

## Veredas: Upper Basin Wetlands Feed the Pantanal Year-round

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### INTRODUCTION

*Veredas*<sup>4</sup> are a unique type of wetlands found in Brazil's Cerrado on the headwaters of streams feeding rivers of Central Brazil, such as the tributaries of the Paraguay River in the Pantanal wetland (Figure 1). They usually occur in flat valleys, although they sometimes begin on slopes. Their size in length and width is variable. Their soils are hydromorphic organic that store water like a sponge and release it gradually throughout the year, despite the seasonality of region's rainfall. These organic soils are permanently waterlogged, often enhanced by impermeable laterite bedrock which produces high iron contents in soil and water. While *veredas* form small creeks that maintain the rivers running to the Pantanal lowland, in dry years or under drainage, the regularity of outflow is reduced, thereby eliminating river overflow on the adjacent plains. Low rainfall in both highland and lowland favors wildfires, such as occurred in 2020 (Damasceno et al. 2021). The severe drought continues in 2021. Therefore, *veredas* are now under increasing concern for the urgent need for conservation.

### FLORA OF THE VEREDAS

*Veredas* shelter a high plant richness, around 1,000 species of angiosperms (Moreira 2015). The species-richest families are Poaceae, Cyperaceae, Asteraceae, Fabaceae, Melastomataceae, Lamiaceae, Rubiaceae, Eriocaulaceae and Lentibulariaceae. Some of the most abundant species are filiform graminoids, such as tussock grasses and sedges. The main grasses are *Andropogon virgatus*, *Anthraenantia lanata*, *Anthraenantiopsis trachystachya*, *Axonopus unino-dis*, *Eriochrysis* spp., *Paspalum* spp., *Saccharum* spp., and *Setaria paucifolia*. Some of the most frequent sedges are *Rhynchospora* spp. (e.g., *R. emaciata*). Other filiform or slender plants reaching the top of the grassland stands belong to various families and genera, e.g., *Achyrocline*, *Aeschynomene*, *Buchnera*, *Cyrtopodium*, *Habenaria*, *Lessingianthus*, *Schwenckia*, *Sizyrinchium*, *Widgrenia*

and *Xyris*. Two endemic species were recently described: *Cyperus valiae*, so far only found in *veredas* of the Serra da Bodoquena plateau (Pereira-Silva et al. 2018), and *Passiflora pottiae* (Cervi and Imig 2013). A few ferns colonize the decaying straw underneath grass tussocks, like *Pityrogramma calomelanos*, *Cyclosorus* spp., and *Thelypteris serrata*, later to be replaced by shrubs. The most common shrubs are *Byrsonima umbellata*, *Heteropterys subcoriacea*, *Ilex affinis*, *Ludwigia nervosa* and *Miconia chamissois*, and some scattered treelets such as *Cecropia pachystachya*, *Myrsine* spp., and *Tapirira guianensis*. Treelets become denser toward the streamlet, mainly where the channel deepens, forming a creek with downstream gallery forest. Trees also occur on the *vereda* head, where water emerges near the slope.

The palm *Mauritia flexuosa* is often present (Figure 1) and although its presence is not mandatory to characterize a *vereda* (Figure 2), it is used as an indicator for its easy recognition. Unfortunately similar wet grasslands without the palm are overlooked and not recognized as *veredas* and not protected (Moreira et al. 2015). The occurrence of *M. flexuosa* southwards seems limited by frequent frost. Another indicator species is *Miconia chamissois* (Figure 3) which grows in variable densities over the grassland.

Most often, there are three zones in the *veredas*, with varying floristic compositions (Oliveira et al. 2009). The vegetation varies from open marshy grassland, mainly in the external zone, to grassy-shrubby and swampy gallery forest inwards. The ground is quite firm near the edge, with short herbs. It becomes boggy inside, often like a water mattress, and water pours to the surface, forming puddles among grassy mounds and flows slowly, mainly in animal tracks. Intermingled small aquatic plants grow in those gaps, e.g., *Drosera*, *Mayaca*, and *Utricularia*. In some



Figure 1. Vereda wetland with the *Mauritia flexuosa* palm. (Note: All photos courtesy of the authors)

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<sup>4</sup> *Vereda* means path in Portuguese because it was the way of access through the Brazilian woody savanna, the *Cerrado*, while also providing water and grass for horses and oxen.

areas patches of *Sphagnum* spp. can be found. The third zone is the bottom (the lowest elevation), where a stream collects the outflow. Temporary ponds with aquatic plants may occur within the *veredas* (Moreira et al. 2011).



Figure 2. Vereda wetland without the *Mauritia flexuosa* palm. Note the filiform grasses.



Figure 3. Shrub *Miconia chamissois*, an indicator of vereda wetland.

Note that while the flora of the Pantanal wetlands (Pott and Pott 2020) is distinct from the *veredas*, some patches of *vereda* occur in the eastern edge of the Pantanal lowland, only along the few short permanent streams. The occurrence of *Mauritia flexuosa* along the Aquidauana River, however, are just palm stands because they lack the other species characteristic of the *veredas* (Moreira et al. 2017; Pott and Pott 2020).

### FAUNA OF THE VEREDAS

*Veredas* function as water and food source, nursery and refuge for the Cerrado fauna. Flowers occur year-round for pollinators, e.g., *Ferdinandusa brasiliensis* and *Sinningia elatior* are visited by hummingbirds. Many species are bird-spread and provide fruits for fauna, e.g., *Byrsonima umbellata*, *Cecropia pachystachya*, *Mauritia flexuosa*, *Miconia chamissois* (Figure 3), *Myrsine leuconeura*, *Piper fuliginum* and *Tapirira guianensis*. Some of the common animals are anaconda, *urutu* (*Bothrops alternatus*), caiman, giant anteater, tapir, and the maned wolf that is depicted on the current top-value Brazilian bill (R\$200). Many birds nest in the *veredas*, such as the blue-and-yellow macaw (*Ara ararauna*), on dead stems of *M. flexuosa*.

### OTHER VALUES OF THE VEREDAS

*Veredas* function as a sponge, filter and storage, producing clean water year-round, feeding streams and rivers. For example, the main water supply of the capital of Mato Grosso do Sul comes from *veredas* of the Guariroba preservation area - we can drink *veredas* water straight from the tap! (No filtration required.)

Besides being a vital water resource, the *veredas* are an income source for local people. Traditional handicraft is jewelry from *Syngonanthus nitens* inflorescence stalk. The *Mauritia* palm is very useful: 1) the young leaf fiber is woven into various objects, 2) the petioles are used a very light wood for furniture, and 3) the oily fruit pulp (rich in carotene) is used to produce a sort of marmalade, ice cream, and cosmetics. The orange-colored roots of the obligate hemiparasitic plant *Escobedia grandiflora* is traditionally used as a natural colorant for food and medicines (Pennel 1931).

### THREATS

*Veredas* has not been under much direct human pressure. Cattle access drinking water and, in the dry season, often there is grazing. Small impoundments are often built on the outlet stream for cattle. However, the most severe disturbances are changes by drainage. Despite being protected by law as permanent preservation areas, some were recently drained for rice on the headwaters of the Sucuriu River and for other crops (oats, corn, soybean) on the headwaters of



the Prata River (*prata* is silver in Portuguese, alluding to the crystalline water), affecting tourist resorts by turbidity (Pott et al. 2019). On karstic ground, with underground flow and sinkholes, marshes of the Bodoquena plateau often have sawgrass (*Cladium mariscus* subsp. *jamaicense*). Drainage causes water table drop and consequent increase of ruderal annual plants, shrubs and treelets, and invasion of exotic trees such as *Leucaena leucocephala*.

Silting from erosion of surrounding deforested slopes can kill the *vereda*, choking the herbaceous and woody vegetation. Trees die in standing water dammed by road embankment, including *M. flexuosa*. Although a wetland palm, it does not survive when its pneumatophores are drowned in stagnant water or buried. Fire may also occur, causing severe damage when the organic soil is dry and burns.

Natural or human interferences induce plant succession, primarily via changes in rainfall and human activities inside the *veredas* or in the surrounding lands. Lowering the water table leads to increased woody plant abundance. Moreover, lack of conservation of *veredas* on the upper basin hinders the hydrologic regime of the Pantanal wetland.

## CONCLUSION

Besides the species richness and the vital role of this water resource, it is crucial to preserve the *vereda* wetlands with or without the *Mauritia flexuosa* palm on the upper basin of the Pantanal to maintain the hydrology of the Pantanal floodplain.

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