

HYACINTH MACAW (*ANODORHYNCHUS HYACINTHINUS*) REPRODUCTION IN THE NORTHERN PANTANAL, MATO GROSSO, BRAZIL

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Resumo. – Reprodução de Arara Azul (*Anodorhynchus hyacinthinus*) no norte do Pantanal de Mato Grosso, Brasil. – A Arara Azul (*Anodorhynchus hyacinthinus*) é uma das muitas espécies da fauna brasileira que é ameaçada pela atividade humana, principalmente devido a perda de habitat. A população total com de cerca de 3.000 indivíduos de Arara Azul de vida livre ocorrem principalmente no Pantanal de Mato Grosso, Brasil, uma das maiores áreas alagadas do mundo. Queimadas para a manutenção das pastagens e o tráfico ilegal tem sido e ainda são as maiores ameaças para a sobrevivência da espécie no Pantanal. Nós estudamos as necessidades ambientais, o sucesso reprodutivo e aspectos da biologia reprodutiva da Arara Azul em uma área de 31.000 ha na região norte do Pantanal, de modo a aumentar as informações necessárias para elaboração de estratégias de manejo e conservação desta espécie. Procuramos por ninhos, marcamos e medimos as cavidades dos ninhos e tentamos identificar o potencial de forrageamento e de sítios de nidificação que podem ser colonizados no futuro. Na área de estudo, as Araras Azuis usam cavidades de árvores para nidificar, em árvores entre 10–25 m de altura, a maioria nas bordas de matas. Catorze ninhos foram encontrados (0,045 ninho/100 ha), sendo 12 (85,7%) em apenas uma espécie de árvore, *Sterculia apetala* (Sterculiaceae). Os locais de reprodução permanecem os mesmos a cada ano sendo as cavidades reutilizadas pelas aves. O sucesso reprodutivo em 1995 foi de 1,8, em 1996 de 2,0 e em 1997 de 2,0 filhotes por ninho ativo. Existem sinais de que a área de estudo foi recentemente colonizada pela Arara Azul e que a população local ainda está crescendo: a maioria das cavidades de ninho aparentemente vem sendo usada por poucos anos.

Abstract. – Hyacinth Macaw (*Anodorhynchus hyacinthinus*) is one of many species of the Brazilian fauna that are threatened by human activities, mainly those resulting in habitat loss. The global population of about 3000 free-living Hyacinth Macaws has its breeding stronghold in the Pantanal of Mato Grosso, Brazil, one of the largest floodplains of the world. Burning for pasture maintenance and illegal trapping have been and still are major threats to the survival of the species in the Pantanal. We studied habitat requirements, reproductive success and aspects of breeding biology of Hyacinth Macaws in an area of 31,000 ha in the northern part of the Pantanal, in order to increase the information needed for management and conservation strategies. We searched for nests, marked and measured nest cavities, and tried to identify potential foraging and nesting sites that might be colonized in the future. In the study area, Hyacinth Macaws use tree cavities for nesting, in trees 10–25 m high, mostly at the edge of forests. A total of 14 nests were found (0.045 nests/100 ha), 12 (85.7%) of these in just one tree species, *Sterculia apetala* (Sterculiaceae). Breeding sites remained the same each year, as the birds reused the same cavities in the same trees. Reproductive success in 1995, 1996 and 1997 was 1.8, 2.0 and 2.0 nestlings per active nest, respectively. There are signs that the study area has only recently been colonized by Hyacinth Macaws and that the local population is still growing: most nest cavities have apparently been used for only a few years. Accepted 26 July 2002.

Key words: Hyacinth Macaw, *Anodorhynchus hyacinthinus*, Pantanal of Mato Grosso, *Sterculia apetala*, reproductive success, potential habitats.

INTRODUCTION

With at least 69 species and 17 genera (Sick 1997), Brazil has more species of parrots (Psittacidae) than any other country in the world. In early maps of Brazil from the 1500s this wealth was already acknowledged, as the country was called “the land of parrots”. The largest of all parrot species, the Hyacinth Macaw (*Anodorhynchus hyacinthinus*), has become a “flagship species” for conservation of the Pantanal of Mato Grosso in central South America, generally considered as the world's largest wetland (Por 1995). Hyacinth macaws were formerly widely distributed in Brazil, with records from the states of Mato Grosso, Mato Grosso do Sul, Goiás, Minas Gerais, Bahia, Piauí, Maranhão and Pará, but are now limited to a few areas, the Pantanal of Mato Grosso being its main breeding area (Sick 1997). It also occurs in Bolivia (Remsen & Traylor 1989) and Paraguay (Madroño & Esquivel 1997). The global population size of Hyacinth Macaws is estimated at about 3000 free-living individuals (Collar *et al.* 1994), most of them surviving in the Pantanal.

Hyacinth Macaws live in pairs that stay together during their lifetime. Breeding sites usually are hollow trunks of palms or other trees, cliff cavities, or even burrows in the ground. Generally, the lack of breeding cavities can be a limiting factor for parrot populations (Sick 1997). Hyacinth Macaws lay two eggs, but usually do not breed in every year (Guedes *et al.* 2000a).

Munn *et al.* (1987) recorded the nesting of Hyacinth Macaws in the Pantanal in two tree species, *Enterolobium contortisiliquum* (Mimosoidea, “Ximbuvera”) and *Sterculia apetala* (Sterculiaceae, “Manduvi”). In the latter tree species were 95% of the nests ($n = 94$) found by Guedes (1993) in the southern Pantanal.

Long-term studies on this species are

being conducted in the southern Pantanal (Guedes *et al.* 2000b), while there are few data from the northern part (see Whittingham *et al.* 1998). In this study, we tried to assess the status of a population of Hyacinth Macaws in the northern Pantanal, with special regard to habitat requirements for breeding, to breeding success, and to potential future breeding sites, as a data base for management strategies for this species.

STUDY AREA

The study area is located in the northern Pantanal, in the sub-region of the Pantanal of Poconé, in the locality called Pirizal (16°15'S, 56°20'W; Fig. 1). Several rivers with extensive floodplains cross the region, great parts of which are shallowly inundated by rain or river water during several months every year. Climate is highly seasonal. The rainy season with almost daily showers lasts from October until April (Tarifa 1986). The remaining dry and, in the daytime, mostly very hot months (daily maximum temperatures often surpass 40°C) in most years suffer several short but intensive cold spells from the south (see Willis 1977).

Vegetation in the Pirizal region consists of a mosaic of forest patches, pastures with some older trees, permanent and seasonally dry lakes with a wealth of aquatic plants, and secondary vegetation. Palm trees, whose fruits are preferred by Hyacinth Macaws as food source, are abundant, especially *Scheelia phalerata* (Palmae, “Acuri”), which forms pure stands in some forests. The human population of the Pirizal region is small because of difficult access during the annual flood period. Economic activities are almost entirely restricted to extensive cattle ranching, using both grassland and forests as pasture. The low human interference contributes to the conservation of the landscape.

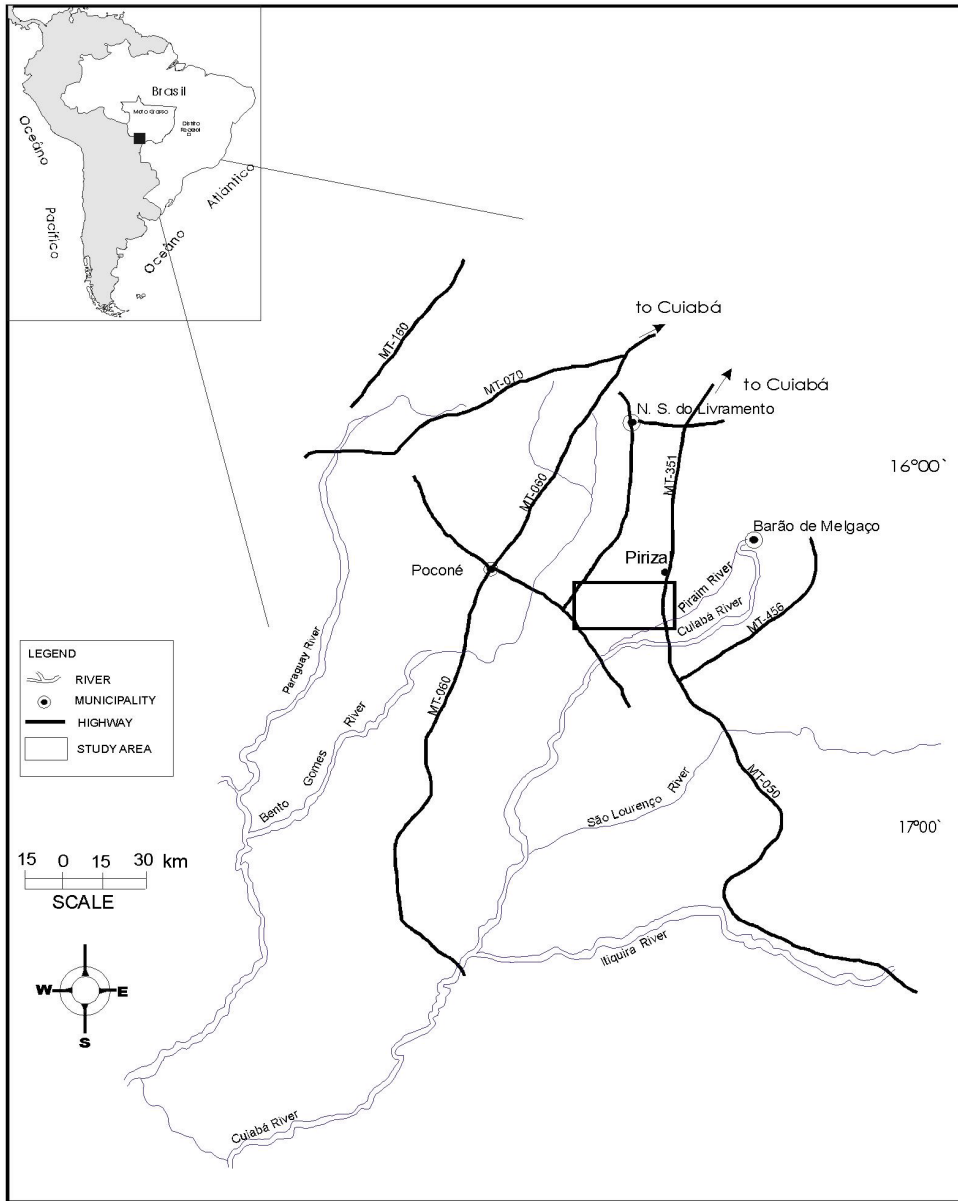


FIG. 1. Study area localization map. Modified from INTERMAT (1997) and Simielli (1992).

MATERIALS AND METHODS

Nest characteristics and breeding behavior were studied between July 1995 and Decem-

ber 1997. Nest trees were marked with small (4 x 8 cm) numbered aluminum plates attached to the main trunk. For each nest tree, we recorded its location with a GPS

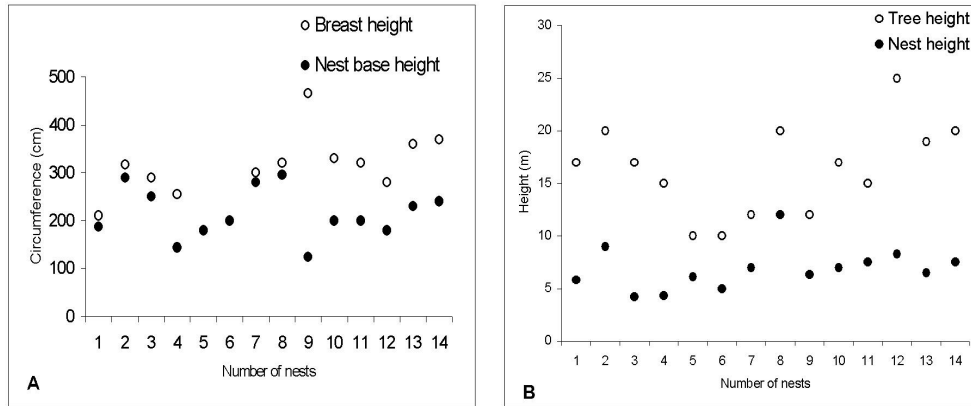


FIG. 2. Location of nest cavities of Hyacinth Macaws in nest trees in the northern Pantanal. (A) Circumference of nest trees at breast height and at nest base, (B) height of nest trees and nest cavities.

(type “Magellan 2000”), its height and circumference at breast height, the origin and number of nest cavities, their location in the tree (main trunk or secondary branch), the height of the cavities above ground, the circumference of the tree at the base of the nest, size of the cavity opening (horizontal and vertical), size of the cavity interior (horizontal and vertical, measured from the bottom to the opening), and whether the nest was active or not.

The indicators used to detect breeding activity included nestlings or eggs inside the nest, macaw's feathers or feces near or inside the nest cavity, aggressive behavior, or *Scheelea phalerata*-palm nuts on the ground broken-open by macaws to feed on the seeds.

The nest location was classified as being at the forest border (no more than 20 m inside the forest, measured from the outmost tree), or in the interior (more than 20 m from border). The nests were further classified as undisturbed (free from human influence), little disturbed (close to small settlements), or highly disturbed (located in small woods surrounded by larger pastures, or near dirt roads).

The reproductive success was studied

between August 1995 and December 1997. Nests were controlled using mountaineering equipment (rappel) to climb the trees. A nest was considered “active” when eggs, young birds, or females in preparation phase for laying were recorded, and “inactive” when the cavity was used by other species of birds or other animals. A nest was considered successful when in each reproductive phase it produced at least one young.

For intensive studies of reproductive behavior (August 1995 to September 1997), one particular nest was chosen because of rather easy access in all seasons. Here activities of Hyacinth Macaws were recorded from the beginning of the courtship phase through the preparation of the nest, oviposition, and hatching, until the subadult phase. In three-day-turns every month, in the morning (from 06:00 to 12:00) and afternoon (from 13:00 to 18:00), the activities were recorded from 20 to 100 m distance with binoculars (7 x 35) or a telescope (30 x 65). The total time of observation was 60 h.

We also searched for areas with potential, but currently unoccupied breeding sites. An area was considered “potential” based on the presence of preferred nesting tree species in

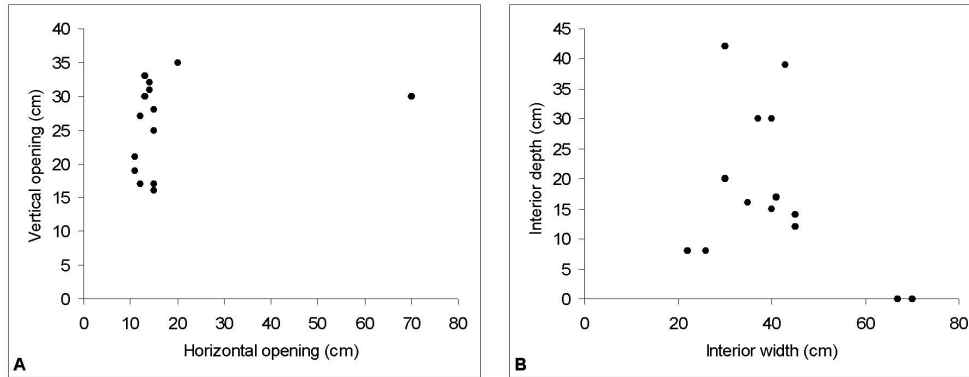


FIG. 3. Dimension of 14 nest cavities of Hyacinth Macaw in the northern Pantanal. (A) Size of the cavity opening, (B) Size of the cavity interior, vertical measurement from the bottom to the opening.

suitable sizes, and of preferred food plants (palm trees).

RESULTS

Nest site characteristics. From 1995 to 1997, a total of 14 nests used by Hyacinth Macaws were found, marked and measured in the study area: seven in 1995, five more in 1996, one of which was occupied by bees (*Apis mellifera*), preventing Hyacinth Macaw breeding, and two more in 1997. The density of nests in the study area (31,000 ha) was 0.045 nests/100 ha. Thirteen nests (92.9%) were used more than once for breeding by Hyacinth Macaws.

Twelve nests were in *Sterculia apetala*, one each in *Enterolobium contortisiliquum* and in *Vitex cymosa* (Verbenaceae, “Tarumã”). The mean height of nesting trees was 16.3 ± 4.3 m ($n = 14$), the mean cavity height 5.8 ± 6.9 m, the mean circumference at breast height 3.0 ± 0.8 m, and the mean circumference at the base of the nest 2.1 ± 0.5 m (Fig. 2).

The cavity opening had a mean height of 26 ± 7 cm and a mean width of 18 ± 15 cm (including one exceptionally wide opening of 70 cm); the cavity interior had a mean depth of 41 ± 14 cm between the bottom and the

opening and a width of 18 ± 13 cm (Fig. 3).

All nest cavities had only one opening. Nine (64%) originated from the breaking-off of branches, and 5 (36%) from other causes, such as termites, ants, fungi, or bacteria. Twelve nests were built in the main trunk and two in secondary trunks. Twelve nest trees were located at the borders of forests, only two in the interior of forests.

Hyacinth Macaws in the study area did not avoid human disturbance when choosing their nesting sites: only two nests were in undisturbed areas, ten were subject to a low degree of disturbance because of their proximity to small human habitations, and two nests were subject to a high degree of human disturbance. Most active nests (those with greater reproductive success) were located in areas with low disturbance (Table 1).

The search for potential nesting sites indicated 20 forest patches currently not occupied by Hyacinth Macaws in the study area which, because of the presence of *Sterculia apetala*-trees with a sufficiently large circumference at breast height for eventual creation of nest cavities, and the abundance of tree species used for feeding, are potential sites for future colonization. All of these sites suffer little human disturbance.

TABLE 1. Degree of human disturbance at active and inactive nests of Hyacinth Macaws in the northern Pantanal (IS = isolated, no disturbance; LD = low disturbance; HD = high disturbance).

Year	Condition	IS	LD	HD	Total observed
1995	Active	0	5	2	7
	Inactive	0	0	0	0
1996	Active	1	8	2	11
	Inactive	1	0	0	1
1997	Active	1	10	2	13
	Inactive	1	0	0	1

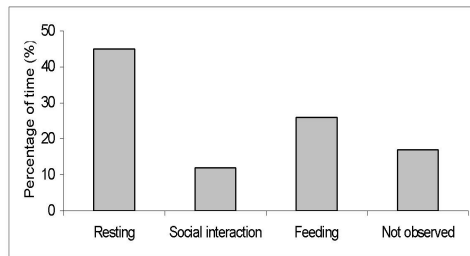


FIG. 4. Time budget of activities of Hyacinth Macaws in the northern Pantanal, during 60 h of

Breeding success. Breeding season of Hyacinth Macaws in the study area was between August and November, with a peak in October. The incubation time was 28 to 30 days. The female takes over the incubation while the male acts as a sentinel and feeds the female.

In 1995, seven pairs constituted the reproductive population. Two pairs showed only exploratory behavior, with some defensive actions and nest preparation. Five nests had eggs, but one egg was lost to an unknown predator. Nine young birds fledged successfully. Total breeding success was 1.3 fledging young birds/nest. In 1996, of 12 pairs one lost the nest to bees. Nine pairs bred successfully, producing 18 fledging birds, or 1.6 young birds/nest. In 1997 of 14 pairs, again one lost its nest to bees. Of the thirteen remaining pairs, only four had eggs. With a 100% hatching rate, 8 young fledged successfully. The total breeding success was 0.6 young birds/nest. In

1996 and 1997 no nest predation was observed.

Predation on young birds was never observed. They hatched lacking downs, and with a very thin and transparent skin. Black down feathers subsequently covered the body, and at the end of the third week the first blue feathers appeared at the head, wing and tail. The fledglings abandoned the nest about 100–105 days after hatching and stayed with the parents until the next breeding period.

Behavior of Hyacinth Macaws in the breeding season.

Breeding pairs and non-reproductive individuals were seen feeding together. In the study area, three main groups of Hyacinth Macaws were encountered, with seven, six and four individuals, respectively. While the group was feeding, one bird usually remained as sentinel at the top of the highest nearby tree, vocalizing at any sign of danger, and thus causing the group to fly off.

Time dedicated to each type of activity was verified. Times of more intensive social interaction were between 06:00 and 07:00 and 17:00 and 18:00. During the hottest hours of the day, the macaws tend to be resting, generally in the shade of high trees. While resting, Hyacinth Macaws showed little activity (Fig. 4).

Direct interactions with other species were never observed, nor were other bird species recorded nesting in the same cavities.

However, during reproduction, Hyacinth Macaws showed a peculiar defensive behavior against other bird species, consisting of calling and flying around the nest tree. This behavior was observed on three occasions, when a Toco Toucan (*Ramphastos toco*), a Red-shouldered Macaw (*Diopsittaca nobilis*), and a Purplish Jay (*Cyanocorax cyanomelas*), respectively, were close to the nests.

DISCUSSION

The density of nests is rather low (0.045 nests/100 ha), but higher than that found in the southern Pantanal by Guedes (1993: 0.021 nests/100 ha). Twenty potential breeding sites were unoccupied by macaws during this study. The theoretical maximum population of Hyacinth Macaws in this area can thus be estimated to be 34 pairs or 0.11 nests/100 ha.

In both this study and the study from the southern Pantanal (Guedes 1993), the most important tree species used to build the nests was *Sterculia apetala*. This tree has soft and light wood (Pott & Pott 1996), probably facilitating the excavation of nest cavities by Hyacinth Macaws. Other tree species were used much less frequently, mainly *Vitex cymosa* and *Enterolobium contortisiliquum* (this study, Guedes 1993, Munn *et al.* 1987). Observations outside the study area revealed that Hyacinth Macaws also had nests in *Vochysia divergens* (Vochysiaceae), *Aspidosperma australe* (Apocynaceae), *Buchenavia tomentosa* (Combretaceae) and *Berberonia sericea* (Fabaceae) (Pinho unpubl.).

The variation in the height of nest trees (10 to 25 m) and nest cavities (4 to 12 m) shows that macaws are adaptable in the choice of nest cavities. In the southern Pantanal, 30% of the nest trees were 12 to 13 m high, whereas 82% of the active nests were 6 to 9 m high. The form of the opening of the nest cavities varied considerably, but not the

size, although one nest had an exceptionally wide opening of 30 x 70 cm. The depth of the cavity interior does not vary much, probably because of the short time of occupation of the cavities by Hyacinth Macaws. In the southern Pantanal, Guedes (1993) found larger vertical openings (14 to 240 cm). All cavities have free space above the opening, which is very important for the development of the young birds and for their first attempts to fly (Guedes 1993).

Due to the short time of observation, the origin and development of nest cavities could not be studied. However, 64% of the cavities were made apparently in the break-off of branches. Observations showed that Hyacinth Macaws take advantage of such situations: after the break-off of a branch of *Sterculia apetala*, a macaw worked at the spot intensively with the beak, increasing the hole caused by the break-off. These findings differ from those of Guedes (1993), who found termites, ants, bacteria and fungi to be the causal agents for at least 56% of the cavities.

Borders of forest patches are favorite sites for reproduction. Macaws showed a preference for breeding in rather open forests. This may be due to a greater area of vision, better access, but also to greater food availability. Salis *et al.* (1996) found that the fruit production of some palm species may be lower when the palm tree is shaded.

Nest-site fidelity in the study area was high. Ninety percent of the nests were used again in the following year, while in the southern Pantanal Guedes (1993) found nest-site fidelity in only 41% of the nests. The repeated use of nest cavities makes some maintenance necessary. It becomes vital to increase the opening and vertical depth of the nest because, during the incubation period, the Hyacinth Macaws fill the bottom of the cavity with pieces of wood, thus decreasing its depth. The pieces of wood absorb rainfall humidity and excretions of the young birds.

Guedes (1993) recorded that some trees died as consequence of their repeated use as nest trees. Although the same was not yet observed in the study area, it might become important for management of the species in the northern Pantanal, where most nests in *Sterculia apetala* are reused.

In both 1995 and 1996, two (different) pairs did not breed, probably due to inexperience or sexual immaturity (Guedes 1993), as they appeared to be very young. In 1997, only four of the 14 nests had young birds what may be caused by unfavorable climatic-environmental factors, e.g., the unusually short inundation of the Pantanal. However, even so, the breeding success (1.8 to 2.0 young/nest) was higher than known from literature. Yamashita (1992) found an average of 0.6 young birds per Hyacinth Macaw pair ($n = 10$) in the southern Pantanal, and Guedes (1993) observed in two years 1.29 and 1.25 young birds, respectively. The present data suggest a recent colonization of the study area, as well as continuing population growth.

Competition for nest-sites may occur between Hyacinth Macaws and woodpeckers (Picidae), araçaris (*Pteroglossus*, Ramphastidae), hawks (Accipitridae), as well as small mammals, e.g., opossum (*Didelphis* sp.), or social insects (Sick 1997). In the study area, common bird species that could compete with Hyacinth Macaw for nest sites are Savanna Hawk (*Heterospizias meridionalis*, Accipitridae), Bat Falcon (*Falco rufigularis*, Falconidae) and Toco Toucan. However, local farmers fear that these species might harm domestic fowl, and do not tolerate their presence close to the settlements. This might explain why during this study no competition for nest sites between Hyacinth Macaws and other bird species was observed, considering that most nests ($n = 10$) were close to small settlements.

The occupation of one cavity by bees prevented its use for reproduction by Hyacinth

Macaws. However, macaws and bees may occupy different cavities close to one another in the same tree. Guedes (1993) found that in the southern Pantanal nest cavities are occupied by other species in the non-breeding season of macaws.

As a way to alleviate the competition for nest cavities, Guedes (1993) proposed the installation of nest boxes. However, the present study indicates that in the northern Pantanal the food offer and the availability of potential nest sites do not seem to be the limiting factors for the population of Hyacinth Macaws. It seems more urgent to work on environmental education to assure the conservation of the remaining forest patches, which are so important for shelter, feeding and reproduction of the macaws. Experimental research on the possibilities to increase the support capacity of natural pastures for cattle (Yamashita 1992) could be an important step to diminish the pressure on forests with macaw breeding sites. Despite rising environmental consciousness the illegal capture of Hyacinth Macaws is still a problem (Pinho & Nogueira 2000).

Hyacinth Macaws tolerate a certain degree of human disturbance at their breeding sites. Like in the southern Pantanal (Guedes 1993), in our study area there was no significant correlation between the nesting success and the degree of disturbance, despite the preference of macaws for areas close to farmhouses. However, the human population density in the study area is small, due to the annual inundations, which make economic activities difficult. The region is inhabited by traditional people born there, who respect the fragility of the landscape. They live on subsistence cultures, adapted to the seasonal cycles of inundation and drought. When clearing an area for pastures, farmers leave some shade trees standing, as well as palms, because of their value for domestic animals, and there is not much loss of natural vegetation to planted

cattle pasture, compared to other areas in the Pantanal (Alho *et al.* 1988, da Silva 2000). The area has not received immigrants from other parts of Brazil who could influence the regional culture and nature management. All these factors are favoring the Hyacinth Macaw population in this part of the northern Pantanal of Mato Grosso.

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REFERENCES

- Alho, C. J. R., T. E. Lacher, Jr., & H. C. Gonçalves. 1988. Environmental degradation in the Pantanal ecosystem. *BioScience* 38: 164–171.
- Collar, N. J., M. J. Crosby, & A. J. Stattersfield. 1994. Birds to watch 2. The Birdlife International world list of threatened birds. Birdlife International, Cambridge, UK.
- Da Silva, C. J. 2000. Ecological basis for the management of the Pantanal – Upper Paraguay River Basin. Pp. 97–117 *in* Smits, A. J. M., P. H. Nienhuis, & R. S. E. W. Leuven (eds.). New approaches to river management. Backhuys Publishers, Leiden, The Netherlands.
- Guedes, N. M. R. 1993. Biologia reprodutiva da Arara Azul (*Anodorhynchus hyacinthinus*) no Pantanal de Mato Grosso do Sul, Brasil. M. Sc. thesis, Univ. São Paulo, Piracicaba, Brazil.
- Guedes, N. M. R., F. C. Vargas, V. M. Bernardo, M. R. F. Cardoso, P. J. Faria, R. F. Araújo, V. O. Vilela, M. C. L. L. Perez, M. R. Werneck, & A. Gorski. 2000a. Impacto da predação, ectoparasitos e mortalidade de Arara-Azul *Anodorhynchus hyacinthinus* no Pantanal Sul, Brasil. Pp. 212–213 *in* Resende, K. E., V. S. Nunes, R. A. Mauro, E. L. Cardoso, I. H. Ishii, J. C. Gonçalves, E. F. Leite, & L. H. L. Borges (eds.). III Simpósio sobre recursos naturais e sócio-econômicos do Pantanal. Empresa Brasileira de Pesquisa Agropecuária–Centro de Pesquisa Agropecuária do Pantanal, Brasília, Brazil.
- Guedes, N. M. R., F. C. Vargas, M. F. R. Cardoso, V. M. Bernardo, & L. A. Paiva. 2000b. Projeto Arara Azul – Dez anos de pesquisa e conservação. Pp. 214–215 *in* Resende, K. E., V. S. Nunes, R. A. Mauro, E. L. Cardoso, I. H. Ishii, J. C. Gonçalves, E. F. Leite, & L. H. L. Borges (eds.). III Simpósio sobre recursos naturais e sócio-econômicos do Pantanal. Empresa Brasileira de Pesquisa Agropecuária–Centro de Pesquisa Agropecuária do Pantanal, Brasília, Brazil.
- INTERMAT (Instituto de Terras de Mato Grosso). 1997. Mapa político administrativo do estado de Mato Grosso. Cuiabá, Mato Grosso, Brazil.
- Madroño N. A., & E. Z. Esquivel. 1997. Noteworthy records and range extensions of some birds from the Reserva Natural del Bosque Mbaracayú (Mbaracayú Forest Nature Reserve), Departamento de Canindeyú, Paraguay. *Bull. Br. Ornithol. Club* 117: 166–176.
- Munn, C. A., J. B. Thomsen, & C. Yamashita. 1987. Survey and status of the Hyacinth Macaw (*Anodorhynchus hyacinthinus*) in Brazil, Bolivia, and Paraguay. Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Lausanne, Switzerland.
- Pinho, J. B., & F. Nogueira. 2000. Mostra da retirada de Psitacídeos em cativeiro na cidade de Cuiabá e Pantanal de Poconé, MT, no período de 1995–1997. *Ararajuba* 8: 51–53.
- Por, F. D. 1995. The Pantanal of Mato Grosso (Brazil). World's largest wetlands. Kluwer Acad. Publ., Dordrecht, The Netherlands.
- Pott, A., & V. J. Pott. 1996. Plantas do Pantanal. Empresa Brasileira de Pesquisa Agropecuária–Centro de Pesquisa Agropecuária do Pantanal Corumbá, Brasília, Brazil.
- Remsen, J. V., & M. A. Traylor, Jr. 1989. An annotated list of the birds of Bolivia. Buteo Books, Vermillion, South Dakota.
- Salis, S., P. P. Mattos, & L. V. S. Chalita. 1996.

- Fenologia de *Scheelea phalerata* (Mart.) Bur. (acuri) no Pantanal da Nhecolândia, Corumbá-MS. Pp. 101–102 in Dantas, M., J. B. Castro, & E. K. Resende (eds.). Resumos do simpósio sobre recursos naturais e sócio-econômicos do Pantanal. Manejo e conservação, 2, Corumbá, 1996. Empresa Brasileira de Pesquisa Agropecuária–Centro de Pesquisa Agropecuária do Pantanal, Brasília, Brazil.
- Sick, H. 1997. Ornitologia brasileira, uma introdução., Nova Fronteira Rio de Janeiro, Brazil.
- Simielli, M. E. 1992. Geoatlas. Ed. Ática, São Paulo, Brazil.
- Tarifa, J. R. 1986. O sistema climático no Pantanal: da compreensão do sistema á definição de prioridades de pesquisa climatológica. Pp. 9–27 in Mac-Dowell, C. M. P., F. A. Borgens, G. B. Gil, & N. R. Albuquerque (eds.). Anais do simpósio sobre recursos naturais e sócio-econômicos do Pantanal. 1. Empresa Brasileira de Pesquisa Agropecuária–Centro de Pesquisa Agropecuária do Pantanal. Corumbá, Brasília.
- Whittingham, M. J., A. F. Brown, & S. Rees. 1998. Finding Hyacinth Macaw *Anodorhynchus hyacinthinus* in the Pantanal, Mato Grosso, Brazil. *Cotinga* 10: 66–67.
- Willis, E. O. 1977. Effects of a cold wave on an Amazonian avifauna in the upper Paraguay drainage, Western Mato Grosso, and suggestions on Oscine-Suboscine relationships. *Acta Amazônica* 6: 379–94.
- Yamashita, C. 1992. Comportamento de Araraúna (*Anodorhynchus hyacinthinus*) Psittacidae, Aves. *An. Etol.* 10: 158–162.