

## Biodiversity of the Pantanal: its magnitude, human occupation, environmental threats and challenges for conservation

Alho, CJR.\*

Programa de Pós-graduação em Meio Ambiente e Desenvolvimento Regional, Universidade Anhanguera – Uniderp,  
Rua Alexandre Herculano, 1400, CEP 79037-280, Campo Grande, MS, Brazil

\*e-mail: alho@unb.br

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The Pantanal biome is a wetland – a floodplain in a geographic depression – formed by the Paraguay River and its tributaries from the left bank: Bento Gomes, Cuiabá, São Lourenço-Itiquira, Taquari, Negro, Aquidauana-Miranda, Nabileque, and Apa. The Paraguay River and its tributaries form the Upper Paraguay Basin and drain into the Pantanal depression, running southward between highlands to the west and the upland plateaus to the east, where the tributaries have their springs. These large rivers are shaped largely by type of soil, water flow rate, levels of dissolved oxygen, nutrient loads, temperature, and type of river bed. The rivers are slow moving when they leave the upland plateaus surrounding the floodplain and meet the flatlands, where they periodically overflow their banks.

The maze of fluctuating water levels within this sedimentary floodplain, plus annual nutrient cycling through biogeochemical cycles with influx of nutrients, particulate material, microorganisms and invertebrates form a dynamic ecosystem, with a complex mosaic of habitats and diverse and abundant wildlife. The four phases of the hydrological cycle (water rising or flooding, flood season, receding water or drainage season, and dry season) are essential for wildlife. The annual tides of the rivers, causing seasonal flooding, result in availability of feeding and reproductive niches for wildlife.

**Macroinvertebrates.** The diversity of benthonic macroinvertebrates (zoobenthos such as decapods, molluscs, oligochaetes, insect larvae which feed upon microorganisms and algae) were estimated in 70 taxa (Takeda et al., 2000). Zoobenthos are important in the food chain because they serve as food for fish, birds, mammals and other animal groups. Ostracoda (aquatic crustacea) and Nematoda (free living non-parasitic roundworms) are the two most abundant groups.

**Crustacean diversity.** Shrimps and crabs are represented by 10 species and the shrimp *Macrobrachium amazonicum* and the crabs *Dilocarcinus pagei*, *Sylviocarcinus australis*, *Trichodactylus borellianus* and *Valdivia camerani* are found in field surveys (Magalhães, 2000). These decapod crustaceans play an important role in ecological processes of the Pantanal's aquatic ecosystem since they participate in the trophic chain as herbivores, predators, decomposers and are prey for fish and other animal groups.

**Plant diversity.** Three articles discussing plants of the Pantanal are presented in this volume.

**Fish.** Fish are an important resource, both ecologically and socially. Britiski et al. (1999) listed 263 species for the Pantanal. However, a survey carried out in the Negro River region of the Pantanal showed that 19% of the species collected are believed to be new to science (Willink et al., 2000). This list does not include species living in the upper river habitats. The number of fish species increases from the headwaters (plateau upland region or *planalto*) to the base of the drainage (Pantanal).

Because of the great variety of feeding and reproductive niches for fish, the Pantanal harbours high species abundance. Fishing is of fundamental social-economic importance for local people. In addition, fishing for sport is one of the incentives to bring tourists to the region. Junk et al. (2006) discuss more on fish diversity of the Pantanal.

Fish resources in the Pantanal have been recognised according to their use as:

- a fundamental biotic component of the ecosystem, supporting the local biodiversity and being part of it;
- food for subsistence and income of local people;
- of interest for sport fishing;
- a genetic resource;
- an ornamental resource.

**Herpetofauna.** Compared to other Brazilian biomes, the Pantanal presents a herpetofauna low in diversity but high in abundance. There are 135 herpetofaunal species living on the plains (40 species of anuran amphibians, three species of turtles, 25 species of lizards, two species of amphisbaenians, 63 species of snakes and two of crocodylians (Junk et al., 2006). A survey carried out in the southern Pantanal recorded 41 anuran and 24 reptile species (Strüssman et al., 2000).

During the rainy season the region presents vigorous populations of amphibians, thanks to the expansion of favourable habitats. Three reproductive activity patterns are recognised among the species: continuous, explosive, and prolonged; 50% of the species were explosive breeders (Prado, 2003).

Many Pantanal species are distributed throughout Brazil, such as the rococo-toad *Bufo paracnemis* and the Chaco-frog *Leptodactylus chaquensis*, the dwarf-tree frogs *Hyla fuscovaria*; *Hyla acuminata*, *Hyla raniceps*, the green-leaf-frog *Scinax acuminatus*, the marbled-tree-frog *Phrynohyas venulosa* and the common-washroom-frog

*Scinax* cf. *nasicus*. The abundant tine green frog *Lysapsus limellus* has a semi-aquatic habit, lives on floating plants, eating insects and other invertebrates (Alho et al., 2002).

About half of the anuran species in the Pantanal live in trees. Some species, such as the spotted-tree-frog *Hyla punctata*, are associated with permanent bodies of water (rivers and ponds) and others, such as the purple-barred-tree-frog *Hyla raniceps*, the green-leaf-frog *Scinax acuminatus*, the yellow-and-black-tree-frog *Scinax fuscovarius*, tolerate droughts but the population suddenly grows when flooding comes, usually October to May. Frogs are also more vocal during this period.

The tiny clicking-frog *Lysapsus limellus* lives on floating vegetation and also vocalises by day. Also vocalising on floating plants are the paradox-frog *Pseudis paradoxa* and the speckled-bellied-frog *Physalaemus albonotatus*. During the rainy season this *Physalaemus albonotatus* frog is one of the most conspicuous and vocal when they join in sonorous choir, even by day.

Amphibians with terrestrial habits are the leaf-toad *Bufo typhonius*, the frogs *Chiasmocleis mehelyi*, *Leptodactylus elenae*, *Physalaemus cuvieri*, and the arboreal frog *Phrynohyas venulosa*. Another tiny frog living in dead tree holes in the forest is *Chiasmocleis mehelyi*, which has only recently been reported in the Pantanal. Some other species live at the water line between aquatic and terrestrial habitats, such as *Pseudopaludicola* aff. *falcipes*, *Leptodactylus fuscus*, *Leptodactylus podicipinus*, *Bufo paracnemis*, *Bufo granulosus* and *Elachistocleis* cf. *ovale*. A colourful aposematic species is *Phyllomedusa hypochondrialis*.

Among reptiles, there are more than 30 species of snake. The yellow-anaconda *Eunectes notaeus* is very common on the plains and is small in size compared to the other species, the green anaconda *E. murinus* that lives at the edge of the Pantanal and may reach 5 m in size, some observations reporting a size of 6-8 m. Another large snake is the water-queen *Hydrodynastes gigas*, which occurs at the borders of gallery forests or patches of savannas looking for toads, their preferred food. Small nocturnal snakes, which prey upon frogs, are *Thamnodynastes* cf. *strigilis*, *Leptodeira annulata* and *Liophis poecilogyrus*.

There are four species of poisonous snakes in the Pantanal: the Brazilian-lancehead *Bothrops moojeni*, the Neuwied' lancehead *B. neuwiedi*, the neotropical-rattlesnake *Crotalus durissus* and the Pantanal-coral-snake *Micrurus tricolor*.

The occurrence of species within the sub-regions of the Pantanal varies according to the local species composition and distribution, depending on the influence of the nearby biomes such as the Chaco, the Cerrado and the Amazonia. Among the snakes of the northern sub-region of Poconé, for example, Strüssmann and Sazima (1993) observed that the most abundant species are *Eunectes notaeus*, *Helicops leopardinu* and *Hydrodynastes* cf. *strigilis*. While the southern sub-region of Nhecolândia presented different species composition with *Leptodeira annulata*, *Liophis typhlus* and *Lystrophis mattogrossensis*, snakes common throughout the Brazilian Cerrado. The same pattern is

observed for amphibians, but with difference in local abundance, which is more remarkable in the Pantanal for these species.

There is one terrestrial turtle, the red-footed-tortoise *Geochelone carbonaria* plus one aquatic species, the large-headed-Pantanal-swamp-turtle *Acanthochelys macrocephala*. The caiman *Caiman crocodillus* is abundant and conspicuous, particularly during the dry season, being one of the symbols of the Pantanal.

Twenty species of lizards are known for the region, all preferring dry habitats except for the Pantanal-caiman-lizard *Dracaena paraguayensis* which lives in the water. Two lizard species, *Kentropyx viridistriga* and *Mabuya guaporicola*, are able to swim and dive to escape predators. Common geckos, *Phyllopezus pollicaris* and *Polychrus acutirostris*, exploit the branches of bushes. Three lizards can be easily observed searching for prey on the ground or rapidly escaping from intruders: *Tupinambis merianae*, *Ameiva ameiva* and *Cnemidophorus ocellifer*. The green-iguana *Iguana iguana* is also seen in trees along the rivers or on riverbanks.

**Bird Diversity.** There are 444 bird species recorded only for the floodplains, 665 species when the uplands are included and 837 species for the Cerrado biome (Tubelis and Tomas, 2002; Silva, 1995).

A bird field guide published in Portuguese "Aves do Brasil: Pantanal & Cerrado" and in English, "Birds of Brazil: Pantanal & Cerrado" (Gwynne et al., 2010) pointed out 740 species for both biomes highlighting the birdlife to inspire bird watching to enjoy the biomes' vibrant ecosystems and natural heritage, addressing an ecological context an conservation messages.

More discussion on bird diversity is provided by Junk et al (2006). Bird species with aquatic habits are very common and abundant, including egrets such as species of the genera *Casmerodius*, *Egretta*, *Ardea*, *Tigrisoma*, *Botaurus*, in addition to the wood-stork *Mycteria americana*, the maguari-stork *Ciconia maguari* and the jabiru *Jabiru mycteria*. Kingfishers are present with 5 species of the two genera *Ceryle* and *Choroceryle*. Other aquatic species are the southern-screamer *Chauna torquata*, the muscovy-duck *Cairina moschata*, the fulvous-whistling-duck *Dendrocygna bicolor*, the white-faced-whistling-duck *D. viduata*, the black-bellied-whistling-duck *D. autumnalis* and the Brazilian-duck *Amazonetta brasiliensis*. Among birds of prey are the snail-kite *Rosthamus sociabilis*, the black-collared-hawk *Busarellus nigricollis*, the great-black-hawk *Butteogallus urubitinga* and the Crane-hawk *Geranoospiza caerulescens*. Parrots are abundant. I observed a group of 206 turquoise-fronted-parrots *Amazona aestiva* in the SESC Reserve at Barão de Melgaço. There are 19 species of psittacids including the hyacinth macaw *Anodorhynchus hyacinthinus*.

**Conservation.** The biome's biodiversity has been impacted by unsustainable socio-economic practices, including:

- deforestation (conversion of natural vegetation into pastures for cattle, conversion of Cerrado

vegetation into crop fields in the uplands where the headwaters are located, charcoal production, habitat loss and alteration); data on deforestation of the Pantanal biome for the period 1976-2008 show about 15% of natural vegetation loss with degradation reaching near 60% in the surrounding uplands (Silva et al., 2010);

- environmental contaminants (petroleum-based inputs of agricultural chemicals, mainly in the uplands, mercury contamination in gold mining, in addition to iron ore, manganese, and calcium carbonate, sewage and domestic waste from the great majority of the cities surrounding the Pantanal);
- infrastructure and unplanned human occupation (large cargo convoys navigate the large rivers of the Pantanal, mainly the Paraguay and Cuiabá rivers, and vessels damage riverbanks with oil spills and waste; road kills of wildlife along roads throughout the wetlands);
- unregulated tourism (predatory invasion of waterfowl nesting grounds, sport fishing with illegal campsites in gallery forests spreading waste);
- fragility of law enforcement (some protected areas, hunting activities, commercial and sport fishing, deforestation with soil degradation are generally out of the control of the environmental agencies, with consequent impacts on habitats and biodiversity loss);
- introduction of exotic species (there are a considerable number of introduced species within the natural habitats, both deliberate and accidental: tucunará fish, feral pig, *Limnoperna fortunei* mussel and others).

The major economic activities in terms of land occupation are cattle ranching and tourism. Many large ranches have been subdivided into small farms, modifying the original arrangement of extensive cattle ranching. In recent years, over-fishing has been seen to be a major problem in the region.

Some major projects and studies have been carried out:

- The EDIBAP (Study for the Integrated Development of the Upper Paraguay River Basin), between 1977 and 1989;
- The PCBAP (Plan for Conservation of the Upper Paraguay Basin), conducted in 1997;
- The ANA/GEF/UNEP/OAS (Strategic Action Program for the Integrated Management of the Pantanal and the Upper Paraguay River Basin), carried out by ANA (Brazilian National Water Agency) in 2005;
- INAU – Instituto Nacional de Ciência e Tecnologia em Áreas Úmidas (The National Institute of Science and Technology in Wetlands). This new institute aims to carry out research to support public policies for the conservation and sustainable management of natural resources in

the Pantanal. The working structure of INAU facilitates the integration of the Pantanal Research Center (CPP) and the Universidade Federal de Mato Grosso (Federal University of Mato Grosso) in Cuiabá;

- NGO's ACTION PLANS – Different NGOs play important role on biodiversity conservation of the Pantanal. For example, the diagnosis entitled “*Monitoring Alterations in Vegetation and Land Use in the Brazilian Portion of the Upper Paraguay River Basin*” was carried out by the nongovernmental organizations: Ecoa - Ecologia e Ação, Conservation International, Avina Foundation, SOS Pantanal and WWF - Brasil and received technical support from Embrapa Pantanal. The purpose of the study was to make a detailed analysis of changes in vegetation patterns and land use that took place in the period from 2002 to 2008. The diagnostic study shows that compared to other Brazilian biomes like the Atlantic Forest formations, the Pantanal is relatively well-conserved although it is very vulnerable especially to impacts occurring in the highland regions of the Upper Paraguay River basin. While the lower floodplain region has 86.6% of its natural vegetation cover intact, only 43.5% of the highland plateau areas have their original vegetation;
- ACADEMIC CONTRIBUTIONS – Regional Universities such as the UFMT (Universidade Federal do Mato Grosso = Federal University of Mato Grosso); the UFMS (Universidade Federal do Mato Grosso do Sul = Federal University of Mato Grosso do Sul), the state Universities for both states, and private universities like the Anhanguera-Uniderp (Universidade para o Desenvolvimento do Estado e da Região do Pantanal = University for the Development of the State and the Region of the Pantanal) are contributing with academic research including thesis and dissertations;
- CPAP (Embrapa Pantanal = Embrapa Pantanal Research Center) of Embrapa (Empresa Brasileira de Pesquisa Agropecuária = Brazilian Agricultural Research Corporation) – The Center was implanted in Corumbá in 1975. Its mission is to make technological solutions viable for the sustainable development of the Pantanal agribusiness with the valorization of nature, including fauna and flora conservation;
- There have been different programmes and activities to establish initiatives to identify critical priorities for the conservation of biodiversity, including the creation of new protected areas. The conservation strategy should consider the Pantanal as a whole biome, connecting all sub-regions and different ecosystems, with protected areas representative of the major sub-region, as

well as considering the role of ecological corridors for the dispersion of species and integration of the adjacent biomes.

The challenge for conservation of the magnificent biodiversity of the Pantanal increases as time passes and, unfortunately, we can testify to the loss of habitats and species, not as a result of natural selection, but because of human disturbance. If on the one hand scientific knowledge is fundamental for the implementation of conservation, on the other hand, scientific results alone cannot solve the problems of environmental disruption. However, we are convinced that the scientific information available in this special number of the *Brazilian Journal of Biology* will play a vital role in conserving the regional biodiversity of the Pantanal biome. It will add important scientific knowledge to environmental awareness, providing a basis for government action and encouraging us all to practise humanitarian values to protect our natural treasures through ethical attitudes.

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