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Check-list de *Charophytas* de lagoa urbana em Aquidauana, com novos registros para Mato Grosso do Sul, Brasil

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RESUMO

O conhecimento sobre a composição, abundância e distribuição de espécies que compõem o fitoplâncton, é relevante para a compreensão da dinâmica dos ecossistemas aquáticos e para o monitoramento da qualidade da água. Considerando a inexistência de informações na área da ficologia no município de Aquidauana (MS) e visando contribuir para ampliar o conhecimento acerca do assunto na região, o objetivo deste estudo foi realizar um levantamento qualitativo de algas verdes Charophyta, no Parque Natural Municipal da Lagoa Comprida. O estudo foi conduzido entre fevereiro e novembro de 2019, abrangendo quatro coletas amostradas em três pontos distribuídos ao acaso na lagoa. As amostras foram coletadas seguindo o protocolo de filtragem com rede de plâncton. Registramos 125 (morfo)espécies de Charophyta, distribuídos em 19 gêneros, pertencentes a classe *Zygnematophyceae*. Do total identificado, 79 espécies e quatro gêneros constituem novos registros para o Estado de Mato Grosso do Sul. A riqueza registrada no presente estudo, equivale a 15% de toda a riqueza conhecida de fitoplâncton no estado e constitui um avanço no conhecimento sobre grupo na região.
Palavras-chave: Ambientes lênticos, Bacia do Rio Paraguai, Microalgas, Taxonomia.

THE CHECK LIST OF CHAROPHYTAS OF AN URBAN LAKE IN AQUIDAUANA, WITH NEW RECORDS FOR MATO GROSSO DO SUL, BRAZIL

ABSTRACT

Knowledge about the composition, abundance, and distribution of phytoplankton species is crucial for understanding the dynamics of aquatic ecosystems and monitoring water quality. Given the lack of information in the field of phycology in the city of Aquidauana (MS) and with the aiming to contribute to the expansion of knowledge about the subject in the region, this study sought to conduct a qualitative survey of green algae (Charophyta) in the Lagoa Comprida Natural Park. The research spanned from February to November 2019, encompassing four collections sampled at three randomly distributed points in the lagoon. The samples were collected following the plankton net filtering protocol. A total of 125 morphological species of Charophyta were documented, distributed across 19 genera and belonging to the class *Zygnematophyceae*. Notably, 79 of the identified species and four genera represent new records for the State of Mato Grosso do Sul. The richness recorded in the present study is equivalent to 15% of all known phytoplankton richness in the state and constitutes an advance in knowledge about the group in the region.
Keywords: Lentic environments, Paraguay river basin, Microalgae, Taxonomy.

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Introduction

There are numerous organisms inhabiting aquatic ecosystems, with the phytoplankton community standing out as the most crucial. They play a pivotal role in the primary productivity of aquatic environments and are considered excellent bioindicators (Rodrigues 2004). This diverse taxonomic group constitutes the photosynthetic portion of aquatic plankton, encompassing members of the Eukaryote domain (Protozoa, Plantae, and Chromista) and the Prokaryotic domain (Bacteria) (Falkowski *et al.* 2004).There are more than 50,000 species of algae recorded globally (Guiry 2024). Note that they only considered species that are taxonomically valid based on many monographs, journals, and national and local lists. After looking into various studies conducted across Brazil, the estimate is around 10,000 species of microscopic algae (Agostinho *et al*. 2005). It is important to highlight that most research on phytoplankton is primarily concentrated in the South and Southeast regions of the country (Bicudo & Menezes 2010).

The phylum Charophyta, belonging to green algae, comprises 5,676 species worldwide (Guiry & Guiry 2020). In Brazil, there are approximately 420 species distributed across 35 genera, including 11 endemic species (Bicudo & Menezes 2010). Algae in this phylum may be single-celled, filamentous unbranched, parenchymal, microscopic, or macroscopic. Certain cellular structures and biochemical evidence found in charophytes are commonly observed in plants, making this phylum a key candidate for tracing the ancestry of plants. Charophyta are predominantly found in freshwater but can also be present in salty water (Raven *et al.* 2014).

Charophyta are classified into six classes: Charophyceae, Chlorokybophyceae, Coleochaetophyceae, Klebsormidiophyceae, Mesostigmatophyceae, and Zygnematophyceae. Among these, the class Zygnematophyceae has the highest number of described species (4,146), followed by Charophyceae (679) (Guiry & Guiry 2020). Despite the increasing research on phytoplankton in the country, there is a lack of studies on charophytes in the state of Mato Grosso do Sul. Bueno *et al*. (2018) review of the Charophyceae class reported 16 species in the state. Moresco *et al*. (2015) documented 43 species for Zygnematophyceae, Dos Santos (2019) described 13 new genera, and Silva & Godoy (2018) listed 16 species of *Zygnemaphyceae* (339 species in total). All these studies emphasize the deficiency of research in the state, particularly in the countryside and, to our knowledge, no research has been conducted on phytoplankton in the municipality of Aquidauana.

Knowledge about the composition, abundance, and distribution of species in the phytoplankton community is relevant for understanding and monitoring the quality of water that will be used for various purposes. In pursuit of this knowledge, the objective of this work

was to carry out an inventory of Charophyta species. We are actively seeking to contribute and expand the knowledge of microalgae in the state of Mato Grosso do Sul and support aspects of the management plan for an urban lake in the municipality of Aquidauana.

Methodology

This research was conducted in the Lagoa Comprida Municipal Natural Park, located in the central zone of the municipality of Aquidauana in the state of Mato Grosso do Sul, situated in an ecotone area between Cerrado and Pantanal (Figure 1). The park covers a total area of 74.2 hectares, and the water slide extends over 27 hectares, exhibiting semi-lentic water quality characteristics (Souza & Martins 2010). The region's climate is classified as tropical rainy savanna subtype Aw (Peel *et al.* 2007) characterized by two distinct seasons: a dry and cold period (winter) from May to September and a rainy and hot period (summer) from October to April. The average annual precipitation is 1,200 mm, with maximum temperatures reaching 33 degrees Celsius and minimum temperatures at 19 degrees Celsius (Schiavo *et al.* 2010).

The fieldwork consisted of four campaigns in 2019 (February, May, August, and November) with three points randomly distributed across the lake (Figure 1). Qualitative samples were collected in three points by campaign (total 12 collection points) by filtering 100 liters through a plankton net with a mesh size of 20 micrometers from the water's surface. The collected samples were placed in polyethylene bottles, labeled, and preserved in Transeau solution at a 1:1 ratio (Bicudo & Menezes 2006) for a few days until laboratory analysis.

For taxonomic analyses, the samples were homogenized by shaking the bottles, and subsequently, the samples were distributed in drops on temporary slides protected by cover glass. The samples were observed under an optical microscope using the zigzag scanning technique. It's noteworthy that for each sample, 15 slides were prepared to ensure a comprehensive survey of the species present in the samples totaling 180 slides.

The subsequent step involved photomicrography, where a magnification of 50x was considered the standard. Taxa identification was carried out with the assistance of identification keys and morphological comparison using specialized bibliographic material for each taxonomic group (De Lamonica-Freire & Bicudo 1985, Bicudo 2007, Oliveira 2011, Oliveira *et al.* 2016). The final classification of species was verified in AlgaeBase, a global database that is regularly updated with taxonomic information, nomenclature, and distribution of algae, using taxonomies that serve as references in each specific area.

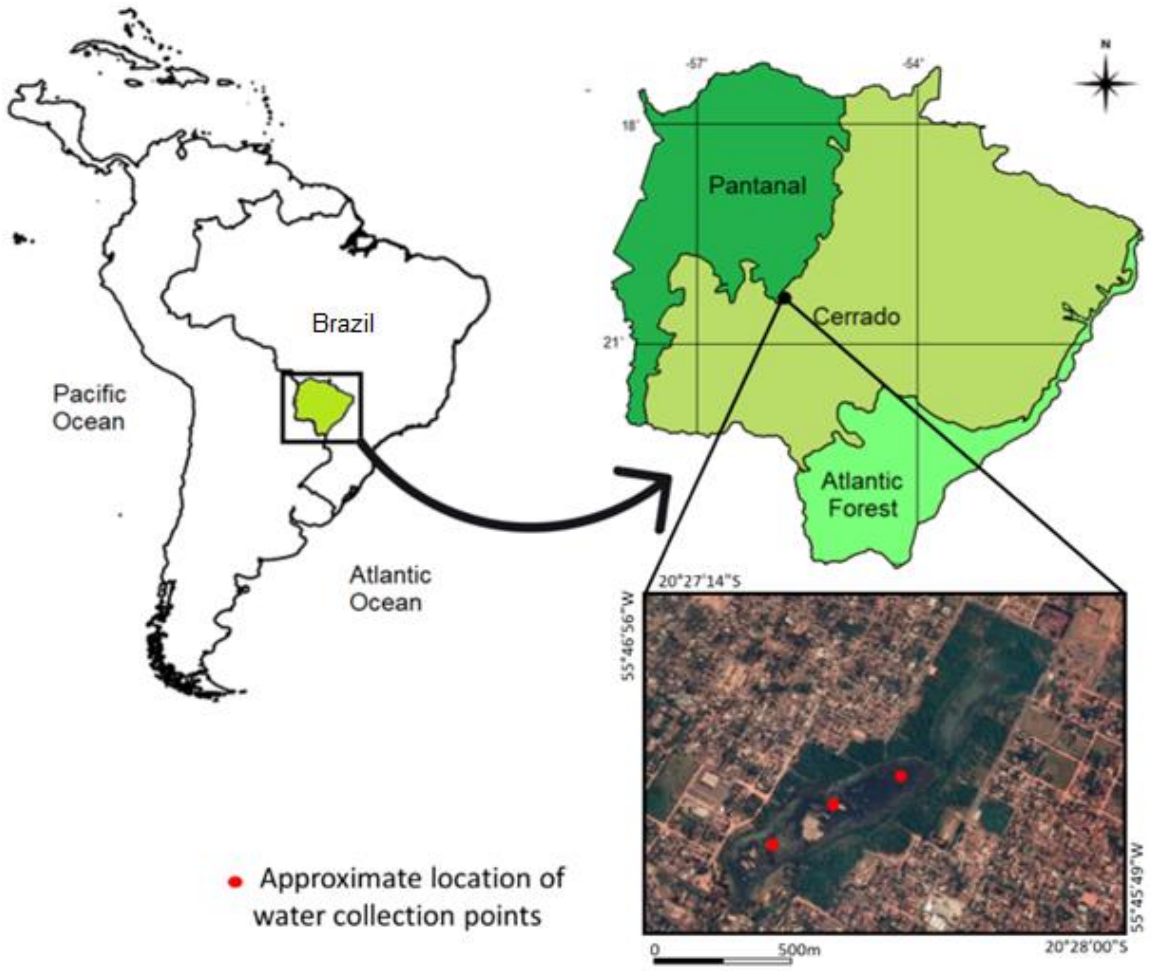

Figure 1. Location of the study area, Lagoa Comprida Municipal Natural Park, municipality of Aquidauana, Mato Grosso do Sul, Brazil.

Results and discussion

Charophyta is a phylum belonging to the Eukaryota domain within the kingdom Plantae. Our survey of Charophyta in the Municipal Natural Park of Lagoa Comprida documented 125 morphological species, with new records of 79 species and four genera to the state (Table 1, Figures 2, 3 and 4), all falling under the class *Zygnematophyceae*, with a notable prevalence of the *Desmidiales* order. In comparison to other groups of green algae, *Zygnematophyceae* exhibits significant morphological diversity in continental aquatic ecosystems (Wehr & Sheat 2003). These microalgae that are a part of this class can be found in periphyton, phytoplankton, and metafiction (Šťastný 2010). As noted by Coesel (1982, 1996) the Charophyta phylum is commonly present in oligotrophic to mesotrophi nmc environments, particularly in acidified aquatic ecosystems; although some species have been recorded in alkaline environments (Brook

1981). Charophyta demonstrate high sensitivity to environmental changes and can be utilized for monitoring, management, and conservation of aquatic systems (Coesel 2001).

In the study area, three of four *Desmidiales* families were identified: *Closteriaceae* (9 species) *Gonatozygaceae* (3), and *Desmidiaceae* (110), with the *Desmidiaceae* family exhibiting significantly higher richness. The family *Zygnemataceae*, belonging to the order *Zygnematales*, was represented by only three species. *Desmidiaceae* has a cosmopolitan distribution, occurring in periphyton, metaphyton, and plankton across almost all freshwater environments (Coesel 1996). This family contributes approximately 70% of the total known species of *Zygnematophyceae* (Gontcharov & Melkonian 2005) and its abundance is expected in surveys of this group.

Table 1 – Occurrence of Charophyta species in the Municipal Natural Park of Lagoa Comprida (Aquidauana, MS), in different months [February (F), May (M), August (A), November (N)]

Family	Species	Months			
		F	M	A	N
Closteriaceae	*Closterium angustatum* Kützing ex Ralfs*		X		
Closteriaceae	*Closterium braunii* Reinsch*		X		
Closteriaceae	*Closterium closterioides* (Ralfs) A. Louis & Peeters *				X
Closteriaceae	*Closterium kuetzingii* Brébisson	X	X	X	X
Closteriaceae	*Closterium lagoense* Nordstedt*		X		
Closteriaceae	*Closterium lineatum* Ehrenberg ex Ralfs	X			
Closteriaceae	*Closterium* sp. 1 Nitzsch ex Ralfs				X
Closteriaceae	*Closterium* sp. 2 Nitzsch ex Ralfs			X	X
Closteriaceae	*Closterium tumidum* L.N.Johnson*	X			
Desmidiaceae	*Actinotaenium* sp. 1 (Nägeli) Teiling			X	
Desmidiaceae	*Cosmarium blyttii* Wille*		X		
Desmidiaceae	*Cosmarium candianum* Delponte*		X		
Desmidiaceae	*Cosmarium capense* (Nordstedt) De Toni*				X
Desmidiaceae	*Cosmarium connatum* Brébisson ex Ralfs*			X	
Desmidiaceae	*Cosmarium contractum* O. Kirchner		X		
Desmidiaceae	*Cosmarium depressum* Bailey*	X			X
Desmidiaceae	*Cosmarium granatum* Brébisson ex Ralfs*		X		
Desmidiaceae	*Cosmarium isthmochondrum* Nordstedt*	X			
Desmidiaceae	*Cosmarium logiense* Bisset*			X	X
Desmidiaceae	*Cosmarium monomazum* P. M. Lundell*	X		X	
Desmidiaceae	*Cosmarium naui* Kiselev*			X	
Desmidiaceae	*Cosmarium obliquum* Nordstedt*		X		
Desmidiaceae	*Cosmarium obsoletum* (Hantzsch) Reinsch*	X	X	X	
Desmidiaceae	*Cosmarium obtusatum* (Schmidle) Schmidle*			X	
Desmidiaceae	*Cosmarium ordinatum* (Børgesen) West & G. S. West*	X			
Desmidiaceae	*Cosmarium pachydermum* P.Lundell*			X	X
Desmidiaceae	*Cosmarium paraguayense* Borge*		X		
Desmidiaceae	*Cosmarium porteanum* W.Archer*	X	X	X	X
Desmidiaceae	*Cosmarium pseudoprotuberans* O.Kirchner*			X	
Desmidiaceae	*Cosmarium punctulatum* Brébisson*			X	
Desmidiaceae	*Cosmarium quadrum* P.Lundell*	X	X		X
Desmidiaceae	*Cosmarium* sp. 1 Corda ex Ralfs			X	
Desmidiaceae	*Cosmarium* sp. 2 Corda ex Ralfs			X	
Desmidiaceae	*Cosmarium* sp. 3 Corda ex Ralfs			X	
Desmidiaceae	*Cosmarium* sp. 4 Corda ex Ralfs			X	
Desmidiaceae	*Cosmarium* sp. 5 Corda ex Ralfs	X			
Desmidiaceae	*Cosmarium* sp. 6 Corda ex Ralfs	X			
Desmidiaceae	*Cosmarium* sp. 7 Corda ex Ralfs				X

Family	Species	Months			
		F	M	A	N
Desmidiaceae	*Cosmarium subgranatum* (Nordstedt) Lütkemüller*				X
Desmidiaceae	*Cosmarium subnudiceps* West & G. S. West*		X	X	
Desmidiaceae	*Cosmarium variolatum* P. Lundell*		X		
Desmidiaceae	*Cosmocladium constrictum (*W. Archer) W. Archer ex Joshua*	X			
Desmidiaceae	*Desmidium aptogonum* Brébisson ex Kützing	X		X	X
Desmidiaceae	*Desmidium graciliceps* var. *groenbladii* C. E. M. Bicudo & I. M. Samanez*		X		
Desmidiaceae	*Desmidium* sp. 1 C.Agardh ex Ralfs	X			
Desmidiaceae	*Desmidium swartzii* C.Agardh ex Ralfs*				X
Desmidiaceae	*Desmidium swartzii* var. *quadrangulatum* (Ralfs) J.Roy*				X
Desmidiaceae	*Euastrum abruptum* Nordstedt	X	X	X	
Desmidiaceae	*Euastrum denticulatum* F.Gay*		X		
Desmidiaceae	*Euastrum didelta* Ralfs*			X	
Desmidiaceae	*Euastrum dubium* Nägeli*				X
Desmidiaceae	*Euastrum evolutum* (Nordstedt) West & G. S. West				X
Desmidiaceae	*Euastrum platycerum* Reinsch*	X			X
Desmidiaceae	*Euastrum rectangulare* Fritsch & M. F. Rich*		X	X	
Desmidiaceae	*Euastrum* sp. 1 Ehrenberg ex Ralfs*	X			
Desmidiaceae	*Groenbladia undulata* (Nordstedt) Kurt Förster*	X		X	
Desmidiaceae	*Heimansia* sp. 1 Coesel	X	X		X
Desmidiaceae	*Heimansia* sp. 2 Coesel		X		
Desmidiaceae	*Hyalotheca dissiliens* Brébisson ex Ralfs*		X	X	X
Desmidiaceae	*Hyalotheca mucosa* Ralfs	X	X		
Desmidiaceae	*Micrasterias arcuata* Bailey*			X	
Desmidiaceae	*Micrasterias foliacea* Bailey ex Ralfs*				X
Desmidiaceae	*Micrasterias furcata* C. Agardh ex Ralfs	X	X		X
Desmidiaceae	*Micrasterias incisa* Ralfs*	X			
Desmidiaceae	*Micrasterias laticeps* Nordstedt			X	
Desmidiaceae	*Micrasterias mahabuleshwarensis* J. Hobson	X			X
Desmidiaceae	*Micrasterias pinnatifida* Ralfs*			X	
Desmidiaceae	*Micrasterias radiosa* Ralfs*			X	
Desmidiaceae	*Micrasterias torreyi* Bailey*			X	
Desmidiaceae	*Micrasterias tropica* Nordstedt*	X	X	X	X
Desmidiaceae	*Onychonema filiforme* (Ralfs) J. Roy & Bisset*	X		X	
Desmidiaceae	*Onychonema laeve* Nordstedt*	X	X	X	X
Desmidiaceae	*Pleurotaenium ovatum* (Nordstedt) Nordstedt*	X			
Desmidiaceae	*Pleurotaenium* sp. 1 Nägeli		X		
Desmidiaceae	Pleurotaenium sp. 2 Nägeli		X		
Desmidiaceae	*Pleurotaenium trabecula* Nägeli				X
Desmidiaceae	*Spondylosium panduriforme* (Heimerl) Teiling*		X	X	X

Family	Species	Months			
		F	M	A	N
Desmidiaceae	*Spondylosium planum* (Wolle) West e G. S. West*				X
Desmidiaceae	*Spondylosium pulchrum* (Bailey) W. Archer*	X		X	X
Desmidiaceae	*Spondylosium* sp. 1 Brébisson ex Kützing				
Desmidiaceae	*Spondylosium tetragonum* West & G. S. West*	X	X		X
Desmidiaceae	*Staurastrum brasiliense* Nordstedt*			X	
Desmidiaceae	*Staurastrum dilatatum* Ehrenberg ex Ralfs*			X	
Desmidiaceae	*Staurastrum disputatum* West & G. S. West*				X
Desmidiaceae	*Staurastrum leptacanthum* Nordstedt			X	X
Desmidiaceae	*Staurastrum leptocladum* Nordstedt	X	X	X	X
Desmidiaceae	*Staurastrum manfeldtii* Delponte*				X
Desmidiaceae	*Staurastrum minnesotense* Wolle*		X	X	
Desmidiaceae	*Staurastrum nudibrachiatum* Borge*	X	X	X	
Desmidiaceae	*Staurastrum octoverrucosum* A. M. Scott & Grönblad*			X	
Desmidiaceae	*Staurastrum pseudosebaldi* Wille*			X	X
Desmidiaceae	*Staurastrum quadrangulare* Brébisson				X
Desmidiaceae	*Staurastrum rotula* Nordstedt*	X	X	X	X
Desmidiaceae	*Staurastrum sebaldi* Reinsch*		X	X	
Desmidiaceae	*Staurastrum setigerum* Cleve*		X		X
Desmidiaceae	*Staurastrum* sp. 1 Meyen ex Ralfs			X	X
Desmidiaceae	*Staurastrum* sp. 2 Meyen ex Ralfs			X	
Desmidiaceae	*Staurastrum* sp. 3 Meyen ex Ralfs			X	
Desmidiaceae	*Staurastrum* sp. 4 Meyen ex Ralfs	X			
Desmidiaceae	*Staurastrum* sp. 5 Meyen ex Ralfs	X			
Desmidiaceae	*Staurastrum* sp. 6 Meyen ex Ralfs		X		
Desmidiaceae	*Staurastrum* sp. 7 Meyen ex Ralfs		X		
Desmidiaceae	*Staurastrum* sp. 8 Meyen ex Ralfs				X
Desmidiaceae	*Staurastrum* sp. 9 Meyen ex Ralfs				X
Desmidiaceae	*Staurastrum* sp. 10 Meyen ex Ralfs				X
Desmidiaceae	*Staurastrum subnudibrachiatum* West & G. S. West*			X	
Desmidiaceae	*Staurastrum subpolymorphum* Borge*		X	X	X
Desmidiaceae	*Staurodesmus convergens* (Ehrenberg ex Ralfs) S. Lillieroth*	X			
Desmidiaceae	*Staurodesmus dejectus* (Brébisson) Teiling*			X	X
Desmidiaceae	*Staurodesmus dickiei* (Ralfs) S. Lillieroth*			X	
Desmidiaceae	*Staurodesmus glaber* (Ralfs) Teiling*				X
Desmidiaceae	*Staurodesmus mamillatus* (Nordstedt) Teiling*			X	
Desmidiaceae	*Staurodesmus maximus* (Borge) Teiling*		X	X	X
Desmidiaceae	*Staurodesmus mucronatus* (Nägeli) Thomasson*			X	
Desmidiaceae	*Staurodesmus subulatus* (Kützing) Croasdale*		X	X	X
Desmidiaceae	*Staurodesmus triangularis* (Lagerheim) Teiling			X	

Family	Species	Months			
		F	**M**	**A**	**N**
Desmidiaceae	*Staurodesmus unicornis* (W. B. Turner) Coesel & Van Geest*	X	X	X	X
Desmidiaceae	*Staurodesmus validus* (West & G. S. West) Thomasson*	X	X		
Desmidiaceae	*Xanthidium antilopaeum* Kützing*		X		X
Gonatozygaceae	*Gonatozygon aculeatum* W. N. Hastings*		X	X	
Gonatozygaceae	*Gonatozygon pilosum* Wolle*			X	
Gonatozygaceae	*Gonatozygon* sp. 1 De Bary	X			
Zygnemataceae	*Mougeotia* sp. 1 C. Agardh		X		
Zygnemataceae	*Spirogyra* sp. 1 Link				X
Zygnemataceae	*Zygnema* sp. 1 C. Agardh				X
Riqueza total		**39**	**45**	**59**	**51**

Species with * are new records identified for the State of Mato Grosso do Sul

A total of 19 genera were documented, with 73% of them belonging to the family *Desmidiaceae* (Table 1, Figure 5). The most abundant genera were *Cosmarium* Corda ex Ralfs (31 species) and *Staurastrum* Meyen ex Ralfs (25). *Cosmarium,* one of the oldest genera, boasts one of the highest numbers of described taxa, totaling approximately 1,500 species. These species are inclined towards acidic and pristine aquatic systems but have also been identified in alkaline and polluted environments. *Staurastrum* is the second-most prolific genus within *Desmidiales*, with around 1,200 species described (Bicudo & Menezes 2006). Many *Staurastrum* species are cosmopolitan, found both in the water column and adhered to substrates (Souza & Melo 2011) and they are common in acidic and oligotrophic environments (Guiry & Guiry 2020).

In this study, four new genera were recorded for the state of Mato Grosso do Sul, namely *Gonatozygon* De Bary, *Groenbladia* Teiling, *Heimansia* Coesel, and *Onychonema* Wallich. According to AlgaeBase, *Gonatozygon* De Bary comprises 12 described species. Species of this genus are often found in waters with low concentrations of mineral salts and in acidic environments (Prescott, 1972). A study by Zariello & Muldavin (1990) also indicated that this genus responds very efficiently to acidified environments. Comforming to Guiry (2013), species of the genus *Groenbladia* Teiling (4 species described) are found in the periphyton of acidified and oligotrophic lakes. *Heimansia* Coesel (2 species described) is reported in mesotrophic environments with acidic waters (Coesel, 1993; Pinilla, 2000). A study by Pulido López (2015) demonstrated that the increase in the number of species in this genus correlates with increased depth, ammonium nitrogen, total nitrogen, orthophosphates, and more acidic pH

levels. Finally, species of *Onychonema* Wallich (2 species described) are found in calm water environments, often abundant with floating aquatic plants. These species thrive submerged in large amounts of plant detritus, with an ideal pH around 6.5. All these genera are found in acidic environments, the pH of the lake analyzed in this study ranged between 6 and 7, which contributes to the appearance of these species.

Remarkably, over 65% of the species were observed in a single month, with only seven species recorded throughout the four months of evaluation: *Closterium kuetzingii* Brébisson, *Cosmarium porteanum* W. Archer, *Micrasterias tropica* Nordstedt, *Onychonema laeve* Nordstedt, *Staurastrum leptocladum* Nordstedt, *Staurastrum rotula* Nordstedt, and *Staurodesmus unicornis* (W.B. Turner) Coesel & Van Geest. The month with the highest species count was August (Figure 6) potentially linked to temperature variations and low nutrient concentrations. The lake's pH fluctuated between 6 and 7 during the study months, contributing to a greater richness of Charophyta.

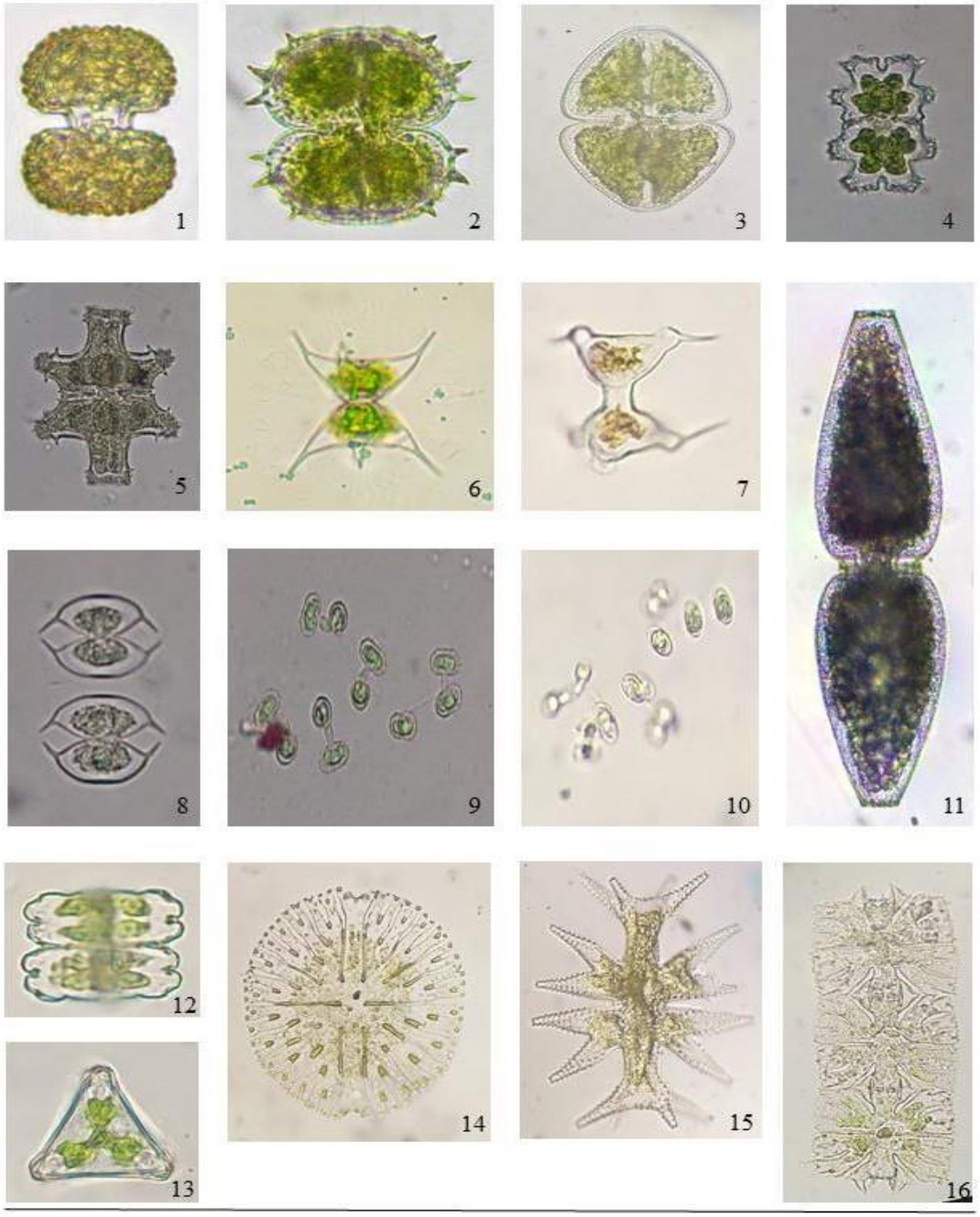

Figure 2. 1. *Cosmarium porteanum* W.archer**; 2.** *C. paraguayense* Borge**; 3.** *C. capense* (Nordstedt) De Toni*;* **4.** *Euastrum abruptum* **5.** *E. platycerum* Reinsch; **6.** *Staurodesmus dejectus* (Brébisson) Teiling; **7.** *Std. Unicornis* Nordstedt (W.B turner) Coesel & Van Geest; **8.** *Std. Convergens* (Ehrenberg ex Ralfs) S. Lillieroth; **9.** *Cosmocladium constrictum* (W.Archer) W.Archer ex Joshua; **10.** *Heimansia sp. 1* Coesel; **11.** *Pleurotaenium ovatum* (Nordstedt) Nordstedt; **12,13.** *Desmidium swartzii* C.Agardh ex Ralfs; **14.** *Micrasterias radiosa* Ralfs**; 15.** *M. mahabuleshwarensis* J.Hobson**; 16.** *M. foliácea Bailey ex Ralfs*

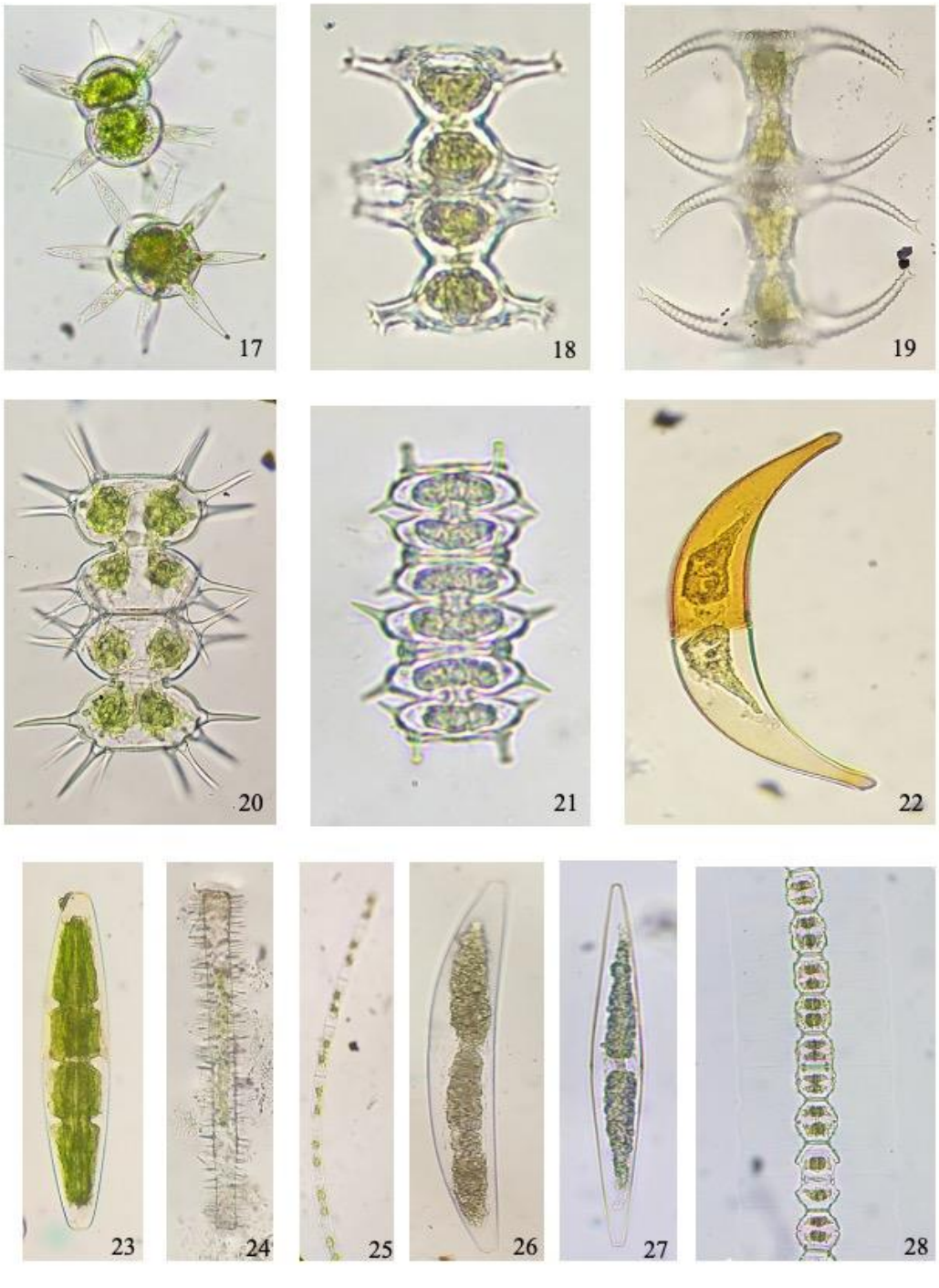

Figure 3. 17. *Staurastrum nudibrachiatum* Borge; **18.** *Staurastrum subpolymorphum Borge* **19.** *Staurastrum pseudosebaldi* Wille **20.** *Xanthidium antilopaeum* Kützing; **21.** *Onychonema laeve* Nordstedt; **22.** *Closterium lagoense* Nordstedt; **23.** *C. closterioides* (Ralfs) A.Louis & Peeters; **24.** *Gonatozygon aculeatum* W.N.Hastings; **25.** *Zygnema* sp. 1 C. Agardh; **26.** *Closterium braunii* Reinsch; **27.** *Closterium tumidum* L.N.Johnson; **28.** *Desmidium graciliceps var. groenbladii* C.E.M.Bicudo & Samanez

Figure 4. 29. *Onychonema laeve* Nordstedt; **30.** *Onychonema filiforme* (Ralfs) J.Roy & Bisset; **31.** *Spondylosium panduriforme* (Heimerl) Teiling; **32.** *Spondylosium pulchrum* (Bailey) W.Archer; **33**. *Spondylosium planum* (Wolle) West e GSWest; **34.** *Spondylosium tetragonum* West & G.S.West; **35.** *Groenbladia undulata* (Nordstedt) Kurt Förster; **36.** *Gonatozygon pilosum* Wolle;

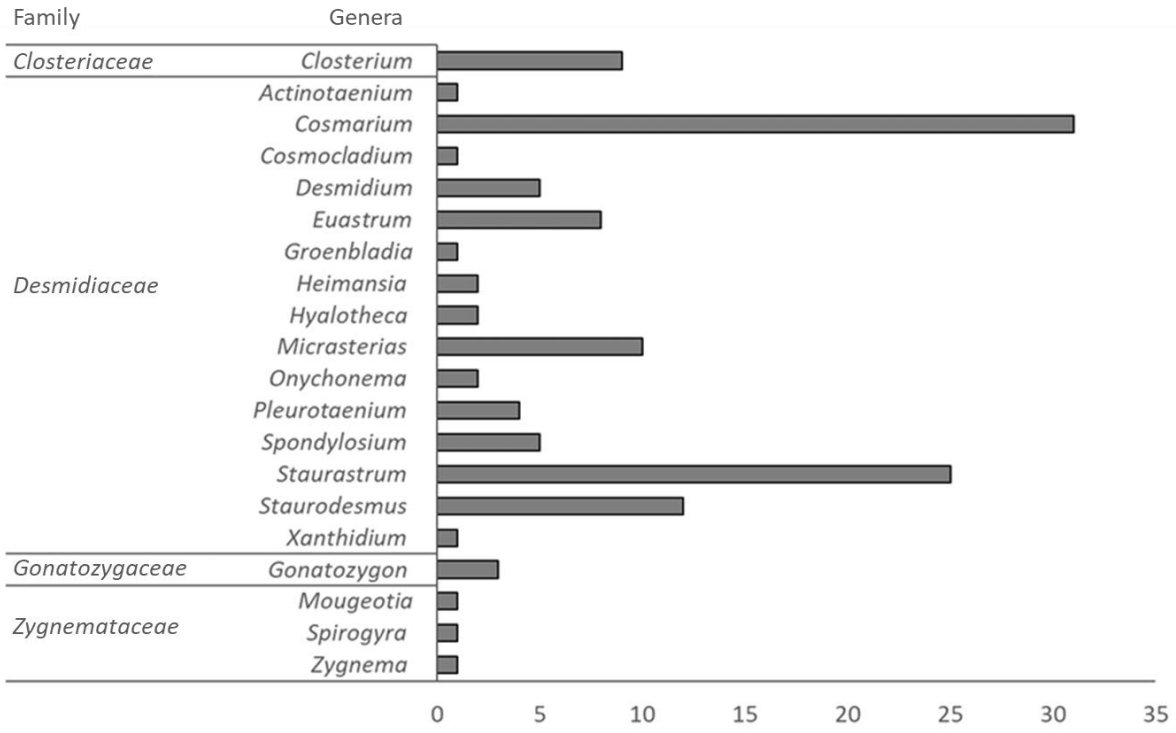

Figure 5- Species richness by genus of Charophyta, ordered by family, recorded in the Municipal Natural Park of Lagoa Comprida, Aquidauana, MS.

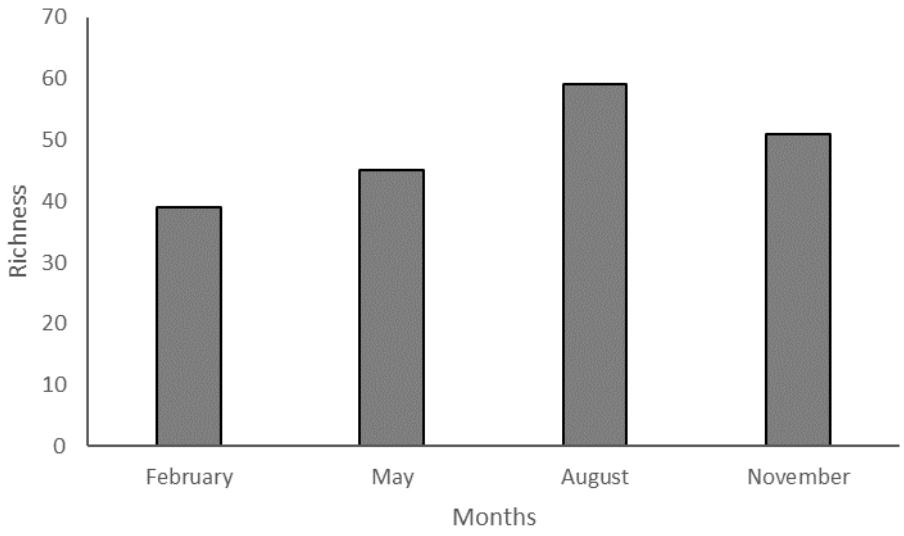

Figure 6 – Species richness of Charophyta recorded over the months in the Municipal Natural Park of Lagoa Comprida, Aquidauana, MS.

Final conclusion

In this research, 79 species are discovered as new occurrences for the State (Table 1, Figure 4), including four new genera: *Gonatozygon* De Bary, *Groenbladia* Teiling, *Heimansia* Coesel, and *Onychonema* Wallich. The study presents significant importance for understanding

the distribution and ecology of freshwater microalgae in the state. In addition, further research is essential to gain a more comprehensive and nuanced understanding of the ecological dynamics and environmental factors influencing microalgae in Mato Grosso do Sul. This foundational work lays the groundwork for future studies, which can explore seasonal variations, the impact of climate change, potential applications in environmental monitoring and taxonomy.

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