10.1071/MF23018

Marine and Freshwater Research

Supplementary Material

Effects of mine tailings on aquatic macroinvertebrate structure within the first year after a major dam collapse

Juliana S. Leal[A,B], *Bruno E. Soares*[C], *Joseph L. S. Ferro*[A,B], *Rafael Dellamare-Silva*[B], *Cláudia Teixeira*[B], *Virgílio José M. Ferreira Filho*[B], *and Vinicius F. Farjalla*[A,D,*]

[A]Programa de Pós-Graduação em Ecologia (PPGE), Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil.

[B]Núcleo Prof. Rogério Valle de Produção Sustentável (SAGE/COPPE), Universidade Federal Do Rio de Janeiro, Rio de Janeiro, RJ, Brazil.

[C]Institute of Environmental Change & Society, University of Regina (UofR), Regina, SK, Canada.

[D]Departamento de Ecologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil.

*Correspondence to: Vinicius F. Farjalla, Programa de Pós-Graduação em Ecologia (PPGE), Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil. Email: vinicius.farjalla@gmail.com

Table S1. Geographic coordinates of the sampled sites in the Paraopeba River.

Distance from Ferro-Carvão (km)	Latitude (DD)	Longitude (DD)
–23.58	–20.2462	–44.1365
–16.7	–20.2332	–44.1323
–12.25	–20.2138	–44.1215
–10.42	–20.2006	–44.1239
–4.26	–20.1769	–44.1494
4.03	–20.1443	–44.1905
16.25	–20.0836	–44.2073
37.74	–20.0061	–44.2597
99.95	–19.7266	–44.463
185.8	–19.3552	–44.5342
250.62	–19.1208	–44.7036

Fig. S1. Sampled microhabitats in the Paraopeba River. (A) sediment rich in organic matter; (B) sand; (C) mine tailings; (D, E, F) marginal vegetation; (G) boulder and cobble; (H) gravel.

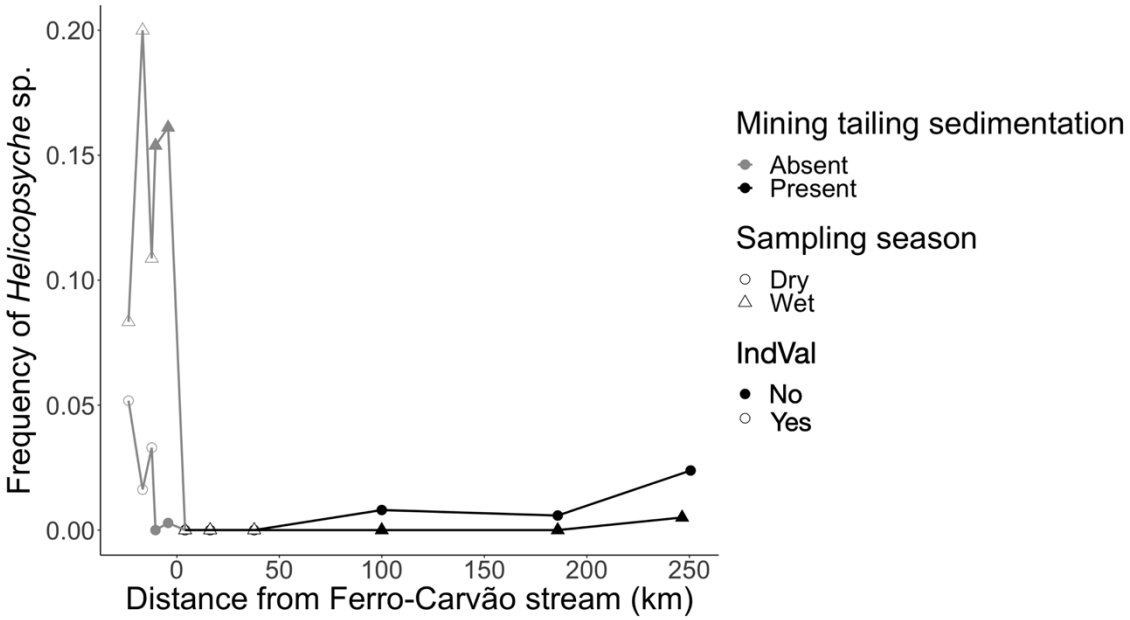

Fig. S2. Frequency of *Helicopsyche* spp. individuals in the aquatic macroinvertebrate assemblages collected along the Paraopeba river in the dry and wet seasons. The distance from the Ferro-Carvão stream equals zero in its confluence with the Paraopeba river.

Table S2. Identified macroinvertebrate taxa and their respective abundance in each site during both wet and dry seasons.

Sampling season	Wet											Dry										
Distance from Ferro-Carvão	-23.58	-16.7	-12.25	-10.42	-4.26	4.03	16.25	37.74	99.95	185.8	250.62	-23.58	-16.7	-12.25	-10.42	-4.26	4.03	16.25	37.74	99.95	185.8	250.62
Corbicula_fluminea	0	0	1	0	0	0	0	0	1	0	0	1	0	18	11	1	0	0	0	8	0	51
Bivalvia_NI	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
Ancylidae	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	7	0	0	0	15	11	17
Pomacea_sp	0	0	0	0	0	0	1	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
Biomphalaria	0	0	0	2	0	0	0	1	1	8	0	0	0	0	0	0	0	0	0	0	2	15
Lymnaea_sp	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Melanoides_turbeculatus	0	0	0	0	14	0	0	0	0	0	13	0	0	0	0	3	0	0	0	0	0	9
Physa_sp	0	0	0	1	0	0	0	0	0	1	9	0	0	1	0	1	0	0	0	4	3	87
Hirudinida	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	4	2	0	0	0	0	0	0	1	3	0	2	9	0	0	2	0	0	0
Hydracarina	0	0	1	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0
Progomphus_sp	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Cyanogomphus_sp	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1
Phyllogomphoides_sp	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	2	0
Epigomphus_sp	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Phyllocycla_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	9	1	0	2	19	2	0
Aphylla_sp	0	1	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Planiplax_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Macrothemis_sp	0	0	0	0	0	0	0	0	0	0	0	9	0	0	6	0	0	0	0	0	0	0
Idiataphe_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0
Erythrodiplax_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Elasmothemis_sp	0	0	2	1	4	0	0	0	0	0	0	0	0	2	0	5	1	5	1	0	5	3
Brechmorhoga_sp	0	0	0	0	2	0	0	0	0	0	0	0	5	20	0	2	0	0	0	12	0	0
Corduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Calopterigidae	3	1	3	5	4	2	0	4	1	0	2	1	6	0	5	8	11	3	2	20	18	4
Coenagrionidae	0	0	0	2	0	0	0	1	1	0	0	0	2	0	1	4	4	0	10	18	0	2
Perilestes_sp	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0
Baetidae	0	1	6	0	4	0	3	6	1	1	0	30	54	12	3	25	1	6	1	5	0	0
Cloeodes_sp	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	91	15
Apobaetis_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Camelobaetidius_sp	0	0	0	0	0	0	0	0	0	0	0	3	0	17	0	6	0	4	0	0	0	9
Farrodes_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Hagenulopsis_sp	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Leentvaaria_sp	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptohyphes_sp	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Paramaka_sp	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Traverhyphes_sp	0	0	1	10	11	0	1	0	0	1	0	70	6	5	1	3	1	6	1	5	14	12
Tricorythodes_sp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Polycentropus_sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atanatolia_sp	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Notalina_sp	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Leptophlebiidae	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1
Anacroneuria_sp	0	0	0	0	0	0	0	0	0	0	0	0	6	12	0	1	0	0	0	0	0	0
Paragripopteryx_sp	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Atopsyche_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chimarra_sp	0	0	0	0	0	0	0	0	0	0	0	1	0	10	0	0	0	34	0	1	0	0
Cyrnellus_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Nytiophylax_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Grumicha_sp	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Helichopsyche_sp	4	9	5	18	24	0	0	0	0	0	1	38	5	19	0	1	0	0	0	2	6	19
Leptonema_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	3	0	0	0	0
Smicridea_sp	3	2	4	0	6	0	5	5	0	4	0	0	1	7	1	0	0	73	0	0	5	7
Leuchotrichia_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Hydroptila_sp	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	1	0	1	0	0
Neotrichia_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Oecetis_sp	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Triplectides_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Nectopsyche_sp	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Limnephilidae	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Phylloicus_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Sampling season	Wet											Dry										
Distance from Ferro-Carvão	-23.58	-16.7	-12.25	-10.42	-4.26	4.03	16.25	37.74	99.95	185.8	250.62	-23.58	-16.7	-12.25	-10.42	-4.26	4.03	16.25	37.74	99.95	185.8	250.62
Corydalus_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ambrysus_sp	0	0	0	13	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Limnocoris_sp	2	0	1	0	1	0	0	0	1	0	2	2	0	1	0	0	0	0	0	0	2	3
Pelocoris_sp	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Belostomatidae	0	0	0	0	0	0	0	0	0	0	0	2	0	9	0	0	2	3	0	0	0	1
Belostoma_sp	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	3	0	1	0	0	0	0
Hebridae	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0
Neogerris_sp	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachymetra_sp	0	1	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	5	3	0
Brachymetra_albinervis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cylindrostethus_sp	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Tachygerris_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Trepobates_sp	0	9	0	7	11	1	0	1	0	0	27	0	0	0	0	0	0	0	0	0	0	0
Stridulivelia_sp	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0	0
Tenagobia_sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
Notonectidae	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0
Martarega_sp	0	5	0	5	1	0	0	2	0	0	12	0	0	0	0	0	0	0	0	5	0	0
Ranatra_sp	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	1	0	0
Veliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0
Rhagovelia_sp	0	0	0	0	0	0	0	0	0	0	0	12	7	32	0	59	1	9	0	0	8	0
Pyralidae	0	0	0	0	0	0	2	0	0	0	0	3	1	0	0	5	1	1	0	0	0	6
Dryopidae	0	0	2	5	1	0	0	0	0	0	0	2	0	2	0	2	0	0	0	1	0	1
Dysticidae	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Heterelmis_sp	0	0	1	3	2	0	0	0	0	0	0	4	2	0	1	0	0	1	0	0	0	1
Macrelmis_sp	0	0	1	0	5	0	0	0	0	1	0	3	4	13	1	0	0	1	0	0	1	9
Microcylloepus_sp	1	0	0	5	0	0	2	0	0	0	0	3	1	3	0	0	0	0	0	0	0	0
Neoelmis_sp	0	1	0	5	35	0	1	2	0	20	82	1	0	6	0	0	0	0	0	0	26	17
Phanocerus	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
Elmidae_sp1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Elmidae_sp2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gyrinidae	0	0	0	1	0	0	0	0	0	0	0	0	1	9	0	0	1	0	2	0	0	0
Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hydrophilidae	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	55	0
Lampyridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Torrindiculidae	3	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lutrochidae	2	0	0	0	0	0	1	0	0	0	0	2	0	4	0	0	0	0	0	0	0	0
Staphylinidae	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	2	0	0	0	0
Coleoptera_NI	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Culicoides_sp	0	1	0	0	0	0	0	0	0	0	0	8	6	3	4	0	0	9	7	1	12	5
Dasyhelea_sp	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atrichopogon_sp	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0
Chironominae	1	2	0	1	1	0	4	0	0	4	0	144	109	93	5	75	7	108	877	92	559	384
Stenochironomus_sp	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	2	0	2	4	6	2	12
Orthocladiinae	0	0	2	0	1	0	1	2	0	0	0	192	48	97	0	37	5	71	32	23	87	52
Tanypodinae	0	0	0	2	4	0	0	0	0	0	0	10	8	6	5	7	1	10	126	3	28	33
Tipulidae	0	1	0	0	0	0	0	0	0	0	0	42	2	3	3	2	0	0	0	1	0	0
Empididae	0	0	0	0	0	0	0	0	0	0	0	33	1	14	0	0	0	2	0	0	58	3
Simulidae	2	0	2	2	2	0	15	0	0	1	0	12	17	136	0	59	0	44	0	0	1	5
Stratiomydae	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxonomic richness	**12**	**15**	**15**	**26**	**28**	**3**	**15**	**15**	**9**	**14**	**18**	**40**	**29**	**38**	**20**	**38**	**17**	**28**	**18**	**23**	**30**	**36**
Abundance of individuals	**48**	**45**	**46**	**117**	**149**	**5**	**54**	**33**	**10**	**48**	**198**	**734**	**308**	**576**	**63**	**351**	**42**	**408**	**1083**	**249**	**1029**	**797**

Table S3. Result of the Indicator Value (IndVal) analysis, highlighting the value of IndVal index for each taxon in the upstream and downstream sites' groups and their associated *P*-value

Sampling season Distance from Ferro-Carvão	IndVal Upstream	 Downstream	 *P*
Corbicula_fluminea	0.50	0.00	0.189
Bivalvia_NI	0.17	0.00	1.000
Physa_sp	0.17	0.00	1.000
Oligochaeta	0.22	0.06	0.722
Hydracarina	0.33	0.00	0.449
Progomphus_sp	0.17	0.00	1.000
Cyanogomphus_sp	0.17	0.00	1.000
Phyllogomphoides_sp	0.08	0.08	1.000
Epigomphus_sp	0.17	0.00	1.000
Aphylla_sp	0.17	0.00	1.000
Macrothemis_sp	0.17	0.00	1.000
Brechmorhoga_sp	0.33	0.00	0.462
Cloeodes_sp	0.17	0.00	1.000
Camelobaetidius_sp	0.28	0.03	0.743
Leentvaaria_sp	0.17	0.00	1.000
Leptohyphes_sp	0.17	0.00	1.000
Paramaka_sp	0.08	0.08	1.000
Traverhyphes_sp	0.60	0.07	0.514
Tricorythodes_sp	0.17	0.00	1.000
Atanatolia_sp	0.17	0.00	1.000
Leptophlebiidae	0.17	0.00	1.000
Anacroneuria_sp	0.33	0.00	0.486
Paragripopteryx_sp	0.17	0.00	1.000
Atopsyche_sp	0.17	0.00	1.000
Grumicha_sp	0.17	0.00	1.000
Helichopsyche_sp	**1.00**	**0.00**	**0.004**
Leptonema_sp	0.08	0.08	1.000
Hydroptila_sp	0.28	0.03	0.420
Oecetis_sp	0.17	0.00	1.000
Limnephilidae	0.17	0.00	1.000
Limnocoris_sp	0.67	0.00	0.067
Belostomatidae	0.23	0.10	0.893
Brachymetra_sp	0.33	0.00	0.454
Trepobates_sp	0.14	0.06	1.000
Corixidae	0.10	0.07	1.000
Notonectidae	0.11	0.06	1.000
Martarega_sp	0.12	0.05	1.000
Rhagovelia_sp	0.42	0.05	0.336
Dryopidae	0.50	0.00	0.168
Dysticidae	0.33	0.00	0.429
Heterelmis_sp	0.44	0.02	0.279
Macrelmis_sp	0.64	0.01	0.108
Microcylloepus_sp	0.53	0.03	0.157
Neoelmis_sp	0.36	0.09	0.654
Phanocerus	0.17	0.00	1.000
Elmidae_sp1	0.17	0.00	1.000
Gyrinidae	0.26	0.08	0.867
Torrindiculidae	0.13	0.04	1.000
Lutrochidae	0.44	0.02	0.188
Coleoptera_NI	0.17	0.00	1.000
Atrichopogon_sp	0.17	0.00	1.000
Tipulidae	0.67	0.00	0.066
Empididae	0.48	0.01	0.320
Simulidae	0.62	0.09	0.193