ACTA
AMAZONICA | http://dx.doi.org/10.1590/1809-4392201903831

SHORT COMMUNICATION

New records of the invasive macrophyte, *Urochloa arrecta* extend its range to eastern Brazilian Amazon altered freshwater ecosystems

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ABSTRACT

Invasive species influence the structure and functioning of ecosystems, as they affect native species, significantly decreasing their diversity. Aquatic ecosystems harbor a great biodiversity, and invasive macrophytes significantly affect the native plant communities, causing a cascade effect on other trophic levels. Among invasive macrophytes, *Urochloa arrecta* is cause for concern in the Neotropics and is found in several regions of Brazil, specially in the southeastern and southern regions. So far the species had been recorded only in the northern state of Amazonas. We report the first record of the species in the state of Pará, in the eastern Brazilian Amazon. We emphasize that identifying sites where this species is invasive is the best strategy to prevent its spread, aiming at the protection and conservation of Amazonian freshwater ecosystems.

KEYWORDS: aquatic plants, invasion ecology, grasses, Poaceae, Amazonas state, Pará state

Novos registros da macrófita invasora *Urochloa arrecta* ampliam sua distribuição a ecossistemas aquáticos alterados na Amazônia Oriental brasileira

RESUMO

Espécies invasoras influenciam a estrutura e funcionamento dos ecossistemas, pois afetam as espécies nativas, diminuindo significativamente sua diversidade. Ecossistemas aquáticos abrigam uma grande biodiversidade, e as macrófitas invasoras afetam significativamente a comunidade de plantas nativas, causando um efeito cascata nos diferentes níveis tróficos. Dentre as macrófitas invasoras, *Urochloa arrecta* é fonte de preocupação nos Neotrópicos, sendo encontrada em diversas regiões do Brasil, principalmente no sul e sudeste. Na região norte, a espécie só havia sido registrada no Amazonas. Trazemos aqui o primeiro registro desta espécie no estado do Pará, na Amazônia oriental brasileira. Destacamos que a identificação dos locais onde a invasão desta espécie ocorre é a melhor estratégia para que medidas de prevenção que evitem sua dispersão sejam tomadas, visando a proteção e conservação dos ecossistemas aquáticos amazônicos.

PALAVRAS-CHAVE: plantas aquáticas, ecologia de invasão, gramíneas, Poaceae, Amazonas, Pará

Invasive species are a recurrent problem for biodiversity conservation in several ecosystems (Simberloff *et al.* 2013), as their performance increases with global trade (which makes it easier to cross biogeographical barriers) and the higher tolerance of invasive species to environmental change (D'antonio and Vitousek 1992; Mooney and Cleland 2001). Invasive species are a worldwide concern, as they can change ecosystems through habitat structure, and displacement (McKinney and Lockwood 1999; Alho *et al.* 2011) or even extinction of native species due to direct biotic interaction (e.g., competition, predation) or indirectly, by altering environmental parameters (Mooney and Cleland 2001; Clavero and García-Berthou 2005; Gallardo *et al.* 2016).

Freshwater ecosystems have the highest biodiversity per unit area in the planet (Balian *et al.* 2008), and thus, more species are threatened by invasions in aquatic than in terrestrial ecosystems (Moorhouse and Macdonald 2015). The invasion

CITE AS: Fares, A.L.B; Nonato, F.A.S.; Michelan, T.S. 2020. New records of the invasive macrophyte, *Urochloa arrecta* extend its range to eastern Brazilian Amazon altered freshwater ecosystems. *Acta Amazonica* 50: 133-137.

of rivers, lakes, wetlands, and reservoirs by macrophytes is especially harmful due to negative effects on native macrophytes (Madsen *et al.* 1991; Kovalenko and Dibble 2011) and their role in providing high habitat complexity and keeping biological diversity (Thomaz and Cunha 2010). By affecting native species, invasive macrophytes may cause cascade effects on other trophic levels (Kovalenko and Dibble 2011), reducing animal, plant, and microbial diversity (Lougheed *et al.* 2008; Thomaz and Cunha 2010), and by affecting structural ecosystem properties (Bunn *et al.* 1998; Cuassolo *et al.* 2016).

Grasses can be classified as highly invasive plants and a model group to understand invasion processes, given their resistance to stress and widespread distribution (D'antonio and Vitousek 1992; McKinney and Lockwood 1999). Poaceae are actively moved around by humans, can effectively compete with native species in a wide range of ecosystems, and can reduce native diversity and change ecosystem processes ranging from nutrient cycling to regional microclimate (D'antonio and Vitousek, 1992; McKinney and Lockwood 1999; Amorim *et al.* 2015). The Poaceae genus *Urochloa* has already shown great invasive potential, both in terrestrial (Williams and Baruch 2000) and aquatic ecosystems (Thomaz *et al.* 2009; Michelan *et al.* 2010).

Urochloa arrecta (Hack. ex T.Durand & Schinz) Morrone & Zuloaga is an aquatic species native to Africa, which has infested tropical and subtropical zones around the world (Amorim *et al.* 2015). It is a perennial grass with long, floating branches, forming thick mats with accumulated stems, leaves and roots. Details for the identification of the species are provided by Lorenzi (2001) under the synonymous name *Brachiaria subquadripara*. The species can propagate by stolons (Amorim *et al.* 2015), and through rhizomes or any other fragment that can be carried by water flow (Pott *et al.* 2011; Michelan *et al.* 2017). It is a source of concern in hydrodam reservoirs such as Itaipu, in southern Brazil (Thomaz *et al.* 2009) and natural aquatic environments, such as the Pantanal (Pott *et al.* 2011), where it reduces native biodiversity (Michelan *et al.* 2010). The occurrence of *U. arrecta* has already been reported in anthropized areas of several Brazilian states, specially in the northeastern, southeastern, and southern regions, in different biomes, such as the Cerrado savanna and the Atlantic Forest, but also in the northern state of Amazonas, the only one so far in the Brazilian Amazon region (Flora do Brasil 2020; Figure 1).

During a field survey in July 2017, we found extensive *U. arrecta* mats along stream shores and small lakes at several sampling sites in the state of Pará, in Paragominas

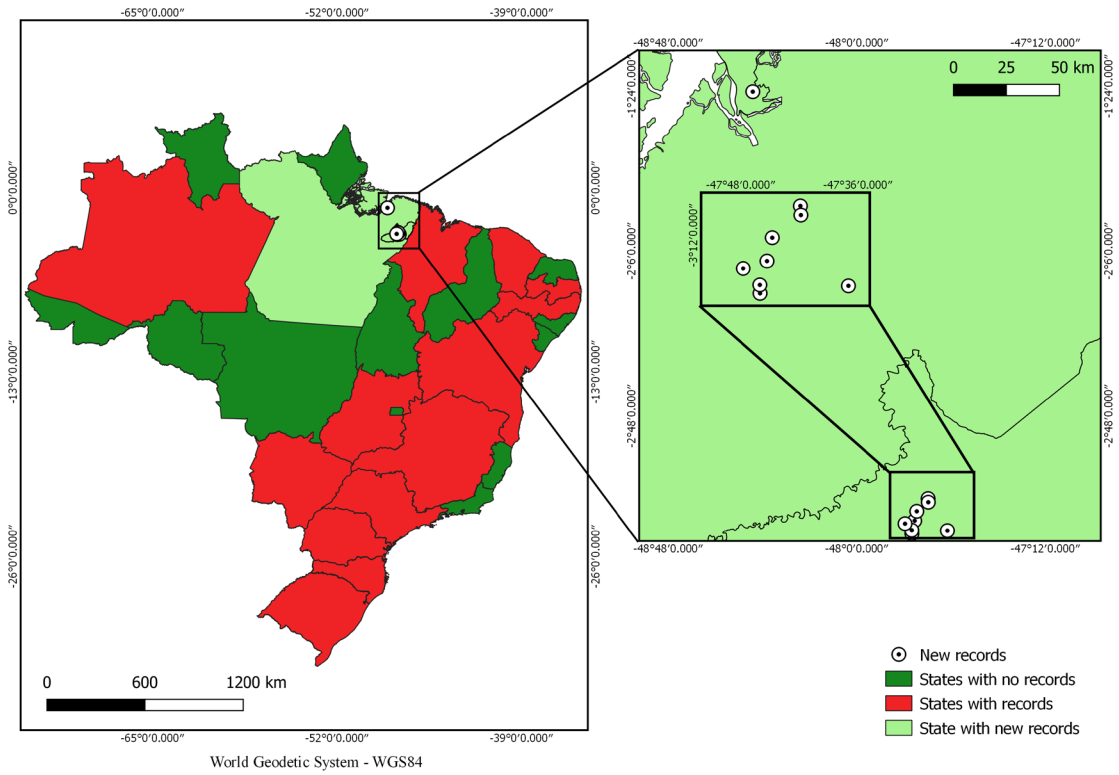

Figure 1. Map showing the new records of *Urochloa arrecta* in Pará state (light green), Brazil. States in red are those where the species has already been recorded. States in dark green are those with no records of the species to date. Information on species distribution in Brazil from Flora do Brasil (2020) and Michelan *et al.* (2010) for Paraná state. This figure is in color in the electronic version.

(02°59'45"S, 47°21'10"W) (Figure 2), and in Belém (01°27'21"S, 48°30'16"W), in the reservoirs inside Utinga Park, which supply most of the drinkable water to Belém (Figure 2; Table 1). We collected and herborized some plant samples for species identification according to standard herbarium techniques, and all the material is deposited in the Herbarium Felisberto Camargo at Universidade Federal Rural da Amazônia. T.S. Michelan identified the material.

Most sites where we found *U. arrecta* are anthropisized (e.g., pasture, agriculture, mining, and urban areas), and had shorelines cleared of riparian vegetation (Table 1). Considering the geographical location of our records (Figure 1), it is possible that the species spread into Pará from the neighboring state of Maranhão, as deforestation for pasture and agriculture in Pará created suitable conditions for its dispersal and establishment. Human activity, particularly multiple land use, has likely facilitated the introduction, spreading and stabilization of *U. arrecta* in the surveyed aquatic ecosystems. The expansion of the grass was likely facilitated by decreased shading due to deforestation or forest thinning, increased nutrient availability (e.g. phosphorous and nitrogen) in water and soil, and altered water depth and turbidity. These impacts can disrupt biological processes in native macrophyte species (Vitousek *et al,* 1997; Kowarik 2003; Lougheed *et al.* 2008; Gołdyn 2010; Sass *et al.* 2010; Quinn *et al.* 2011; Gallardo *et al.* 2016). The shading by native riparian vegetation can be a limiting factor for the establishment and spreading of *U. arrecta* (Evangelista *et al.* 2017; Fares *et al.* 2020), though in Australia the congeneric *U. mutica* can occur in sites with dense riparian vegetation (Mackay *et al.* 2010). This means that land-use change (i.e. loss of riparian vegetation) could increase the potential spread of *U. arrecta*, but that the species might also potentially pose a threat to undisturbed habitats, specially in wider rivers whith undisturbed riparian vegetation, where the light penetrates in between the margins. In this case, if fragments/propagules reach freshwater ecosystems that are naturally unshaded, such as floodplain lakes or wetlands connected to streams and rivers that can act as dispersal corridors (Säumel and Kowarik 2010), they can become a threat to native macrophyte communities there.

We emphasize that our records are a matter for concern, considering that the Amazon biome shelters so many important freshwater ecosystems and biodiverse communities, many of which are under constant land use pressure, and therefore already highly vulnerable to biodiversity loss due to

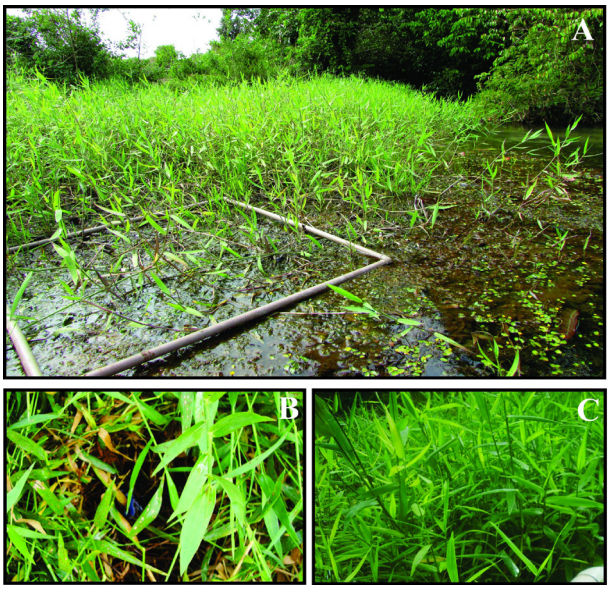

Figure 2. Stream shoreline dominated by *Urochloa arrecta* in Paragominas, Pará state, Brazil. A – *U. arrecta* mat; B-C – Details of the species (leaves and stems are glabrous). This figure is in color in the electronic version.

Table 1. Description of the sites where *Urochloa arrecta* was recorded in Pará state. The degree of invasion was determined according to *U. arrecta* cover percentage inside 1 m^2 quadrants, where: 1-25% = low invasion level, 25-50% = intermediate invasion level, and 50-100% = high invasion level.

Municipality	Site coordinates	Type of water body	Site characteristics	Degree of invasion	Voucher code
Paragominas	3°12'16"S, 47°44'48"W	Stream	2-m channel, next to pasture	Intermediate	6599
Paragominas	3°14'39"S,47°45'20"W	Stream	Deep channel with low water flow, riparian vegetation with open spots, inside a bauxite mine	Low	-
Paragominas	3°17'12"S, 47°37'01"W	Lake	Next to a plantation and a dirt road	Intermediate	65601
Paragominas	3°17'58"S, 47°46'02"W	Stream	Next to pasture and secondary vegetation.	Low	-
Paragominas	3°09'01"S, 47°41'55"W	Stream	Dammed next to a household and a dirt road	High	65600
Paragominas	3°17'06"S, 47°46'04"W	Stream	Next to pasture and a household	High	-
Paragominas	3°15'25"S, 47°47'47"W	Pond	Dry, next to secondary vegetation	High	65602
Paragominas	3°09'57"S, 47°41'52"W	Lake	Next to ***Eucalyptus*** plantation, with a grass-dominated vegetation on the shoreline, not shaded, and next to a dirt road	High	-
Belém	1°25'26.5"S, 48°26'30.9"W	Stream	In Utinga Park, site with human influence	High	65603

human impact. Early detection is the best strategy to prevent damages by invasive species, as it implies higher probability of eradication and prevention of spread. We recommend eradication of *U. arrecta* from aquatic ecosystems in Pará due to the potential ecological damage this grass may represent to these highly diverse ecosystems.

ACKNOWLEDGMENTS

We are thankful to Hydro Paragominas Company for supporting the research projects "*Monitoring Aquatic Biota of Streams on Areas of Paragominas Mining SA, Pará, Brazil*" and "E*ffects of soil use on diversity and ecophysiology on the riparian vegetation, aquatic macrophytes and plankton in streams and lagoons in mining areas of Paragominas, Pará, Brazil*" through the Biodiversity Research Consortium Brazil-Norway (BRC). This paper is number 0008 in the publication series of the BRC. ALBF is thankful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 for her scholarship. FASN is also thankful to Hydro Paragominas Company through the BRC, for her scholarship. We thank the Aquatic Biota field team, especially Calebe Maia for helping with plant collection. We thank Sidinei M. Thomaz for his critical reading, and whose comments improved the final version of our paper.

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RECEIVED: 17/10/2019
ACCEPTED: 26/01/2020
ASSOCIATE EDITOR: Natália Ivanauskas