

Environmental aspects of the Nhecolândia Area, Brazilian Pantanal

The Brazilian Pantanal is characterized by tropical wet and dry climate (Köppen classification – Aw), and is subject to the Intertropical Convergence Zone (ITCZ) seasonal migration, with wet (~855 mm rainfall) and hot (~32 °C average temperature) summer season, and mild (~21 °C) and dry (~180 mm rainfall) winter season (Tarifa, 1986; Furian et al., 2013; Bergier et al., 2014). Additionally, the region is characterized by a ~300 mm hydrologic deficit: while mean annual precipitation is ~1,100 mm, annual evapotranspiration is ~1,400 mm (Furian et al., 2013). The ongoing subsidence of this active sedimentary basin started in the Paleogene, and is recorded by >500 m-thick sedimentary succession (Assine and Soares, 2004). Basin sediments record several episodes of climate change, with fluctuations between wet and semi-arid conditions prior to the establishment of the current tropical/savannah-like climate (Assine et al., 2016).

The Soda Lakes in the Nhecolândia region, located in abandoned lobes in the modern Taquari megafan, Brazilian Pantanal, are characterized by high alkalinity resulting from high concentration and solubility of CO_3^{2-} (Andreote et al., 2018) and high concentration of Na^+ , and associated high levels of electroconductivity (Furian et al., 2013). In this highly complex hydrologic system, the chemical equilibrium and the ecological parameters are a function of long- and short-term rainfall trends, water biogeochemistry and substrate permeability (Bergier et al., 2016). These lakes are prolifically colonized by sulfate-reducing prokaryotes, diatoms, extremophile ammonia-oxidizing, and methanogenic Archaea (Duarte et al., 2012), and bacterial mats are commonly developed (Guerreiro et al., 2018). Evaporation is induced by highly variable winds (up to 6 m/s during the winter) resulting from thermal contrast

between saline lakes and the surrounding vegetated areas, with high levels of evapotranspiration leading to water-table variations which result in highly-variable solute concentrations (Quénol et al., 2006; Andreote et al., 2018; McGlue et al., 2014).

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Materials and methods: Location of saline lakes, collection, and description procedures

The structures analyzed here occur in an isolated soda lake informally named as Burro Branco (= White Donkey) (Fig. 1D) (S19°29'36"/W56°09'31"), located in the Barranco Alto Farm, Pantanal of Nhecolândia, State of Mato Grosso do Sul, Brazil. This lake is characterized by black waters, mean water temperature of 36°C, mean salinity of 2560 ppm, and pH of 9.8. The structures were produced under very shallow water conditions (less than 10 cm of depth) and 1-2 m away from the lake shoreline (Fig. 2A). In general, winds blow from W to E and NW to SE, and present mean velocities varying between minimum and maximum of 4 and 6 m/s, respectively (historical series from the Brazilian National Institute of Meteorology). The pseudotraces were observed over a period of three days, and described during a field trip in the autumn-winter of 2015, the regional dry season and the only period when the low topographic areas are not fully flooded. The soda lakes are isolated from flooding waters, and do not dry completely in the dry season that affect seasonally the Brazilian Pantanal from July to October. The epibenthic microbial mats were described macroscopically in the field, sampled, and fixed in hermetic flasks using Transeau solution (1:1) or 4% formaldehyde. These samples were observed and preliminary described under stereoscopic microscope housed in the Department of Applied Geology, São Paulo State University.

All structures described were photographed and recorded *in situ* in order to analyze their generation by the associated sedimentary processes. All the pseudotraces and related structures were observed during their formation. The analyzed chemical and physical parameters (i.e. pH, temperature and salinity) of the water from the soda lake were obtained

using a portable waterproof probe (model Oakton PCSTestr 35). The sediment of the bottom lake was macroscopically characterized in terms of its texture following the Schnurrenberger et al. (2003) protocol for the analysis of lacustrine sediments. All pseudotraces were measured and described in detail in terms of their type of preservation, morphology, continuity, and sediment constitution.

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FIGURE CAPTION

FIGURE DR1 - Width x length comparison between Pantanal pseudotraces, late Ediacaran to early Cambrian simple trace fossils and pseudotraces produced in the laboratory. The color rectangles represent the maximum and minimum limits of length and width measured. An overlap area between the Pantanal trace fossils and those from the fossil record exists at 0.6 x 1.5 cm wide and 9.8 x 25 cm long. Sources: 1 - Weber et al. (2007); 2 - Liu et al. (2010); 3 - Mariotti et al. (2016); 4 - Meyer et al. (2014) and Chen et al. (2013); 5 - Narbonne and Aitken (1990); 6 - Carbone and Narbonne (2014); 7 - Hofmann and Mountjoy (2010); 8 - Jensen and Palacios (2016); 9 - Geyer and Uchman (1995); 10 - Cribb et al., (2019); 11 - Jensen et al. (2003); 12 - Jensen et al. (2006); 13 - Evans et al. (2019). Gr. - Group; Fm. - Formation; Mb. - Member; Lab. exp. - Laboratory experiment.

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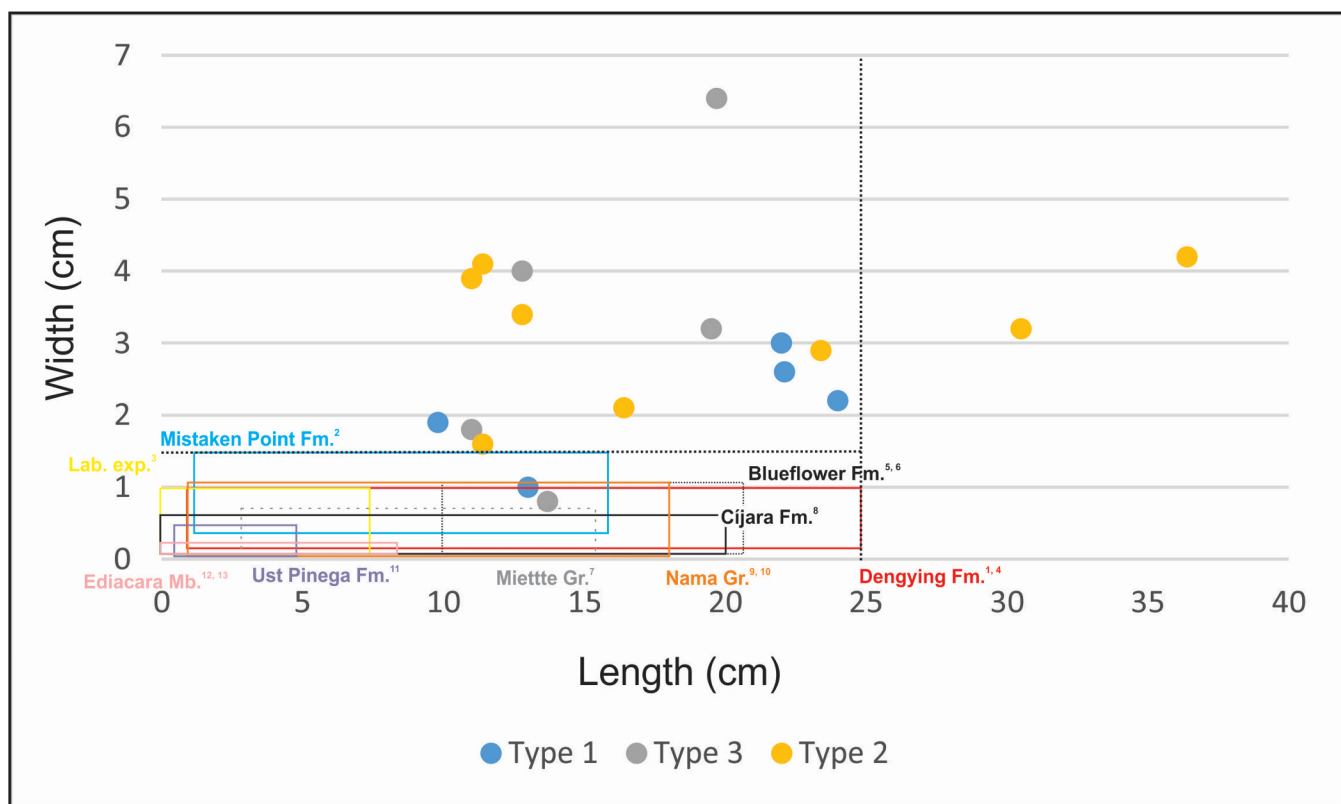


Fig. S1