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Cerrado's areas as a reference analysis for aquatic conservation in Brazil

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ABSTRACT The Cerrado is recognized as a relevant hotspot, being biologically the richest one in the world, with a significant degree of endemism. The central region of Cerrado Domain is considered the "water cradle" of Brazil, with important springs from South American watersheds. Human activities caused several impacts on drainage-basins, as water pollution and silting of running waters, affecting riparian and aquatic biota. The aquatic biodiversity of this region is yet poorly known, despite studies on terrestrial fauna and flora showed an estimate of 160 thousand species. In this review, the aquatic biodiversity of the Cerrado Domain was evaluated on literature survey from 2004 to 2012. Data obtained until now are sparse and focused in some few organism groups, and the aquatic species richness is estimated to 9,580 species. At least 22.8% of fish species in Brazil are expected to occur in Cerrado, as well as 25.2% of bivalve mollusks, and 41.9% of the diatom algae. The endemism is relevant for some groups, reaching 25% for fishes and more than 10% for bivalves and diatoms. Based on the potential of environmental heterogeneity of the aquatic systems located in high and protected areas, their permanent preservation has been a challenge for shelter of endemic and endangered species, revealing a huge genetic patrimony, as grounded by this study for the Cerrado Domain in central Brazil.

KEY WORDS Brazilian savanna; Preserved areas; aquatic biodiversity; endemic species.

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INTRODUCTION

The Cerrado is the most extensive woodland-savanna in South America and comprises 21% of the Brazil`s territory. The central Brazilian Plateau is covered by Cerrado and spreads across an area of 2,031,990 km². It is biologically the richest one in the world, with a significant degree of endemism (Myers et al., 2000).

UNESCO classified the Cerrado as a Biosphere Reserve and it is referred as one of the world's biodiversity hotspots, with a high priority on the biodiversity conservation. This biome has 30% of the Brazilian biodiversity and at least five percent of the flora and fauna richness of the world (Oliveira & Marquis, 2002). The Cerrado region is considered the "water cradle" of Brazil, with important springs from South American basins such as the Platina, Amazonas and São Francisco basins. The predominance of highlands in the central Brazil provides conditions for the surface water drainage to lower regions.

The high quality water sources and springs enable to obtain the water for population uses, and the adequacy of the water management is indispensable. Brazil has a significant portion of the world's surface runoff (12.7%) and the Central Brazil has potential water resources due to preserved headwaters, despite the growing irregular occupation by human population (MMA,1998).

The groundwater is a renewable resource, but adequate time is needed to allow the aquifers replenishment. Such areas must be properly managed in order to prevent the contamination by waste products that can infiltrate and pollute the underground supply.

Thus, the Cerrado in central Brazil comprises a high value region of springs and watersheds, but its management must be directed to the water accumulation in reservoirs for human regional uses. The continent water volume is finite and the springs are irregularly distributed. Currently, the water availability gradually decreases due to environmental degradation, disordered population growth and agricultural expansion (Klink & Machado, 2005).

In the last 35 years, more than 50% of the area has been transformed into pasture and agricultural lands. Deforestation rates have been intensive, but conservation efforts have been modest: only 2.2% is under legal protection. Burning practices for clearing land for cultivation and pasture growth have also caused damages, even in a fire-adapted ecosystem like the Brazilian savanna. Cerrado's agriculture is lucrative, and its expansion is expected to continue, requiring upgradings in transport infrastructure. The landscape modification and threats to numerous species increased the concerns on the Cerrado's conservation, and improvements such as the expansion of protected areas and the development of farming practices are being applied, benefiting the livelihoods of local communities (Klink & Machado, 2005).

These human activities caused several impacts on the drainage-basins, as water pollution, silting of running waters, and losses of riparian and aquatic biota. Despite studies on the fauna and flora of Cerrado showed an estimate of 160 thousand species, the biodiversity of this region is still poorly known. This situation is notable for the diversity of aquatic groups such as invertebrates, algae, macrophytes and fishes (MMA, 2007).

MATERIAL AND METHODS

This paper intends to examine the statement on this high biodiversity estimated in Brazil, which is around 13% of the world's species (Lewinsohn & Prado, 2005). This research was based on a literature survey focused on the aquatic ecosystems of the Brazilian savanna (Cerrado). The Scielo (Scientific Electronic Library Online) and the Web site of the Institute for Scientific Information (Thomson Corporation, 2012) were explored using the keywords "Cerrado"and "biodiversity" (papers published between December 12, 2004 and October 31, 2012). The aquatic biodiversity in Cerrado was also investigated on academic theses referenced by IBICT (Brazilian Digital Library of Theses) from 2005 to 2012.

A comparison between the data presented by this work and those obtained by Agostinho et al. (2005) was made and a short ecological characterization of inland aquatic systems was presented taking into account the hydrological parameters, such as standing or running waters, and the main wetlands categories.

DISCUSSION

A brief characterization of Cerrado's inland waters

The core region of the Cerrado Domain presents a variety of natural aquatic ecosystems. Besides the lotic water bodies (running waters) and the lentic ones (standing waters), there is another specific aquatic systems in this region, which is associated to flooding areas inserted in the category of humid zones. According to the Ramsar convention (1971), a humid zone is considered the whole extension of marshes, swamps, puddles and turfs, or any watery surfaces, artificial or natural, permanent or temporary, fresh or salty. The occurrence and the extension of humid zones in the Cerrado produces a broadening between the terrestrial and aquatic systems and a scientific research still underexplored in these areas.

A large number of low-order streams are part of the Cerrado core region drainage systems. It is a dendritic hydrographic network with small water courses which headwaters emerge at the plateau`s skirts and which extensions are originally protected by a dense riparian vegetation. Under natural conditions, their waters are poor in nutrients, slightly acid and have low electric conductivity (up to 10μS/cm). Because of the shallow, small size and usually shadowed streams, the water temperature remains between 17 and 20°C (Padovesi-Fonseca, 2005). In hotter streams, temperature may reach 25°C during the summer. The dense riparian vegetation cover prevents the direct sunrays incidence, reducing the primary productivity performed by the aquatic vegetation. Scarce light associated with low current and few nutrients limit the aquatic organisms' development, especially of the floating ones, influencing the whole food web. On the other hand, the presence of riparian vegetation regulates excessive water heating, supplies the allochthonous energy by leaves, fruits and seeds for the water system, and furnishes the environmental conditions for reproduction of several species. Allochthonous items, such as vegetal rests and other organisms, are additional feeding sources for the lotic system, linking and broadening the food web. The species present in those regions play an important role in the study of biodiversity, once that many of them occur under distinct environmental conditions, possibly becoming endemic in the Cerrado region (Schneider et al., 2011).

Currently, in many areas, the riparian vegetation is rather altered or even inexistent; due to the frequency it has been replaced by grasses. Margins erosion, water courses silting, pollution and water contamination are the main consequences of the indiscriminate anthropic usage of the drainage basins. Moreover, the mining activities, domestic sewage inflow and the pesticide use in agriculture are the major causes of the water degradation and loss of Cerrado's aquatic biodiversity (De Marco et al., 2014).

About 45,000 km² of the Cerrado are fallow lands, where soil erosion can be as high as 130 tons/ha/year (Klink & Machado, 2005). Agricultural practices at the region include extensive use of fertilizers and lime (Mueller, 2003), which pollute streams and rivers. By 1998, 49% of the Tocantins river basin had been converted to crop lands and pastures, increasing river discharge by 24% (Costa et al., 2003). The widespread and illegal clearing of riparian forests reduces the freshwater supplies for urban areas (Mueller, 2003).

The core of Cerrado Domain has countless number of lakes and natural lagoons formed by the upwelling of the groundwater. These standing waters tend to have well defined shapes and depths. Their physical and chemical characteristics reflect the hydrographic basin conditions, such as soil type, relief and geology (Fonseca et al., 2014).

Lakes are transitory elements in the landscape, once they appear and disappear along the geologic time. Their short life term is associated with various phenomena, like sediments and affluent inputs on the drainage basin, and the accumulation of materials in its bottom (Beuchle et al., 2015).

Lagoons are shallow lakes usually with transparent waters. As sunlight can reach their bottom, they are well illuminated and with a plenty of aquatic plants in their margins and bottom. The colonization by these plants represents a sort of environmental heterogeneity, affecting the lagoon`s metabolism (Pompêo & Moschini-Carlos, 2003) and enlarging the ecological groups and the local biodiversity living in this area.

This vegetal amount has an ecological relationship with lagoon aquatic flora and fauna. Areas with macrophyte species represent important refuges, nursery and feeding habitats for aquatic organisms, with the food availability and structural complexity providingthe protection and microhabitats diversity (Sánchez-Botero et al., 2007). They also reduce the winds action and maintain the water condition. Nutrients present in the lagoons' sediment can be absorbed by the roots, and become available for the plant. Vegetal decomposition delivers nutrients that can be reused, and aquatic macrophytes can become the main producers of the lagoon`s organic matter. The habitat structural complexity and its implications for community structure and food web dynamics were discussed by Warfe & Barmuta (2006).

Lagoons tend to become shallower during the dry season and, in the rainy season, their water level fluctuates according to the precipitation regime. During the rainy season, many of them can present turbid waters due to sediments input from the surrounding soil or from water veins originated in the headwaters (Bleich et al., 2009). Several studies showed the influence of precipitation regime, especially during long dry period, on the nutrients and the biota, with the generation of spatial variability from the water quality properties to primary producers (e.g. Odebrecht et al., 2005).

Many of these lagoons are situated in elevated and protected areas, and, part of them is still unknown by the population or even by scientists.

When located in high places and within watersheds, they can act as ecological corridors interlinking the flora and fauna of contiguous basins. These areas are, in general, the shelter of endemic and endangered species, revealing a huge genetic patrimony (Padovesi-Fonseca, 2008). Even situated in preserved areas, some lagoons are already altered due to human settling and agriculture expansion.

The vegetation development is conditioned by several factors such as the soil type and fertility, the level of soil's saturation during the dry season, depth and fluctuation of the groundwater volume. In high and well drained areas, the vegetal cover is a typical "Cerrado", composed by a mixing of grasses, shrubs and small trees. In lower areas, where the soil is saturated, the vegetal cover is usually grass species, different from the Cerrado ones. And, in the humid highlands, the vegetation is formed by Buritis (*Mauritia vinifera* Mart.) trees, typical of the region (Padovesi-Fonseca, 2005).

The "veredas" are very common vegetation formations of the Central Brazilian Plateau which occur in permanently water saturated soils. It has a dense ground-line vegetal layer formed by swamp herbaceous species that live in puddles, such as grasses, Cyperaceae and Pteridophyta. In the other strata of the vereda, there is a strip of buritis, prominent palms that occasionally can reach more than 20 m high. This formation is ecologically important, once it works as landing, resting, sheltering, nestling and feeding place for birds, serving as well as food source for the terrestrial and aquatic fauna. For birds, veredas have been poorly used by Cerrado's endemic species, but are the major habitat requirement of several species, as revised by Tubelis (2004). Thus, this vegetation is an important ecosystem to the regional biodiversity, requesting efforts to its conservation.

Swamp grasslands are widely distributed in central Brazil. They occur on valley's sloping grounds along the margins of the gallery vegetation. The groundwater remains at the soil's surface during the whole year, especially in the rainy season, and, in the dry season, it keeps the subsurface layers soaked. This vegetation is composed mainly by grasses of herbaceous strata, and exhibits a highly organic and spongy soil (not peat-turf like). Surface and deeper groundwaters tend to be slightly acid (about pH = 5), poor in ions (electric conductivity below 10 μS/cm), have lower temperatures (up to22°C) and enough oxygen. Such marches contain poorly drained hydromorphic soils, as discussed by Haridasan (2008).

Swamp grasslands are situated between gallery forest and the closed grasslands or veredas. The Graminea and reed species composition in humid grassland is diversified and exhibits a spatial zoning (Goldsmith, 1974), where in less soaked areas, it is possible to find marsh plants of *Drosera* L. (Caryophyllales Droseraceae) carnivorous plant, *Sphagnum* L. (Sphagnales Sphagnaceae) peat moss, and *Utricularia* L. (Scrophulariales Lentibulariaceae) carnivorous plant, and in water saturated places, complex filaments algae develop on the soil surface (Amaral et al., 2013).

Inside the swamp grasslands, areas with elevated and exposed soils are called"murundus". The murundus are round shaped and slightly high ranges from 1 to 10 m in diameter and up to two meters in height (Oliveira-Filho, 1992). They are formed by differentiated ground erosion and, more often, are colonized by termites (Goldsmith, 1974).

According to Furley (1986), two situations contribute to murundus formation: one is by the upwelling of the groundwater that remains close to the surface, keeping the generally organic soil soaked in the valley's lower lands. The other possibility is by the seasonal rainfall cycling and water surface runoff, which is more uncommon, but occurs in flatter areas.

The murundus present in clean areas have a discontinuous spatial arrangement along a longitudinal axis that somehow affects the aquatic organisms' abundance and distribution. In a hillside flush marsh near to Brasilia, capital of Brazil, it was recorded an endemic Copepoda species at a Cerrado area, registered as *Murunducaris juneae* Reid, 1994 (Reid, 1993; 1994; Corgosinho et al., 2008, and references). The murundus are widespread in the central Brazil highlands (Reid, 1993) as well as in other areas of Cerrado Domain, but studies in such areas are still needed to improve the knowledge of the abiotic and biotic systems of the Brazilian savanna.

Aquatic biodiversity

The high degree of endemism of the Cerrado's biota is already acknowledged, with an exceptional biological richness, holding five percent of the planet's known biodiversity (Oliveira & Marquis, 2002). For that reason, it is considered a world hotspot, and one of the richest and endangered biomes on earth. The most important areas for biological preservation are situated along the Brazilian Cerrado central axis (MMA, 2007).

A review done by Agostinho et al. (2005) concerning to species diversity and threatened species revealed the difficulty to have a more precise number of the inland aquatic species of Brazil. This literature survey produced 217 results from 1990 to 2004, whereas the present study had 308 results from 2004 to 2012. The results obtained by these two surveys showed two main issues: the lack of data of Brazilian biodiversity and the tendency to produce similar results, in Brazil or Cerrado surveys, although from different periods. Among the 308 researches for Cerrado, only four percent referred to freshwater organisms; while Agostinho et al. (2005) found 11%.

As the not published academic theses were investigated, they revealed a predominance of studies related to aquatic macroinvertebrates (about 40%), followed by phytoplankton and zooplankton (15%). Researches including fish and aquatic macrophyte species reached only six percent of the explored theses (Fig. 1).

The Brazilian savanna richness is estimated in 9,580 species (MMA, 2002; 2004) and, as argued by Agostinho et al. (2005), the number of aquatic species in its inland waters is irregular due to the lack of basic requirements for the production of realistic inventories. The estimated number of species in the Brazilian and Cerrado inland waters is represented in Table 1.

At least 22.8% of fish species in Brazil are expected to occur in Brazilian savanna, as well as 25.2% of bivalve mollusks, and 41.9% of the diatom algae. The endemism is considerably elevated for some groups at the Cerrado, reaching 25% for fishes and more than 10% for bivalves and diatoms (Table 1).

In consideration to the high biodiversity that the Cerrado biome presents, especially for the aquatic biota, the fish diversity is rather expressive. Estimations indicate the occurrence of almost 3,500 fish species in South America, with more than 800 being found in the Cerrado Domain. This estimate can even reach higher values since about 30 to 40% of Brazilian freshwater species are still unknown (Agostinho et al., 2005). Such information highlights the native species composition, including the migratory fishes, of the ichthyofauna presented in the hydrographic regions of the central Brazil (Langeani et al., 2007).

Taking into account the potential endemism and the number of endangered fish species in this region, it is necessary to expand the knowledge on this fauna, especially at the headwaters. A study

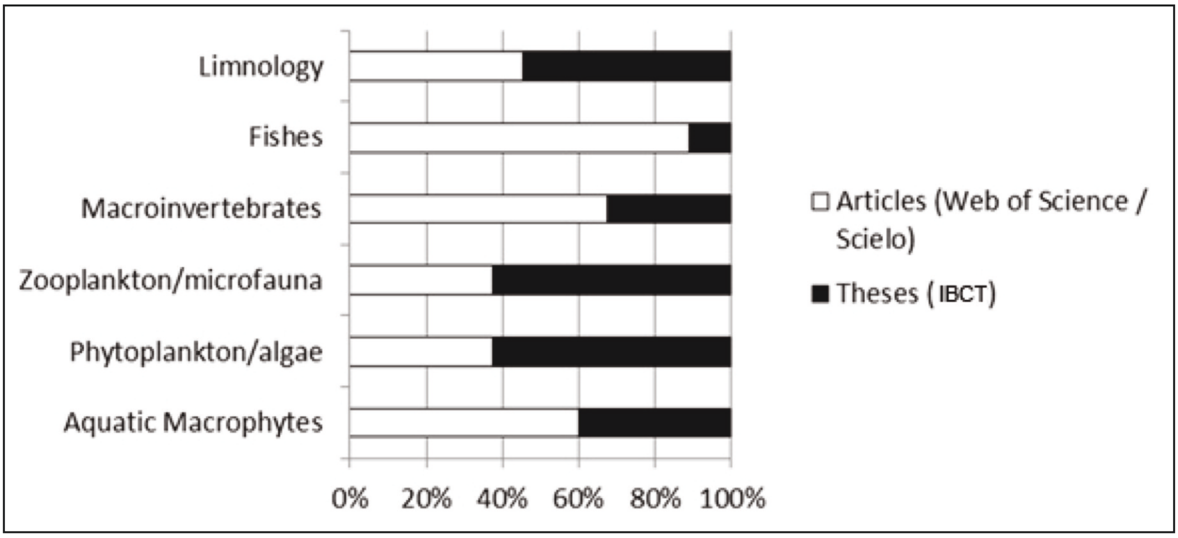

Figure 1. Potential increase of aquatic biodiversity in Cerrado Domain, Brazil.

TAXA	CERRADO [a]	CERRADO (endemic spp) (10–25%)[b]	BRAZIL	References
Macrophytes	100-300**	10–75	500–600	Pott et al., 2011**; Agostinho et al., 2005
Algae total	2,500	250–625	10,000	MMA,2003
Bacillariophyta (diatoms)	503**	51–126	1,000–1,200	Silva et al., 2011**; Lewinsohn & Prado, 2005
Chlorophyta	563**	53–141	2,500–3,500	Freitas & Loverde-Oliveira, 2013**; Lewinsohn & Prado, 2005
Cyanobacteria	115	12–29	460	Sant'Anna et al., 2011
Protozoa (Sarcodina)	400	40–100	550	MMA, 1999
Protozoa (Ciliate)	1,500	150–375	= 1,500	MMA, 1999
Platyhelminthes (Cestoda)	30	3–8	120	Rego, 2004
Mollusca (Bivalvia)	29	3–8	115	MMA, 2003; Agostinho et al., 2005
Mollusca (Gastropoda)	48	5–12	193	MMA, 2003; Agostinho et al., 2005
Rotifera	137	19	457	MMA, 2003
Arthropoda (Acari)	83	8–21	332	MMA, 2003; Agostinho et al., 2005
Crustacea (Copepoda)	31	3–8	273 + 36** Total: 309	MMA, 2003; Previatelli et al., 2013**
Crustacea (Cladocera)	56**	6–14	153	Sousa & Elmoor-Loureiro, 2012; MMA, 2003;
Insecta (Ephemeroptera)	52	–	166	Salles et al., 2004
Insecta (Chironomidae)	47	5–12	379	Mendes, 2014
Insecta (Odonata)	67**	7–17	800	Galvão et al., 2014**; Paulson, 2014
Insecta (Plecoptera)	28	–	110	MMA, 2003; Agostinho et al., 2005
Insecta (Trichoptera)	219–230**[1]	22–55	625 + 29**[2] Total: 406	Paprocki & França, 2014; Santos et al., 2014 **[1]; Dumas et al., 2010**[2]
Pisces	800	200 (25%)	3,500	MMA, 2003; Agostinho et
Amphibia	113	32	687	MMA, 2002; Lewinsohn & Prado, 2005

Table 1. Estimated number of species in freshwater environments in Cerrado (brazilianSavanna) and Brazil, a: estimated number corresponded to 25% registered for Brazil; b: estimated number corresponded to 10-25% registered for Cerrado; **number registered by reference coupled for the taxon.

conducted in the headwater of the Paraná basin region, in the Brasilia National Park, central Brazil, detected 14 new fish species, all of them endemic in the area (Aquino et al., 2009).

The Protozoa is the less known group of the Cerrados's aquatic invertebrates and studies dealing with its importance in the aquatic ecosystems functioning, particularly as an additional link in the food web, and the use of special techniques (expensive in most of the time) for sampling and identification, are really necessary, although the high cost may somehow limit the study (MMA, 2003; Agostinho et al., 2005),

Within Protozoa, Flagellates are the organisms with the grater lack of data, and their diversity cannot even be estimated. Among Sarcodine, the *Thecamoeba* is well studied and its richness is estimated in about 400 species for the Brazilian savanna. Nevertheless, in recent studies, about 20 genera and 150 *Thecamoeba* species were identified (MMA, 2003). The Ciliates, however, are the most expressive members of the Protozoa in terms of species richness, besides being useful as bioindicators for water quality evaluation. From the 8,000 species described around the world, 1,500 are estimated to occur in the Cerrado biome.

In relation to aquatic microinvertebrates besides Protozoa, representatives of Rotifera and microcrustaceans (Cladocera and Copepoda) must be mentioned. A great amount of rotifer species is widely distributed, and they are present in almost all kinds of freshwater habitats. From the 457 Brazilian known species, at least 30% are found in the Cerrado's freshwater environments, where nearly four percent are likely endemic. Copepoda and Cladocera are the mainly groups of freshwater microcrustaceans, with an estimation of almost 100 species, but this number is expected to increase by the registration of new species (Elmoor-Loureiro et al., 2004; Elmoor-Loureiro, 2007; Sousa & Elmoor-Loureiro, 2008). The endemism degree of these groups is high, and when associated to the scarce data for the Cerrado Domain, inserts the possibility of the biodiversity to increase for the area and for the country.

Benthic macroinvertebrates community is composed by several groups that live in the substrates and sediments of the water bodies, such as annelids, molluscs and aquatic insects, with the majority of the studies on the region focusing on aquatic insects. Some research conducted in several streams of central Brazil revealed a wide fauna, with different taxonomic levels, but with only a few organisms identified as species, probably due to the difficulty of the taxonomic identification in some groups (Bispo et al., 2006; Martins-Silva, 2007; Martins-Silva et al., 2008). Therefore, the Cerrado's benthonic fauna composition has a generalized configuration, and shows an increasing perspective of the biodiversity records at the area.

The Cerrado's aquatic flora, which covers macrophytes, phytoplankton and periphyton, has been evaluated in natural environments, but the aquatic assemblages are still poorly documented by the published articles. A rich microflora composed by Desmidiaceae algae was registered at Lagoa Bonita, a lagoon situated in a permanent preserved area of Distrito Federal, central Brazil (Souza et al., 2008 and references). An increase of algae diversity in a periphyton community associated to aquatic macrophytes was also noted in a lotic environment at the Roncador stream, situated in the IBGE Ecological Reserve (Distrito Federal), where it was recorded 171 taxa (Mendonça-Galvão, 2002). Along the Descoberto River, sixteen taxa were registered, with their majority classified as first occurrence in the Distrito Federal and Goiás state (Delgado & Souza, 2007).

Despite such few studies, the high biodiversity of the natural aquatic ecosystems in Cerrado is perceived as requiring more efforts and contributions for researches in the region (Silva et al., 2011). From the 38 studies carried out over almost 30 years, only 19 were published in periodicals. However, sixty-four genera and 503 species of diatoms were catalogued based on these researches.

The existence of wetlands in the Cerrado increases the inventory of aquatic species in the country. The aquatic community that develops in the central Brazilian wetlands is quite unknown; nevertheless, studies conducted in this region detected a rather expressive biological diversity, with some endemic species. Benthonic invertebrates are numerous and the fishes have small size. The fish *Cynolebias boitonei*, Carvalho, 1959, named pirá-brasília, is endemic and endangered in the veredas of Distrito Federal (Aquino et al., 2009). Because of its beauty, the species is used as ornamental fish, raising its demand by aquarists and worsening the species situation in relation to its conservation.

Macrophytes species have been also related to high levels of biodiversity and endemism. As observed by Pott et al. (2011), the number of species collected in the upper watershed of Paraná basin is two times bigger than the one found in the Pantanal, reaching at least 574 species.

In relation to algae species, their high variety with new species in the Cerrado inland waters was mentioned by Senna & Ferreira (1986; 1987), Padovesi-Fonseca & Adamo (2007) and Souza et al. (2008). In a humid grassland habitat, Reid (1982; 1984; 1987; 1993) described a community composed by nematodes, rotifers, Harpacticoida copepods, Protozoa, Turbellaria, Cyclopoida copepods, Cladocera, Ostracoda, Oligochaeta, Hydrocarina and larvae of many families of insects. At least ten Copepoda species were registered for the first time and identified as endemic species for the region.

Therefore, due to the scarce number of studies on various aquatic groups in the central Brazil, the support for new researches is essential, as well as the recognition of the inland waters of Cerrado as a priority on the aquatic biodiversity conservation.

The potential increase of aquatic biodiversity

The Cerrado Domain has a great heterogeneity of aquatic environments across a high altitude landscape. Its nuclear region represents a basin divisor, with spring's profusion, infinite network of small lotic ecosystems, lakes and wetlands formed by the upwelling of groundwater. There, the water courses transit between mountains and rocky cliffs exhibiting shallow and narrow bodies, with backwater areas and small pools formations alternated by fast-current rivers and waterfalls along its course.

The Cerrado's core region involves an area of headwaters and watersheds of the main hydrographic basins of the country, playing an important role in the biological diversity. Brazil owns a significant portion of the world's rivers runoff and the elevated level of endemism for Cerrado's aquatic species reaffirms the importance of the conservation of inland waters in the Brazilian savanna.

Connection areas between basins, comprehending their drainage headwaters, are endemism nucleus for freshwater species, representing one of the aquatic biodiversity conservation priority areas (MMA, 2007). Streams originated in this region naturally flow towards the basins, most of the time forming ecological corridors for many aquatic species. Depending on the species adaptation capacity, and their ability of stabilizing in other regions, the Cerrado's waters can represent dispersion paths for aquatic species. Thus, the core area is indispensable for the preservation of aquatic diversity and its genetic inheritance. Moreover, this necessity is imminent once that less than 0.5% of the Cerrado is covered by truly aquatic conservation areas (MMA, 2007).

Hydrogeological variations along these courses form distinct environments and create degrees of isolation, which affect the distribution of aquatic biota. The geological events had a historical influence on the formation of inland waters in central Brazil, causing the predomination of small aquatic environments, as streams, pools and lakes, and affecting the species distribution. The highest proportion of fish biodiversity in the Neotropical region was registered in the streams' headwaters and lagoons of Cerrado (Langeani et al., 2007).

The potential increase of aquatic biodiversity in Cerrado has also been reported for wetlands as a result of environmental heterogeneity, which enables a higher biodiversity (Leibowitz, 2003), especially in protected areas with a pristine condition. This potential encompasses species from a variety of taxonomic groups, as algae, protozoa, invertebrates, vertebrates and many plant species. However, for instance, this tendency was observed only for microcrustacean fauna as argued by Reid (1982; 1984; 1987; 1993). Phytophilous cladocerans, for example, have been evaluated in several wetlands areas distributed in central Brazil, and more than a half of them were classified as new or endemic species (Elmoor-Loureiro, 2007; Sousa & Elmoor-Loureiro, 2008; Sousa et al., 2013).

Pristine areas as reference for biological analyses

Aquatic species have been used as biological indicators because of their sensitivity and rapid response to subtle changes caused by anthropic or natural impacts. Benthonic macroinvertebrates and fishes have been broadly used in biological analyses due to the particular characteristics of these aquatic assemblages.

Benthonic macroinvertebrates show a wide spatial distribution and, in general, restrict limits of tolerance to environmental variables alterations (Lampert & Sommer, 2007), and each species or functional group have specific tolerances, according to their sensitivity to pollution (Metcalfe,1989). Moreover, their sedentary life and high longevity facilitate the analysis of temporal changes in response to environmental perturbations.

As biological indicator, benthic invertebrates reinforce the relevance of pristine areas in Cerrado as a reference of environmental condition. In these areas, the water courses are protected by gallery vegetation and the large allochthonous matter comes from the forest, allowing the predomination of specific groups (Couceiro et al., 2009).

The preservation of the gallery vegetation provides environmental heterogeneity in the lotic systems, and when associated with natural disturbances, such as droughts and floods, are important factors for the potential increase of benthic macroinvertebrates diversity (Bunn & Davies, 1992).

Fishes of Brazilian streams are highly endemic (Langeani et al., 2007) and little resistant to habitat degradation and other anthropic modifications (Araújo et al., 2003), which enables their use as bioindicators of environmental quality (Karr, 1981).

The Cerrado's natural landscape, as a whole, was very impacted by anthropic activities, but many efforts are still possible in favour of the preservation of reminiscent habitats. In this context, surveys on the Cerrado's fauna and flora are fundamental for future regional research, and indispensable for the creation and management of protected areas.

CONCLUSIONS

Even when the Cerrado has been considered one of the most biodiverse and threatened biomes of the world, little attention has been paid to the conservation of its natural aquatic ecosystems and biota. The high endemism detected in the Cerrado and the ignorance on its aquatic environments, reveal important gaps that hind the evaluation of the aquatic ecosystems, once that, nowadays, the defined areas for conservation rarely include them. This situation can be associated to the widely accepted idea that, once the terrestrial environments are protected, so are the aquatic ones, as discussed by Padovesi-Fonseca (2005).

When considering the Cerrado`s biome broadness and potential high biodiversity, the aquatic flora and fauna must be evaluated and visualized as essential tools for the region's environmental conservation. One of the relevant aspects concerning aquatic environments conservation is the lack of data on the Cerrado's pristine systems. These areas, besides being an important biodiversity source as indicated by this review, can also become a reference for the recover and restoration of degraded habitats.

The springs and wetlands profusion attests that water is an abundant source in the Cerrado region. However, human settlements in the spring's area can result in serious problems due to the low rate of replenishment and the use of groundwater as a water source. The good quality water withdraws for different uses by the industries and population is a main challenge today. Water is a high value resource, with potential uses such as power generation, domestic and industrial supplies, navigation, irrigation, recreation, farming and fishing, among others. As a result, many springs and natural lakes have been drained (Hunke et al., 2014).

In this context, it is evident the necessity of intensifying efforts devoted to the study of these regional peculiar ecosystems, as well as their biodiversity and aquatic species biology and ecology. Such purposes would guarantee the theoretical basement for the preservation and sustainable use of water sources by the current and future generations.

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