

Water quality and phyto-zooplankton communities from mining areas in the upper Paraopeba watershed, Minas Gerais, Brazil.

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The Alto Paraopeba region in Minas Gerais State, comprising municipalities of Congonhas, Jeceaba, Belo Vale, Ouro Branco, among others, is one of the largest iron producer areas in Brazil. This area has been intensely exploited in terms of mining activities, what can become a potential source of heavy metal contamination to the water bodies surrounding the mine areas. The presence of heavy metals in aquatic ecosystems may cause negative impacts not only on biological communities, but also on the human population health due to the bio-magnification through the food chain and its toxic effects.

To provide insights into this issue, characteristics of water condition and description of phyto- and zooplankton communities from streams around the mining areas in the Upper Paraopeba watershed (Iron Quadrangle) have been examined in this work. Water samples were taken to quantify the concentrations of metals (total and dissolved) and nutrients (nitrogen and phosphate) and to describe the phyto- and zooplankton communities present. The location and names of each site are showed in Figure 1. Mãe d’Água was considered the reference area. The nutrients results showed a high concentration of total nitrogen in five sampling sites (Table 1).

However, the concentrations of nitrate and nitrite were very low. These results suggest that the main contributor to the total nitrogen comes from organic material (untreated sewage).



Figure 1. Image taken from google earth showing the location of the nine field sites (yellow) and the major surrounding municipalities (red)

Table 1. Nutrients concentrations in streams at the Upper Paraopeba watershed. Sampling date: July/August 2014.

Sampling sites	Total-N	Nitrite	Nitrate	Ammonium	Total-P	Phosphate
		mg/L				
Mãe d’água	0.109	0.000	0.004			
	4	1	2	0.0672	<BLD	<BLD
		0.000	0.003		0.244	
Maria José	1.1	5	1	0.0281	3	0.0027
		0.005	0.003			
Luis Ventura	28.43	8	4	2.31	2.672	0.4484
		0.059	0.012			
Bananeiras	16.87	2	8	2.31	1.345	0.3412
			0.108		0.280	
Maranhão	9.233	0.111	6	2.368	7	0.125
			0.006		0.618	
Gurita	14.41	0.006	6	0.633	8	0.3262

		0.010	0.004		0.526	
Soledade	8.932	5	3	0.4529	6	0.2
	0.597	0.000	0.002		0.017	
Ponciana	9	7	9	0.0389	2	0.0
		0.001			0.075	
Paraopeba	1.768	1	0.003	0.1326	3	0.0

*< BDL: Below detection limit.

Additionally, the concentrations of total phosphate exceeded 0.15 mg/L reference value by legislation - CONAMA Res. 0357 for waters of class 3 (human consumption after conventional treatment) in six sites. The total and dissolved metal concentrations (Al, As, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Ni, Pb, Si and Zn) did not exceed the established limits except for manganese and aluminium which concentrations are showed in Figure 2.

The diversity of phyto- and zooplankton communities is considered low, although these results are the ones expected for lotic and impacted environments. Some representative members of phytoplankton community are showed in Figure 3. We have recorded in the field samples more than 30 morphologically distinct phytoplankton strains.

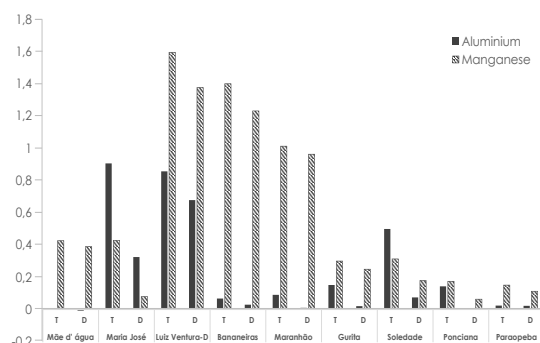


Figure 2. Aluminium and manganese concentrations in streams from the Upper Paraopeba watershed. T= total; D = Dissolved. Sampling date: July/August 2014. Limits of these metals according to the CONAMA to water class 3= 0.2 and 0.5 mg.L⁻¹ respectively.

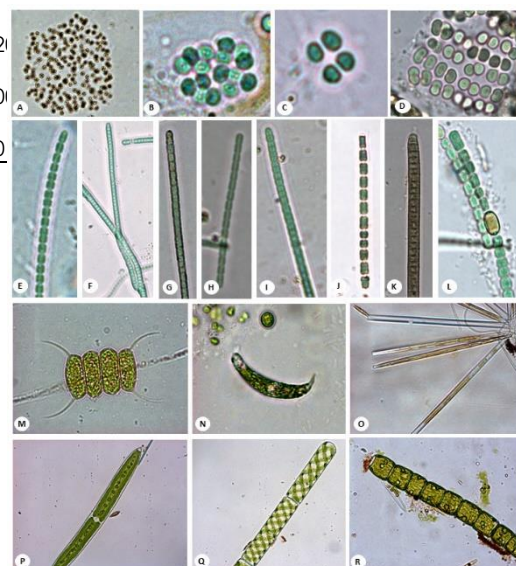


Figure 3. Photomicrographs of representative morphotypes of the phytoplankton community recorded in streams from Upper Paraopeba watershed. **A-L:** morphotypes of cyanobacteria; **M-R:** morphotypes of eukaryotic microalgae group.

In the zooplankton community 16 taxa were recorded (Table 2) with dominance of Rotifers and Protozoa. Rotifers have been reported as a common group in freshwater ecosystems since they are quantitatively more abundant among the three principal zooplankton groups. According to Sarma et al., (2007) they are opportunistic, with short life cycle and able to utilize a wide variety of food resources. *Brachionus*, often found in the samples, and several species of Bdelloidea class are also considered tolerating gross pollution and recognized as indicators of environments rich in organic matter (Sladeczek, 1983) as well as Chironomidae (Marques et al., 1999). Conversely, the Protozoa testate amoebae (*Arcella* sp., *Centropyxis* sp., *Cyphoderia* sp., *Diffugia* sp.) are unable to survive in highly variable environments.

Table2. Zooplankton community from the Upper Paraopeba watershed.

Zooplankton Community	
Protozoa	Rotifera
<i>Arcela</i> sp.	<i>Asplanchna</i> sp.
<i>Arcela hemisphaerica</i>	Bdeloidea
<i>Arcela rotundata</i>	<i>Brachionus angularis</i>
<i>Centropyxis discoides</i>	<i>Brachionus calyciflorus</i>
<i>Cyphoderia ampulla</i>	<i>Lepadella patella</i>
<i>Diffugia</i> sp.	
<i>Epistylis</i> spp.	
<i>Vorticella</i> sp.	Chironomidae
Ciliophora NI	Nematoda

Taken together our results demonstrate that mining activities are not the only potential source to water bodies contamination. Instead, the lack of sewage treatment is the major contributor to water pollution in the Upper Paraopeba watershed. Understanding the factors that disturb the natural dynamic of these water bodies is crucial for predicting future threats as well as understanding how they can affect the health of human population. Despite preliminary this work provides results that can help to design positive measures for preserving aquatic ecosystems, including living resources in mining areas.

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