945.96	100459.71	68685.61	64506.47	26314.19	0.4454	**0.0230**
	Male	16125.97	67539.71	41058.08	41850.09	17354.8	0.4457	
As	Female	21.17	189.36	86.53	75.11	53.12	0.6770	0.1876
	Male	18.86	204.04	64.24	47.1	52.73	0.0019	
Se	Female	1125.92	7567.95	4031.6	3232.05	2398.75	0.3568	0.1100
	Male	699.44	7640.62	2408.3	2162.37	1803.87	0.0040	
Cd	Female	5.71	159.16	47.77	28.53	49.42	0.0170	0.1876
	Male	1.63	52.23	22.58	18.49	16.03	0.3027	
Hg	Female	42.77	341.68	141.81	122.81	99.44	0.2761	0.2973
	Male	14.41	681.67	127.03	83.11	168.89	< 0.0001	
Pb	Female	17.73	953.39	264.04	113.12	331.73	0.0167	0.8676
	Male	16.67	1516.43	248.15	117.15	392.19	< 0.0001	

Table 4. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, Ni, and Zn in the kidney of female and male *Caiman latirostris* captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Variables showing statistically significant differences between sexes ($p < 0.05$) are highlighted. Number of individuals analyzed: females (n = 8) and males (n = 14). SD: Standard Deviation.

Kidney	Sex	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	Female	4146.31	91102.91	23085.52	10918.95	29044.54	0.0010	0.1653
	Male	4487.32	92910.48	30695.51	19220.34	25446.47	0.0326	
Cr	Female	113.65	580.98	241.87	202.66	153.84	0.0365	0.8154
	Male	95.49	1940.80	481.21	245.42	580.49	0.0002	
Mn	Female	3309.22	9882.65	6105.95	6549.64	2139.91	0.5946	**0.0354**
	Male	1401.03	7706.04	4015.45	4298.85	1706.89	0.7861	
Fe	Female	101389.00	428833.70	235461.21	227344.71	95859.59	0.5168449	0.9406
	Male	54467.52	577741.70	239292.56	226340.59	141193.78	0.2359734	
Co	Female	88.95	468.91	253.30	241.73	129.48	0.8024	0.1072
	Male	89.60	301.01	165.97	159.30	62.88	0.1893	
Cu	Female	8.00	6059.57	22770.32	12594.38	11672.27	1717.55	0.0936
	Male	14.00	3264.53	12919.48	8915.28	9622.25	823.11	
Zn	Female	41548.88	134373.40	76066.38	71460.05	26553.75	0.0644	0.1360
	Male	19492.19	91565.06	58697.65	61416.72	20395.49	0.2538	
As	Female	52.62	415.10	207.87	233.20	121.22	0.6028	0.1653
	Male	16.26	638.46	144.07	79.61	161.02	0.0003	
Se	Female	2496.49	17355.15	5986.49	4024.07	4909.20	0.0030	0.12660
	Male	962.84	5154.887	3175.29	3359.33	1216.46	0.8156	
Cd	Female	42.28	369.08	122.63	92.14	105.27	0.0040	0.2382
	Male	25.45	480.43	102.24	57.21	119.70	0.0001	
Hg	Female	15.55	319.47	105.18	53.90	109.36	0.0109	0.3301
	Male	10.15	859.22	106.76	44.15	218.82	0.0000	
Pb	Female	235.79	3705.83	837.57	463.13	1165.91	0.0000	0.8154
	Male	121.72	8430.46	1445.66	601.86	2392.67	0.0000	

Table 5. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, Ni, and Zn in the muscle of female and male *Caiman latirostris* captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Variables showing statistically significant differences between sexes ($p < 0.05$) are highlighted. Number of individuals analyzed: females (n = 8) and males (n = 14). SD: Standard Deviation.

Muscle	Sex	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	Female	3344.03	27895.85	11897.10	8161.50	9723.87	0.0064	0.8154
	Male	3215.61	40669.03	15488.43	8442.90	13069.03	0.0107	
Cr	Female	169.73	372.54	263.72	259.81	79.82	0.2723	0.6642
	Male	72.55	1163.81	323.05	229.53	307.04	0.0043	
Mn	Female	171.69	540.58	363.07	354.42	117.12	0.9542	0.2653
	Male	59.99	961.06	455.32	365.79	257.93	0.4833	
Fe	Female	12042.97	55734.36	29717.29	28565.18	12613.71	0.3574	1.0000
	Male	8783.40	103774.90	33377.94	29010.68	23367.74	0.0024	
Co	Female	2.29	10.39	4.98	4.17	2.71	0.1340	0.1450
	Male	2.50	24.46	9.74	6.45	7.22	0.0288	
Cu	Female	199.07	871.44	699.04	762.01	214.88	0.0063	**0.0422**
	Male	74.75	1739.65	1046.93	961.30	448.47	0.2769	
Zn	Female	1862.08	50156.18	39232.36	44048.51	15577.81	0.0006	0.2973
	Male	1873.36	66185.42	45125.68	47661.87	17273.85	0.1464	
As	Female	183.92	318.23	251.36	253.65	45.35	0.9080	0.1348
	Male	71.48	443.85	186.38	130.26	115.73	0.5166	
Se	Female	60.95	1782.16	1129.51	1170.29	550.84	0.4685	0.3202
	Male	31.13	1299.52	905.24	949.21	336.20	0.0769	
Cd	Female	0.55	6.12	3.06	3.43	1.95	0.6973	**0.0292**
	Male	1.38	99.78	21.87	8.24	32.14	0.0012	
Hg	Female	37.16	99.62	66.49	66.15	24.03	0.5483	0.1348
	Male	17.67	878.39	106.95	32.30	233.42	0.0000	
Pb	Female	5.05	62.32	24.64	18.22	19.67	0.0889	**0.0038**
	Male	14.83	1876.00	381.70	111.25	614.88	0.0001	

Table 6. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, and Zn in the scales of female and male *Caiman latirostris* captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. No statistically significant differences were observed between sexes ($p < 0.05$). Number of individuals analyzed: females (n = 8) and males (n = 14). SD: Standard Deviation.

Scales	Sex	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	Female	4802.37	103589.00	40797.62	25235.88	37794.90	0.0293	0.2119
	Male	3703.96	48183.43	19521.56	17444.18	11912.21	0.3934	
Cr	Female	44.91	1161.79	380.69	209.17	402.32	0.0784	0.8676
	Male	53.57	4669.41	495.75	167.78	1205.02	0.0000	
Mn	Female	284.22	7759.58	1620.77	805.07	2506.65	0.0000	0.8676
	Male	303.88	40961.83	3622.87	670.14	10753.33	0.0000	
Fe	Female	44121.75	1962902.00	364425.00	127904.00	651567.60	0.0000	0.9734
	Male	42632.17	12662456.00	1050196.00	139513.90	3343910.00	0.0000	
Co	Female	8.01	78.88	32.17	24.81	24.93	0.2922	0.8154
	Male	11.40	490.73	76.37	19.05	148.93	0.0000	
Cu	Female	398.73	4081.35	2291.99	1913.89	1156.72	0.9810	0.4822
	Male	1102.17	5577.90	2121.20	1715.59	1275.09	0.0005	
Zn	Female	6627.96	46934.72	21612.20	21094.65	12709.74	0.4509	0.7639
	Male	9817.29	58185.04	20850.94	16043.82	13535.45	0.0011	
As	Female	35.89	206.48	105.29	99.43	58.70	0.6993	0.2545
	Male	28.44	660.49	122.31	58.17	171.96	0.0000	
Se	Female	298.27	1640.88	925.75	925.58	395.07	0.9189	0.1266
	Male	483.88	1264.40	738.02	699.22	192.16	0.0426	
Cd	Female	1.13	14.21	6.31	6.76	4.68	0.3790	0.5252
	Male	1.68	14.30	4.51	3.41	3.52	0.0024	
Hg	Female	2.79	77.52	38.74	37.12	24.60	0.9491	0.2973
	Male	7.04	204.58	39.97	17.03	54.75	0.0001	
Pb	Female	19.63	212.15	110.25	88.66	83.27	0.0646	0.9734
	Male	23.07	243.97	93.07	74.37	67.88	0.0135	

Table 7. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, and Zn in the liver of subadult (Class I) and adult (Class II) *Caiman latirostris* individuals captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Number of individuals analyzed: Class I (n = 17) and Class II (n = 5). SD: Standard Deviation.

Liver	Age group	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	I	4169.25	64693.64	20069.78	13418.38	17143.93	**0.0048**	0.1196
	II	5009.25	12837.38	8065.62	8002.73	3289.26	0.4602	
Cr	I	44.94	926.26	186.33	102.19	217.94	**< 0.0001**	0.0849
	II	10.77	222.03	85.72	68.30	82.08	0.2867	
Mn	I	923.20	4784.41	2753.19	2782.81	1121.25	0.8038	**0.0098**
	II	1327.30	2442.59	1745.07	1549.85	477.51	0.3233	
Fe	I	92535.82	1850171.22	643969.58	465627.71	530887.54	**0.0079**	0.9396
	II	108359.49	1326386.57	625373.58	432922.03	502080.06	0.5773	
Co	I	9.37	104.83	29.95	23.48	22.70	**0.0005**	0.3587
	II	8.68	26.01	18.90	22.92	7.75	0.2182	
Cu	I	6770.93	67757.60	25658.51	25417.35	15858.30	0.1024	0.1444
	II	12509.84	28787.14	18451.92	17081.91	6123.70	0.1655	
Zn	I	16125.97	100459.71	56309.08	59077.39	25188.75	0.4509	**0.0095**
	II	16420.06	45954.82	33408.71	35152.06	10846.04	0.6917	
As	I	21.17	204.04	82.14	65.74	55.72	**0.0264**	0.0706
	II	18.86	62.15	39.06	32.70	19.93	0.2588	
Se	I	833.67	7640.62	3430.06	2565.31	2242.53	**0.0278**	**0.0184**
	II	699.44	2162.86	1531.59	1429.55	633.60	0.4233	
Cd	I	1.63	159.16	37.42	26.95	36.36	**0.0004**	**0.0310**
	II	4.08	16.32	12.44	14.49	5.00	0.1314	
Hg	I	39.11	681.67	151.06	91.14	160.09	**< 0.0001**	0.3193
	II	14.41	97.50	68.98	87.17	35.67	0.1862	
Pb	I	16.67	1516.43	285.59	97.29	406.43	**< 0.0001**	0.9396
	II	19.02	314.46	146.27	145.14	115.34	0.8518	

Table 8. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, and Zn in the kidney of subadult (Class I) and adult (Class II) *Caiman latirostris* individuals captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Number of individuals analyzed: Class I (n = 17) and Class II (n = 5). SD: Standard Deviation.

Kidney	Age group	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	I	4146.31	92910.48	28965.49	16809.37	28834.26	**0.0015**	0.8795
	II	10485.75	48021.95	24401.59	12710.66	17568.53	0.0705	
Cr	I	95.49	1545.36	342.65	224.44	372.42	**< 0.0001**	0.8201
	II	105.79	1940.80	569.39	260.25	777.83	**0.0082**	
Mn	I	1784.39	9882.65	5122.32	4567.32	2148.46	0.7733	0.1087
	II	1401.03	5105.68	3596.90	3543.25	1527.54	0.5694	
Fe	I	93064.42	428833.71	220009.48	212322.81	97259.57	0.0689	0.4215
	II	54467.52	577741.69	298724.85	254750.17	192530.36	0.8926	
Co	I	88.95	468.91	216.52	201.40	105.39	0.1541	**0.0093**
	II	104.04	172.21	133.83	142.25	29.43	0.3502	
Cu	I	3414.23	22770.32	10969.43	11204.90	4229.01	**0.0450**	**0.0477**
	II	3264.53	10454.80	7817.72	9062.71	2867.15	0.3580	
Zn	I	24275.71	134373.40	68070.77	66343.82	24222.44	0.1126	0.2645
	II	19492.19	75933.85	54619.01	57543.93	21168.60	0.2816	
As	I	39.95	638.46	195.03	159.39	156.51	**0.0109**	**0.0583**
	II	16.26	155.82	72.88	55.35	52.56	0.5816	
Se	I	1578.03	17355.15	4695.14	3711.87	3590.68	**< 0.0001**	**0.0193**
	II	962.84	3214.46	2505.70	2773.20	916.96	0.1296	
Cd	I	35.75	480.43	126.26	95.45	122.24	**0.0001**	**0.0477**
	II	25.45	120.72	53.20	32.56	39.52	**0.0444**	
Hg	I	15.55	859.22	125.67	49.89	205.61	**< 0.0001**	0.3587
	II	10.15	56.06	39.93	48.93	18.29	0.2260	
Pb	I	121.72	8430.46	1422.20	531.62	2267.01	**< 0.0001**	0.5946
	II	248.24	1214.94	552.49	311.88	409.13	0.0918	

Table 9. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, and Zn in the muscle of subadult (Class I) and adult (Class II) *Caiman latirostris* individuals captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Number of individuals analyzed: Class I (n = 17) and Class II (n = 5). SD: Standard Deviation.

Muscle	Age group	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	I	3215.61	40669.03	16666.11	9468.42	12452.46	**0.0220**	**0.0310**
	II	4302.99	7417.38	5738.18	5632.24	1174.32	0.9824	
Cr	I	72.55	1163.81	337.48	246.34	266.27	**0.0013**	0.1636
	II	74.14	321.25	179.05	106.77	119.06	0.0712	
Mn	I	171.69	961.06	459.24	378.05	222.37	0.0925	0.1047
	II	59.99	489.04	294.41	337.43	164.34	0.9078	
Fe	I	12042.97	103774.85	33948.63	28605.37	21358.34	**0.0005**	0.5426
	II	8783.40	43100.82	25580.57	25038.68	13334.37	0.9892	
Co	I	2.29	24.46	8.52	6.08	6.35	**0.0066**	0.2177
	II	2.50	18.09	6.26	3.10	6.67	**0.0036**	
Cu	I	199.07	1739.65	991.96	8844.32	409.9	0.1002	0.2177
	II	74.75	960.76	677.19	781.87	347.44	**0.0573**	
Zn	I	1862.08	66185.42	42550.74	44522.01	14431.48	0.0700	0.3587
	II	1873.36	61185.84	44451.15	52781.29	24537.07	**0.0347**	
As	I	74.83	443.85	221.93	250.66	101.67	0.3473	0.2679
	II	71.48	244.67	157.92	157.76	89.64	0.1686	
Se	I	60.95	1782.16	1113.25	1148.67	377.61	0.1091	**0.0009**
	II	31.13	781.00	556.84	614.70	304.87	**0.0477**	
Cd	I	0.55	99.78	16.68	3.67	30.56	< **0.0001**	0.3193
	II	2.20	15.64	9.43	8.94	5.16	0.9408	
Hg	I	17.67	878.39	109.35	62.10	206.97	< **0.0001**	**0.0293**
	II	19.17	38.46	26.54	24.26	8.63	0.4551	
Pb	I	5.05	1876.00	295.40	35.89	581.66	< **0.0001**	0.4008
	II	14.83	160.13	103.81	120.33	54.04	0.2992	

Table 10. Concentrations of Al, Cd, Cr, Mn, Cu, Fe, Pb, and Zn in the scales of subadult (Class I) and adult (Class II) *Caiman latirostris* individuals captured in the Capibaribe River Basin, Recife, Pernambuco, Brazil. Number of individuals analyzed: Class I (n = 17) and Class II (n = 5). SD: Standard Deviation.

Scales	Age group	Min (µg/kg)	Max (µg/kg)	Average (µg/kg)	Median (µg/kg)	SD (µg/kg)	P1 Value	P2 Value
Al	I	3703.96	103588.96	27501.54	19366.85	28894.79	**0.0001**	0.4929
	II	13382.74	48183.43	26431.35	23740.58	14012.74	0.5021	
Cr	I	44.91	1161.79	258.49	152.55	298.32	**0.0001**	0.1404
	II	162.21	4669.41	1118.31	197.61	1987.27	0.0004	
Mn	I	284.22	7759.58	1129.14	589.94	1745.87	< **0.0001**	**0.2827**
	II	431.93	40961.83	8898.17	873.26	17928.08	**0.0003**	
Fe	I	42632.17	1962901.82	244337.22	116570.09	451190.15	**0.0001**	0.2488
	II	56110.67	12662456.04	2692881.29	205999.93	5574660.70	**0.0003**	
Co	I	8.01	78.88	24.95	19.20	18.19	**0.0006**	0.2827
	II	11.40	490.73	180.49	28.36	225.76	0.0571	
Cu	I	398.73	4081.35	1969.40	1748.85	890.21	0.6921	0.3384
	II	1360.28	5577.90	2910.58	1708.70	1907.14	0.1122	
Zn	I	6627.96	46934.72	17695.31	15854.26	9563.26	**0.0071**	**0.0246**
	II	16233.39	58185.04	32798.12	30514.35	17108.85	0.5997	
As	I	28.44	206.48	75.82	65.79	47.66	**0.0067**	0.2398
	II	43.63	660.49	247.25	186.01	255.15	0.2174	
Se	I	298.27	1640.88	823.28	760.04	290.56	0.0687	0.6453
	II	483.88	1264.40	748.50	639.58	308.04	0.2010	
Cd	I	1.13	14.21	4.95	3.15	3.81	0.0102	0.6486
	II	1.68	14.30	5.88	4.37	4.88	0.0774	
Hg	I	2.79	77.52	28.82	19.73	21.57	**0.0491**	0.5426
	II	7.04	204.58	75.91	51.35	82.45	0.3054	
Pb	I	19.63	243.97	99.24	67.47	82.07	**0.0022**	0.3587
	II	69.33	127.09	99.59	98.11	23.24	0.8938	