AQUATIC MACROPHYTES: A FLORISTIC INVENTORY ON THE BANKS OF THE TROMBETAS RIVER, ORIXIMINÁ, PARÁ

Franciele dos Santos Ferreira da Silva [1,6] - Tatyelen de Souza Gemaque [2,6]
Marcos Vinicius Batista Soares [3*] - Dávia Marciana Talgatti [4] - Jorgeane Valéria Casique Tavares [5]

ABSTRACT: Macrophytes are common in flooded and humid environments and stand out for their diverse life forms. The present study aimed to understand the diversity of macrophytes along the banks of the Trombetas River in Oriximiná, Pará. A floristic inventory of species occurring in an urban cove of the municipality was conducted. Collections took place between February and May 2024 along a 300-meter stretch that is submerged during the high-water period in the Trombetas River. A total of 30 families, 63 genera and 74 species were identified. The most abundant families were Euphorbiaceae, Fabaceae and Asteraceae, with *Ludwigia* L. (4 spp.) and *Phyllanthus* L. (4 spp.) being the most diverse genera. A large number of amphibious species were observed, which comprised 69% of the cataloged plants, with 23% being emergent and 8% belonging to other life forms. In the conservation status assessment, 56 species were classified as Data Deficient (DD) and 15 species as Least Concern (LC). *Wedelia rudis* (Baker) H.Rob. was identified as endemic to Brazil, while the others were non-endemic. The geographic distribution analysis showed that 65 species occur throughout Brazil, five in the Brazilian Amazon: *Wedelia rudis*, *Trichospira verticillata* (L.) S.F.Blake, *Eclipta prostrata* (L.) L., *Mimosa dormiens* Humb. & Bonpl. *ex* Willd., and *Melochia siphonandra* (Turcz.) Dorr; and only *Malachra radiata* (L.) L. occurs in the Amazon, Caatinga and Atlantic Forest. This research contributes to understanding the aquatic biodiversity of the Amazon region, which remains understudied, and conserving these plants may be an effective strategy for mitigating pollution in aquatic environments.

Key words: Amazon, aquatic biodiversity, floristic survey.

MACRÓFITAS AQUÁTICAS: INVENTÁRIO FLORÍSTICO ÀS MARGENS DO RIO TROMBETAS, ORIXIMINÁ, PARÁ

RESUMO: As macrófitas são comuns em ambientes alagados e úmidos, destacando-se pelas suas diversas formas de vida. O presente estudo teve o objetivo de conhecer a diversidade das macrófitas da orla de Oriximiná-PA, para isso foi realizado o inventário florístico das espécies ocorrentes em uma enseada urbana do município, no Rio Trombetas. As coletas ocorreram entre fevereiro e maio de 2024 ao longo de uma área de 300 metros que fica submersa no período das cheias do rio Trombetas. Foram identificadas 30 famílias, 63 gêneros e 74 espécies. Entre as famílias mais abundantes encontra-se Euphorbiaceae, Fabaceae e Asteraceae, com os gêneros mais frequentes sendo *Ludwigia* L. (4 spp.) e *Phyllanthus* L. (4 spp.) os mais diversos. Um grande número de espécies anfíbias foi observado, compreendendo 69% das plantas catalogadas, 23% sendo emergentes e 8% são outras formas de vida. Na avaliação do status de conservação, encontrou-se 56 espécies classificadas como Dados Deficientes (DD) e 15 espécies como Pouco Preocupantes (LC). *Wedelia rudis* (Baker) H.Ro foi identificada como endêmica do Brasil, sendo as demais não endêmicas. A distribuição geográfica das espécies evidenciou 65 espécies ocorrentes em todo o Brasil, cinco na Amazônia sendo *Wedelia rudis, Trichospira verticillata* (L.) S.F.Blake, *Eclipta prostrata* (L.) L., *Mimosa dormiens* Humb. & Bonpl. *ex* Willd. e *Melochia siphonandra* (Turcz.) Dorr; e apenas *Malachra radiata* (L.) L. ocorrente na Amazônia, Caatinga e Mata Atlântica. A pesquisa contribui para a compreensão da biodiversidade aquática da região amazônica, ainda pouco explorada, e sugere que a conservação dessas plantas pode ser uma estratégia eficaz para mitigar a poluição em ambientes aquáticos.

Palavras-chave: Amazônia, biodiversidade aquática, levantamento florístico.

[1] Bióloga, Universidade Federal do Oeste do Pará, Campus de Oriximiná, Laboratório de Algas e Plantas da Amazônia, Oriximiná, PA, Brasil. E-mail: francielesfs6@gmail.com
[2] Bióloga, Universidade Federal do Oeste do Pará, Campus de Oriximiná, Laboratório de Algas e Plantas da Amazônia, Oriximiná, PA, Brasil. E-mail: tatyelen16@gmail.com
[3] Dr., pesquisador de pós-doutorado na Universidade Federal do Oeste do Pará, Programa de Pós-Graduação em Recursos Naturais da Amazônia, Santarém, PA, Brasil. E-mail: marcosvbsoares@yahoo.com.br
[4] Dra., Professora na Universidade Federal do Oeste do Pará, Campus de Oriximiná, Laboratório de Algas e Plantas da Amazônia, Oriximiná, PA, Brasil. E-mail: daviatalgatti@gmail.com
[5] Dra., Professora na Universidade Federal do Oeste do Pará, Campus de Oriximiná, Laboratório de Algas e Plantas da Amazônia, Oriximiná, PA, Brasil. E-mail: valerytvares@gmail.com
[6] Parte do Trabalho de Conclusão de Curso das autoras.
* Autor correspondente: marcosvbsoares@yahoo.com.br

INTRODUCTION

Aquatic plants are characterized by their presence in humid environments and are considered to be among the most productive plants on the planet (Odum, 1984; Piedade & Junk, 2000). It is noteworthy that various nomenclatures are used to refer to plants that predominantly inhabit aquatic environments, such as macrophytes, hydrophytes, heliophytes, limnophytes and aquatic macrophytes (Thomaz & Cunha, 2010; Esteves, 2011).

These plants are sensitive to environmental changes, and factors such as nutrient availability and light incidence can affect them. This may allow invasive macrophyte species to establish themselves, since they possess ecological adaptations, rapid growth and dispersal, and a lack of natural predators (Bando *et al.*, 2015; Aoki *et al.*, 2017; Fares *et al.*, 2020; Poveda, 2022; Dissanayaka *et al.*, 2023).

Several studies have focused on the ecological factors, spatial and temporal patterns of aquatic macrophytes in Brazil; however, there are few studies addressing floristic composition (Esteves & Camargo, 1986; Esteves, 1998; Thomaz, 2002; Janes *et al.*, 2017). Brazil has a high abundance of aquatic macrophytes (Moura Junior *et al*., 2015), which results in significant floristic richness distributed across different Brazilian biomes, including the Amazon. Compared to other biomes, however, the Amazon has fewer floristic surveys (Fares *et al.*, 2021).

Floristic inventories are considered one of the primary methods for documenting flora, species richness and patterns of diversity and distribution (Arouche *et al.*, 2021). The classification of macrophytes (amphibious, emergent, free-floating, rooted-floating, free-submerged, rooted-submerged, and epiphytic), as proposed by Irgang *et al.* (1984), Pott & Pott (2000) and Piedade *et al.* (2019), is essential for a more accurate analysis of the distribution and characteristics of different macrophyte species in aquatic environments.

With their diverse life forms, aquatic plants can be used for various purposes, including their excellent filtering potential, which aids in the depollution of water bodies (Lopes *et al.*, 2020). Although studies on aquatic macrophyte flora have increased, they remain scarce in the Amazon region. Such surveys are fundamental for understanding aquatic biodiversity and provide essential information for the implementation of appropriate conservation and management strategies for these plants (Thomaz & Bini, 2003; Viana, 2005).

Moura Junior *et al*. (2015) emphasize the importance of studies that analyze species distribution across different spatial and temporal scenarios. This approach has been widely applied in various research fields, and has provided critical insights for biodiversity conservation in the face of current environmental changes. Therefore, this study aimed to conduct a floristic survey of aquatic macrophytes, assessing species richness and their life forms.

MATERIAL & METHODS

Study Area

The study was conducted in the municipality of Oriximiná, Pará, in the Lower Amazon region, Western Pará. The municipality is bordered by the Trombetas River, which has a high diversity of aquatic plant species. Collections were made in an urban cove known as Viela da Granja or Ponte da Granja, with the following geographic coordinates: 1°45'34" S, 55°52'20" W (Fig. 1). The collection area comprises the downstream region on the right bank of the Trombetas River, starting from the municipal water intake pump. This site is used both as a port for small vessels and as an area of influence for the local government's intake system.

Floristic Inventory

For the collection of botanical material, the focal observation and active search methods were employed in an area of approximately 300 meters on downstream region. Field collections took place from February to May 2024, a period that covers the early rise in river levels in the cove, until almost complete coverage of the site. Plants with fragile reproductive parts were pressed in the field for better preservation, while others were placed in plastic bags until processing in the laboratory (Pott & Pott, 2000; Amaral *et al.*, 2008; Lorenzi, 2008).

The methodology of Fidalgo & Bononi (1989) was used for the collection and processing of the plant material, with all samples incorporated into the HSTM Herbarium collection at the Universidade Federal do Oeste do Pará, in Santarém, Pará, Brazil. The classification of families follows APG IV (APG, 2016) and PPG I (PPG, 2016). Regarding life forms, the species was categorized following Irgang *et al.*, (1984), Pott & Pott (2000) and Piedade (2019), in addition to field observations.

The name of species, endemism and the phytogeographic distribution of aquatic macrophytes were verified through the Flora e Funga do Brasil platform (2025) and POWO (2025). For the conservation status, data from the IUCN (International Union for Conservation of Nature) Red List (2025) and Flora e Funga do Brasil platform (2025) was consulted. The data provided here are limited to the distribution of species within Brazil.

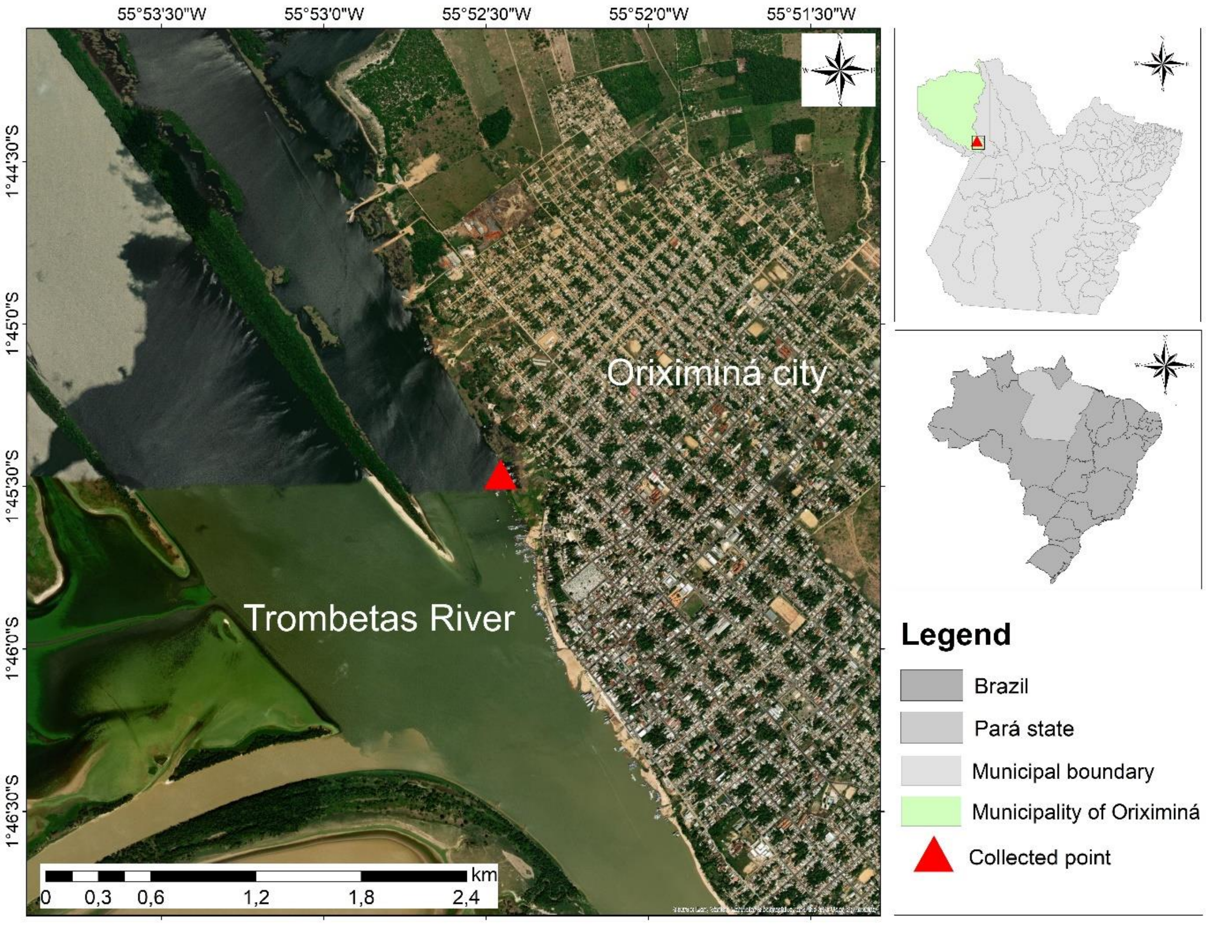

Figure 1. Location map of the study area in the municipality of Oriximiná, PA, Brazil, and the sampling point of collected specimens.

RESULTS AND DISCUSSION

The occurrence of 30 families, 63 genera, and 74 species were recorded. Among the most common families, Euphorbiaceae (8 spp.), Fabaceae (8 spp.), Asteraceae (7 spp.), Onagraceae (4 spp.), Poaceae (5 spp.) and Phyllanthaceae (4 spp.) were highlighted. The study of Neto & Souza (2022) in Tonatins, Amazonas, found different results, with Araceae being the most representative family. This difference may occur by the plants of this family were not fertile during the collection period.

The family Asteraceae is rarely found in aquatic environments, which are typically considered to have low species diversity in this environment; however, in the present study, a significant richness of this family was found. This may be due to the collection period being favorable for its flowering (Fares *et al.*, 2021). Thomas & Bini (2003) emphasize that numerous factors can influence the richness of aquatic macrophytes in water bodies, such as water level fluctuations and nutrient availability, which significantly affect species distribution.

Among the genera, *Salvinia* Ség. (Fig. 2A) stands out due to its bioaccumulation potential, as it accumulates a considerable concentration of lead in its roots, as observed by Bruzzi *et al.* (2019). Another genus associated with bioremediation is *Nymphaea* L. (Fig. 2B), which accumulates zinc and copper in its leaves and roots (Barreto, 2011). The most abundant genus was *Ludwigia* L., with four species (Fig. 2C-F). This result is similar to the work developed by Moura Júnior & Cotarelli (2019), in which this genus was one of the most abundant. However, the study by Neto & Souza (2022) in the Amazonian lake region of the Solimões River found only one species of the genus, indicating that the variation may be influenced by seasonality. According to Hegel & Melo (2016), the presence of some aquatic macrophyte species can be used as bioindicators of water quality, and their presence is associated with eutrophicated environments.

A total of 74 distinct species were identified (Table 1), which is a significant number for a lotic environment, as these limnetic environments are not characterized by the abundant presence of macrophytes, compared to other studies, such as Neto & Souza (2022) and Andrade *et al.* (2018) in Amazonas and Pernambuco, respectively, which identified only 16 species. This highlights the representativeness of macrophytes in the urban cove where the study took place.

Regarding endemism, only *Wedelia rudis* (Baker) H.Rob was found to be endemic to Brazil. As for distribution, 65 species are found throughout Brazil (Flora e Funga do Brasil, 2024), five species occur in the Amazon, including *Wedelia rudis*, *Trichospira verticillata* (L.) S.F.Blake, *Eclipta prostrata* (L.) L., *Mimosa dormiens* Humb. & Bonpl. ex Willd. and *Melochia siphonandra* (Turcz.) Dorr (Flora e Funga do Brasil, 2024), and *Malachra radiata* (L.) L. occurs in the Amazon, Caatinga and Atlantic Forest.

Regarding their conservation status, based on the IUCN (2024) and the Flora e Funga do Brasil (2025), 56 aquatic macrophyte species are classified as Data Deficient (DD) and 15 as Least Concern (LC), reflecting the lack of knowledge about these plants. These results, according to the IUCN (2025), indicate insufficient information to assess the extinction risk of the species. It is important to note that several species were not found in their database.

Among the species collected, *Lemna valdiviana* Phil. (Fig. 2G) stands out for its high adaptability to polluted environments and is considered a bioindicator of water quality (Landolt, 1986; Pott & Cervi, 1999). *Polygonum ferrugineum* Wedd. (Fig. 2H) is considered a phytoremediator of cadmium present in the water (Souza *et al.*, 2009).

Pontederia rotundifolia L.f. (Fig. 2I) is notable for its importance to aquatic biodiversity, highlighting its ecological role, such as providing shelter, serving as a nursery for fish, feeding various species and supporting nutrient cycling (Oliveira *et al.*, 2020; Hadad *et al.*, 2022).

Justicia laevilinguis (Nees) Lindau (Fig. 2J) is a species that is present in various studies on aquatic macrophytes, and is associated with flooded areas and ecological transition zones, such as the study area. This species plays an important role in assessing biodiversity and environmental conditions in these ecosystems, as seen in studies in the Rio Doce State Park in south-eastern Brazil (Ferreira *et al.*, 2010), which identified the relationship between these plants and abiotic parameters, such as water depth and quality.

The species *Eclipta prostrata* (Fig. 2k) and *Emilia sonchifolia* (L.) DC. (Fig. 2l) are characteristic of humid environments, highlighting the diversity of the local flora (Moura Júnior *et al.*, 2015). The collected species exhibit various life forms and, regarding biological form classification, 69% of the species identified in this study were considered amphibious (49 species), 23% emergent (16 species) and 8% are represented by other forms such as lianas (1), free-floating submerged (1), free-floating (3) and rooted floating (1). The significant number of aquatic plants classified as amphibious and emergent is common in studies focused on areas with periodic flooding, such as the Amazon, where the data vary according to the studied location (Fares *et al.*, 2021).

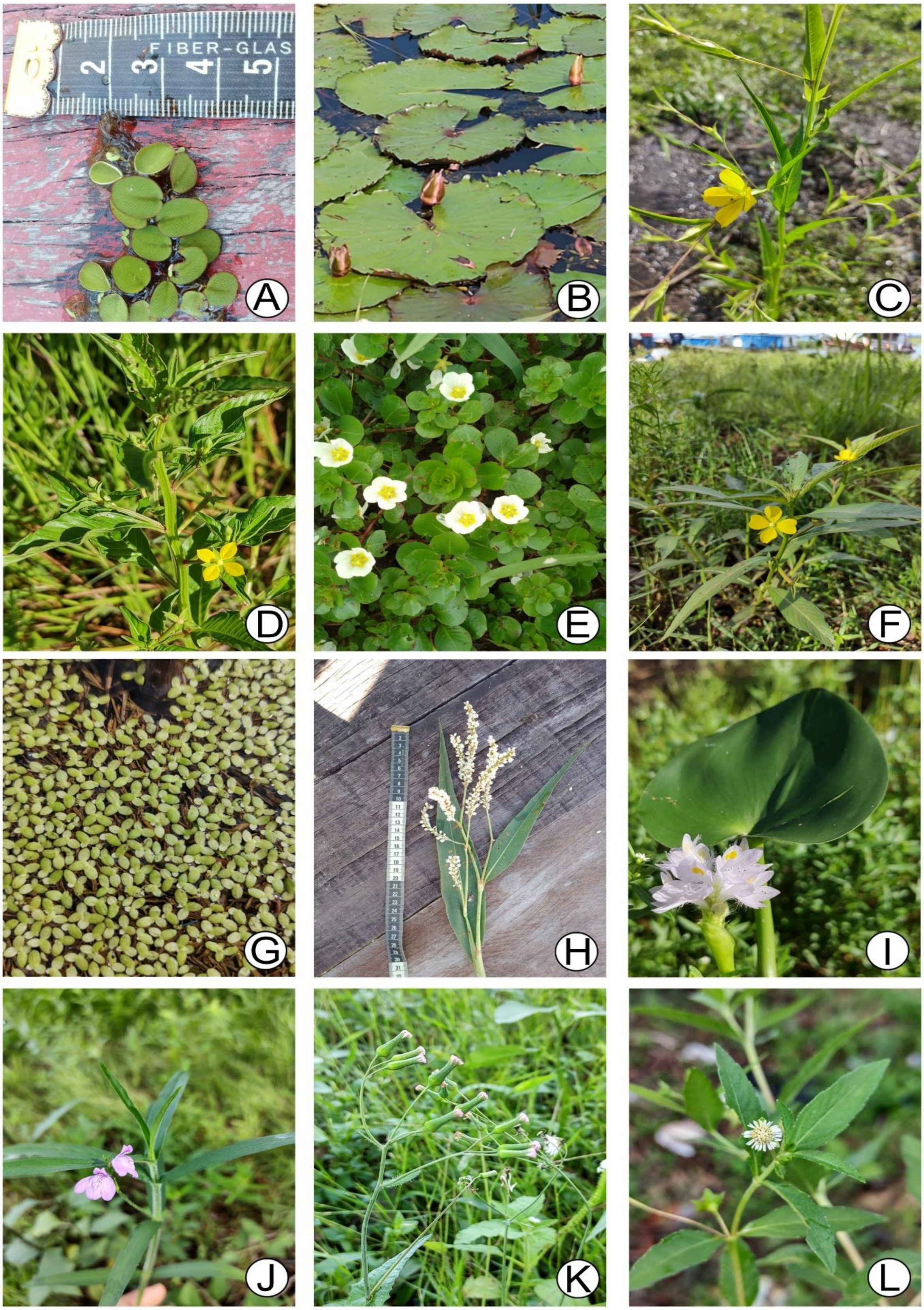

Figure 2. Species diversity of aquatic plants in the study area in the municipality of Oriximiná, PA, Brazil. A. *Salvinia auriculata*; B. *Nymphaea rudgeana*; C. *Ludwigia decurrens*; D. *L. hyssopifolia*; E. *L. helminthorrhiza*; F. *L. leptocarpa*; G. *Lemna valdiviana*; H. *Polygonum ferrugineum*, I. *Pontederia rotundifolia*; J. *Justicia laevilinguis*; K. *Emilia sonchifolia*; L. *Eclipta prostrata*. **Photos: T Gemaque, A, E, G, H; MVB Soares, B-D, F, I-L.**

Table 1 - List of species, endemism, life forms, distribution in Brazil, and conservation status of macrophytes found in the study area, Oriximiná, PA, Brazil. Legend: E = Endemic to Brazil, NE = Not endemic to Brazil, A = Amphibious; LI = Liana; EM = Emergent, FL = Free-floating, FE = Rooted floating, SE = Rooted submerged, SL = Free-floating submerged, AMZ = Amazon, AT = Atlantic Forest, PT = Pantanal, BR = Brazil, CAA = Caatinga.

Family/Species	Voucher	Endemism	Life Form	Distribution	Conservation Status
ACANTHACEAE					
Justicia laevilinguis (Nees) Lindau	HSTM 17896	NE	EM	BR	LC
AMARANTHACEAE					
Alternanthera tenella Colla	HSTM 17878	NE	A	BR	LC
Amaranthus spinosus L.	HSTM 17945	NE	A	BR	DD
Gomphrena celosioides Mart.	HSTM 17926	NE	A	BR	DD
ARACAEAE					
Lemna valdiviana Phil.	HSTM 17905	NE	FF	BR	LC
ASTERACEAE					
Ambrosia artemisiifolia L.	HSTM 17864	NE	A	BR	LC
Eclipta prostrata (L.) L.	HSTM 17881	NE	A	AM	LC
Emilia sonchifolia (L.) DC.	HSTM 17874	NE	A	BR	DD
Mikania micrantha Kunth	HSTM 17959	NE	LI	BR	DD
Praxelis clematidea (Griseb.) R.M.King & H.Rob.	HSTM 17867	NE	A	BR	LC
Trichospira verticillata (L.) S.F.Blake	HSTM 17880	NE	A	AM	DD
Wedelia rudis (Baker) H.Rob.	HSTM 17863	E	A	AM	DD
CLEOMACEAE					
Tarenaya aculeata (L.) Soares Neto & Roalson	HSTM 17895	NE	A	BR	DD
Physostemon guianense (Aubl.) Malme	HSTM 17919	NE	A	BR	DD
COMMELINACEAE					
Commelina erecta L.	HSTM 17862	NE	A	BR	DD
CYPERACEAE					
Cyperus esculentus L.	HSTM 17885	NE	A	BR	LC
Cyperus luzulae (L.) Retz.	HSTM 17932	NE	A	BR	LC
Cyperus surinamensis Rottb.	HSTM 17957	NE	A	BR	LC
EUPHORBIACEAE					
Acalypha arvensis Poepp.	HSTM 17857	NE	A	BR	DD
Astraea lobata (L.) Klotzsch	HSTM 17883	NE	A	BR	DD

Family/Species	Voucher	Endemism	Life Form	Distribution	Conservation Status
Caperonia castaneifolia (L.) A.St.-Hil.	HSTM 17903	NE	A	BR	DD
Croton argenteus L.	HSTM 17892	NE	A	BR	DD
Croton trinitatis Millsp.	HSTM 17922	NE	A	BR	DD
Euphorbia hirta L.	HSTM 17909	NE	A	BR	LC
Euphorbia hyssopifolia L.	HSTM 17888	NE	A	BR	LC
Microstachys corniculata (Vahl) Griseb.	HSTM 17884	NE	A	BR	DD
FABACEAE					
Aeschynomene ciliata Vogel	HSTM 17900	NE	EM	BR	DD
A. eridesii L.L.C. Antunes & M.J. Silva	HSTM 17941	NE	EM	BR	DD
Chamaecrista nictitans (L.) Moench	HSTM 17861	NE	A	BR	DD
Crotalaria pallida Aiton	HSTM 17916	NE	A	BR	DD
Indigofera hirsuta L.	HSTM 17915	NE	A	BR	DD
Mimosa dormiens Humb. & Bonpl. ex Willd.	HSTM 17858	NE	A	AM	DD
Sesbania exasperata Kunth	HSTM 17898	NE	A	BR	DD
Zornia latifolia Sm.	HSTM 17908	NE	A	BR	DD
HELIOTROPIACEAE					
Heliotropium indicum L.	HSTM 17873	NE	A	BR	DD
Euploca filiformis (Lehm.) J.I.M.Melo & Semir	HSTM 17906	NE	A	BR	DD
LAMIACEAE					
Marsypianthes chamaedrys (Vahl) Kuntze	HSTM 17918	NE	A	BR	DD
LENTIBULARIACEAE					
Utricularia foliosa L.	HSTM 17964	NE	FFL	BR	LC
LINDERNIACEAE					
Lindernia crustacea (L.) F.Muell.	HSTM 17897	NE	A	BR	DD
LOGANIACEAE					
Spigelia anthelmia L.	HSTM 17954	NE	A	BR	DD
MALVACEAE					
Malachra radiata (L.) L.	HSTM 17966	NE	A	CAA, AF, AM	LC

Family/Species	**Voucher**	**Endemism**	**Life Form**	**Distribution**	**Conservation Status**
Melochia siphonandra (Turcz.) Dorr	HSTM 17923	NE	A	AM	DD
Urena lobata L.	HSTM 17933	NE	A/EM	BR	LC
MOLLUGINACEAE					
Mollugo verticillata L.	HSTM 17937	NE	EM	BR	DD
NYMPHEACEAE					
Nympheae rudgeana G.Mey.	HSTM 17970	NE	RF	BR	DD
ONAGRACEAE					
Ludwigia decurrens Walter	HSTM 17931	NE	EM	BR	DD
Ludwigia hyssopifolia (G.Don) Exell	HSTM 17921	NE	EM	BR	LC
Ludwigia helminthorrhiza (Mart.) H.Hara	HSTM 17944	NE	FF	BR	DD
Ludwigia leptocarpa (Nutt.) H.Hara	HSTM 17930	NE	EM	BR	LC
PHYLLANTHACEAE					
Phyllanthus caroliniensis Walter	HSTM 17886	NE	EM	BR	DD
Phyllanthus orbiculatus Rich.	HSTM 17859	NE	A	BR	DD
Phyllanthus stipulatus (Raf.) G.L.Webster	HSTM 17886	NE	A	BR	DD
Moeroris stipulata Raf.	HSTM 17868	NE	EM	BR	DD
PIPERACEAE					
Peperomia pellucida (L.) kunth	HSTM 17907	NE	A	BR	DD
PLANTAGINACEAE					
Scoparia dulcis L.	HSTM 17901	NE	A	BR	DD
POACEAE					
Eleusine indica L.Gaertn	HSTM 17952	NE	A	BR	LC
Echinochloa polystachya (Kunth) Hitchc.	HSTM 17960	NE	EM	BR	DD
Hymenachne amplexicaulis (Rudge) Nees	HSTM 17963	NE	EM	BR	DD
Luziola subintegra Swallen	HSTM 17968	NE	EM	BR	DD
Oryza grandiglumis (Döll) Prod.	HSTM 17961	NE	FF	AM, PT	LC
POLYGONACEAE					
Polygonum ferrugineum Wedd.	HSTM 17899	NE	EM	BR	DD
PONTEDERIACEAE					
Pontederia rotundifolia L.f.	HSTM 17910	NE	EM	BR	DD

Family/Species	Voucher	Endemism	Life Form	Distribution	Conservation Status
RUBIACEAE					
Borreria verticillata (L.) G.Mey.	HSTM 17934	NE	A	BR	DD
Oldenlandia corymbosa L.	HSTM 17911	NE	EM	BR	DD
Hexasepalum cf. *teres* (Walter) J.H.Kirkbr.	HSTM 17870	NE	A	BR	DD
SALVINIACEAE					
Salvinia auriculata Aubl.	HSTM 17965	NE	FF	BR	DD
SOLANACEAE					
Solanum americanum L.	HSTM 17877	NE	A	BR	DD
Physalis angulata L.	HSTM 17913	NE	A	BR	DD
TURNERACEAE					
Piriqueta cistoides (L.) Griseb.	HSTM 17866	NE	A	BR	DD
Turnera subulata Sm.	HSTM 17951	NE	A	BR	DD
URTICACEAE					
Laportea aestuans (L.) Chew	HSTM 17956	NE	A	BR	DD
VERBENACEAE					
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson	HSTM 17876	NE	A	BR	DD
Stachytarpheta cayennensis (Rich.) Vahl	HSTM 17920	NE	A	BR	DD
Phyla betulifolia (Kunth) Greene	HSTM 17942	NE	A	BR	DD

CONCLUSION

The results of the present study highlight a rich diversity of aquatic macrophyte species, with the identification of 71 species distributed in 30 families, with emphasis on Euphorbiaceae, Fabaceae, Asteraceae, Onagraceae, Poaceae and Phyllanthaceae. This diversity can be attributed to factors such as the collection period, which directly influences the presence of certain families, such as Asteraceae, which, despite being common in low-diversity environments, exhibited considerable richness in the present study. Genera such as *Salvinia*, *Nymphaea* and *Ludwigia* showed great relevance, either due to their bioaccumulation potential or their abundance, with *Ludwigia* being the most represented genus.

The variation in species representativeness across different regions and in different studies, as observed in the works of Moura Júnior & Cotarelli (2019) and Coelho Neto & Souza (2022), emphasizes the influence of seasonality and environmental conditions on the composition of aquatic macrophytes. The presence of bioindicator species, such as *Lemna valdiviana* and *Justicia laevilinguis*, underscores the importance of these plants for assessing water quality and local biodiversity.

Additionally, the species *Malachra radiata* and *Melochia siphonandra* are poorly collected in the Brazilian Amazon, with this study representing the first record of these species in this environment. The high number of species classified as Data Deficient by the IUCN highlights the lack of information about these plants, emphasizing the need for more studies to better understand their distributions and conservation status. Finally, the predominance of amphibious and emergent life forms reflects the adaptation of these species to environments that are subject to periodic flooding, reinforcing the importance of region- and ecosystem-specific studies.

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