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The Hyacinth Macaw Project in the Pantanal South, Brazil.

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The project

The Hyacinth Macaw Project was initiated in 1990 in South Pantanal, with the objective of obtaining information on the biology and ecology of the species and of developing management alternatives and conservation of the Hyacinth Macaw *Anodorhynchus hyacinthinus*. In spite of having been started through the personnel initiative of this coordinator, the project only had its continuity thanks to the support of patronizers and the cooperation of a large number of companies and institutions through all these years.

Since 1994, the project has been executed by UNIDERP and FMB (Manoel de Barros Foundation). Toyota of Brazil has been a sponsor since the beginning of the project through the cession of its vehicles and WWF – World Wildlife Found Brazil have been the greatest partnership of the project in the latest years. Besides this the project counts with the support of the Refúgio Ecológico Caiman (Caiman Ecological Refuge), the local farmers, Brasil Telecom S.A., Vanzin Escapamentos and the Hyacinth M. Fund–Smart Family Foundation.

The Hyacinth Macaw

The Hyacinth Macaw is the largest representative of the Psittacidae family and may exceed 1m in length and weighs up to 1.3 kilograms. In nature they are highly social birds that live in pairs, couples, families or groups in relatively sedentary populations that can make short daily migrations for alimentation and/or reproduction. At present, their distribution is restricted and they have a low reproductive rate (Guedes 1993, 1996, 2001 e Guedes & Harper 1995). Like the majority thePsittacidae, they live long lives in captivity and it is estimated a 30 year life in nature although is impossible precisely fix this number because the project has only 12 years of monitoring.

Threatened of extinction (Bernardes et al. 1990 e Collar et al. 1992) the most important factors that determined the decline of the Hyacinth Macaws populations were the illegal collect of individuals for commercial exploitation for the pet trading within Brazil and internationally (it is estimated in more than 10 thousand individuals captured from nature until the end of the eighty decade); the drastic habitat alteration or destruction due clearence grounds by fire, deforestation and planting of pasture and finally the use of the feathers by the local indian populations (the ancient indian tribes used the the bow and arrow to hunt, today they used the birds feathers to make artefacts like collars and cockades that lasted for decades. Nowadays they use fire weapons to kill the birds and make souvenirs for the tourists).

The present distribution of the *Anodorhynchus hyacinthinus* is estimated: **1) The Pantanal region**, spreaded over the states of Mato Grosso do Sul (the largest part of the population with more than 3.000 individuals (Guedes 2001)), Mato Grosso (about 800 individuals (Pinho 1998)), Bolivia (about 150 individuals (S.Dammernann 2000, unpublished work)) and Paraguai (only some registers of individuals in short daily migrations for alimentation, leaving the Brazilian Pantanal in the morning and returning at the end of the afternoon, without registers of resident populations or nests in the latest years). **2) In the comun boarder area of the Brazilian states of Tocantins, Piau , Maranh o and Bahia;** **3) In North Brazil along the Xing  and Araguaia rivers and along the Caraj s range of mountains (Munn et al. 1987), without estimated number of individuals or populations for these last occurrence places).**

The objectives

The most important objective of The Hyacinth Macaw Project is the mantainance of a viable population of Hyacinth Macaws in natural habitat as well to make the specie an example for the preservation of the Pantanal as a whole. Nevertheless, activities and especific new goals are discussed and defined every year with the “Comit  para Conserva o e Manejo da Arara-azul-de-lear *Anodorhynchus leari* and the large Hyacinth Macaw *Anodorhynchus hyacinthinus*” under the General Fauna Coordination of the IBAMA – Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renov veis (a Brazilian Government Institution for Environmental and Natural Resources subjects)

The specif objectives are:

- 1) Cadastrating and Monitoring nests in the Pantanal region;
- 2) Manegement of nests and installation of artificial nests box when necessary;

- 3) Make studies about reproductive biology;
- 4) Make studies about behavior in nature;
- 5) Make activities of management of eggs and chicks;
- 6) Monitoring the survival rates of the chicks after leaving their nests;
- 7) Estimulating and realizing activities related to ecological tourism;
- 8) Promoting activities of education and environmental conservation;
- 9) Publishing the results of the research for the scientific community, natives, local communities and the general public.

The local

The Hyacinth Macaw Project is being executed in the Brazilian Pantanal, coordinates 16° and 21° south latitude and 55° and 58° east longitude, mainly in 42 ranches (farms) in Mato Grosso do Sul state and in a ranch in Mato Grosso state, covering an area of 400 thousand hectares. The Project has its most important bases in “Refúgio Ecológico Caiman” in the Pantanal of Miranda and other in the IPPAN/UNIDERP in the Pantanal of Rio Negro. The project also has the important support of Fazenda Rio Negro (a local ranch) in another part of the Pantanal of Rio Negro; Fazenda Nhumirim (local ranch) in the Pantanal of Nhecolândia and Pousada Arara Azul (Arara Azul Lodge) in the Pantanal of Abobral and some ranches in other regions of the Pantanal (Guedes 2001).

With around 139.000 km² the Pantanal is the largest continental wetland on the planet. It is located in the states of Mato Grosso do Sul and Mato Grosso, extends into Bolivia and Paraguay. The Pantanal’s landscape is the result of the flood cycle. During the wet season, up to 80% of the region is under water, becoming into an area of difficult access with long periods of flood and low human population densities. The most characteristic landscapes are the “Cordilleras” (forested corridors), “capões” (small forest island) in a sea of open savannah; “baías” (fresh water) and “salinas” (brackish water) are permanent and temporary lakes and ponds, permanent rivers and “corixos” (creeks of temporary waters). The Pantanal shelters at least 3.500 species of plants, 264 species of fish, 652 species of birds, 102 species of mammals, 177 species of reptiles and 40 species of amphibians.

The Alimentation

The Hyacinth Macaws are ancient (olden) birds that specialized their alimentation through the evolution. In any area of their occurrences they are specialized in eating nuts of only two species of Palmae (Guedes 1993). In the Pantanal, the Hyacinth Macaws have adopted a diet

highly selective. They feed themselves exclusively with *acuri* nuts (*Scheelea phalerata*) and *bocaiúva* (*Acrocomia aculeata*). The acuri palm produces fruit all the year and for this reason they maintain the Hyacinth Macaws populations. The bocaiúva palm fruits attain ripeness between September and December, period coincident with the peak of chick hatching. During this period it is more usual finding individuals of Hyacinth Macaws feeding themselves hanging on bocaiúva clusters. They usually eat the ripe and/or the green ones or even those with liquid inside. The Hyacinth Macaws usually make a good use of the fleshless acuri fruit left by cattle or some wild animals that eat the pulp of the fruit regurgitating monticles on the ground. It is appreciated by the Macaws after being dried by the Sun and time actions. In that case, the macaws are usually found eating on the ground, on fences, stakes or in dried branches of the trees.

The nests

In the Pantanal, the Hyacinth Macaws find few arboreous species with large cavities for reproduction. Because of this, 90% of the nests are found in a single specie of tree, locally named manduvi, *Sterculia apetala*. The rest of the nests are found in species like ximbuva (*Enterolobium contortisiliquun*), angico branco (*Pithecellobium niopioides*), abobreira (*Erythrina* sp), guatambú (*Aspidosperma australe*), tarumã (*Vitex cymosa*). In the boarder of the Pantanal they can also be found on the cliff face of Aquidauana's mountain and in Alegria's mountain (Guedes 1993, 1996, 2001 e Guedes & Harper 1995).

The manduvis are trees with a soft heartwood susceptible to the formation of cavities generally caused by broken branches, fungi infestation, the action of termites, bacteria or woodpeckers. The Hyacinth Macaws do not initiate a cavity but can enlarge them in width and depth very fast. The dimension of the internal cavities of the nest is very variable ranged from 50 cm (the minimum viable) to 2m.

The nests trees with average height of 15 m generally to stand out on vegetation. They are comun in the boarders of the "cordilheras" or "capões". The average height of the nests is 8 m, but it is ranged from a low of 2.40 m to a high of 16 m. The nests have only a single entrance, but this number can also vary from 1 to 5. The nests are generally located on the main trunk of the tree, but they can also be found in primary or secondary bifurcation. The diameter of the opening is very variable ranged from 18 cm to 1m and the orientation of the entarnces is distributed aleatorily.

The monitoring

During the reproduction period, from July to March of the following year, the central activity of the project consists in monitoring cavities and/or on looking for new ones to check (verify) the rate of occupation by Hyacinth Macaws and other species. The percentage of active nests used by the Hyacinth Macaws is ranged from 47% to 70% each year. To make the monitoring possible the Toyota 4X4 vehicles, horses, tractors and boats are used. For reaching the nests climbing equipments are used. The researchers team does not take more than 20 minutes monitoring a cavity. In twelve years, 465 nests were registered and cadastrated, 315 of them are natural nests and 150 artificial nests.

When the Project was initiated, the eggs were measured and weighed as well the chicks growth rate. At the present moment, with all these dates already known, the nests with indication or vestigies of the presence of the Hyacinth Macaws are being monitored with a higher frequency only to establish the eggs laying, the date of hatching (eclosion), predatory events, nativity, survival or mortality of chicks. Before being able to fly, all chicks receive a stainless steel ring and from 2002 they will also receive a microchip. They also have their blood collected to determine the sex and for DNA analysis (genetic variability), realized in association with USP researchers (USP - University of São Paulo).

Reproduction

The Hyacinth Macaws are faithful. They form a single couple separated exclusively by the death of one couple individual. They remain all the time together, inclusive out of the reproduction period and divide all the tasks of selection, reform, improvements and cares with the nests and chicks. During the reproduction period, the couple chooses and defends the nest remaining most of their time inside the cavity, on the tree, or in its proximities. Many couples reuse the same nests years after years.

The Hyacinth Macaws lay an average of 2 eggs what is ranged from 1 to 3. The eggs are white with a spheric ellipsoidal form with microporosity, averaged from 47 mm in length and 36, 9 mm in width. The eggs laying is assincronic. The incubation period varies from 28 to 30 days, and the female incubates the eggs as the male, on the other hand, stays in the next tree as a sentinel. Most of his diary alimentation is regurgitated for the female. The female may leave the nest for food in the immediate vicinity for brief periods, spending, however more than 70% of the time inside the nest cavity.

A fact extremelly rare in the latest years was observed during the reproductive season. (2001/2002) when seven couple have laid three eggs. For the first time, it was observed the eclosion of three eggs with the survival of the three chicks in the same nest. (artificial

N.2141). They had an age difference between three or five days. The parents, extremely careful and great reproducers fed all the chicks well. With approximately 15 days the eldest and the youngest were killed by a predator. The predator is still unidentified and the survivor chick was removed with success to another nest. After this event the parents have laid 2 new eggs, but unfortunately they did not have success because a new predation occurred.

The eclosion period varies from 4 to 28 hours. The chicks are born at a range from 8 to 10 cm length and weight 18 to 27 g. Hyacinth Macaws chicks are practically naked with only a sparse covering of white down feathers. The skin is pink and transparent and the internal organs and yolk are visible. They are born with ears and eyes closed. They have pink beaks and feet with soft parts in the base, on the superior and inferior maxillae junctions, and the egg-tooth is present.

The alimentation is regurgitated by the parents. The first regurgitation can occur 24 hours after eclosion. Before the regurgitation, the first alimentation is more digested than the others. The chicks grow and gain weight rapidly. Gradually the body of the chicks become covered with black down feathers. Around the 22ND day of life, canons of Hyacinth feathers appear on the head, wings and tail. The 23RD day of life is the average time for them to open their eyes and the egg tooth disappears around the 73RD day of life. Maximum weight is reached at about 77 days of life at a peak average weight of 1,520 g. Some chicks reach up to 1700 g.

The chicks have an especific vocalization and they use it for communicating with their parents. They respond to their parents vocalization at the vicinity of the nest. They do not respond to other couples. They stay inside the nest an average of 107 days (range from 90 to 120 days) and lost weight while training their first flight. In a few days they abandon definitively their cavities. After leaving the nests they are still fed by their parents for an average time of six months, when they finally start learning how to break nuts themselves. Most chicks remain in the company of their parents for around one year and a half when then they usually integrate other groups of young Macaws.

About 30% of the couples that lay their eggs are failures due to egg predation or lost (range from 20% to 40%) depending on the weather and environmental variations every year. The eggs predatory events can be caused by avian predators like toco toucans (*Ramphastos toco*), jays (*Cyanocorax* sp) and caracaras (*Polyborus plancus*). Predators may include mammals such as opossum (*Didelphis albiventris*) and tayra (*Eira barbara*). The losses also can be caused due storms, rains, fires, nests breaking branches, unfertile eggs or embryonic development interruption. However, 22% of the couples that had eggs or chicks losses can

lay eggs again. In the period of 2001/2002, six couples restarted laying eggs and 50% of them were well succeeded with their chicks survival. An average of 70% (63% to 86 %) of the couples reach success with the birth of their chicks. Among the couples that have chicks, around 76% get the survival and the first flight of at least one chick. The reproductive potential of the females varied from 1.71 to 2 eggs per female. In these 12 years of the project the survival rate varied from 0.97 to 1.29 chicks per couple due the action of predators and mortality of the chicks before completing one month of life, especially of the second chick up to the 5th day of life. So, less than half couples obtain the survival of both chicks. At the end of the reproductive period (2001/2002), 58 chicks have flown out of their nests reaching the reproductive success of 1.27 chicks per couple.

The results of the project has demonstrated that Hyacinth Macaws have low reproductive rates due mainly for the following factors:

- 1) Low offer of cavities for the nests;
- 2) Losses ranged from 2 to 5% of the natural cavities every year provoked by the rains, storms, winds, fires and deforestation;
- 3) High competition for the existant nests (inter and intraespecific);
- 4) Elevated number of eggs losses caused by natural predators;
- 5) Due non-synchronous layings as also happens to other psittacidae, a high mortality, especially of the second chick was observed (Guedes et al. 2001);
- 6) Chicks deaths caused by predators.

Sex determining and DNA analysis

According to Miyaki et al. (1993, 1997 e 1998) e Guedes (2001), a sample of 152 chicks were determined Sex, the proportion of males and females was equivalent to 1:1. The genetic variability of the Hyacinth Macaws in the Pantanal is around 65% lower than that observed for others psittacidae threatened. Nevertheless, the genetic similarity among chicks of the same nest has confirmed the monogamy of the couples. All the chicks had the same parents. The low genetic similarity between chicks of the same nest in consecutive years also confirmed the camp observations in which the majority of the individually identified couples only reproduce in alternated years (each 2 years).

Management of the nests.

Based on the first results in what the scarceness of cavities was a limitant factor for the Hyacinth Macaws reproduction, many models and different materials were tested for the

confection of the artificial nests boxes. The offer of artificial nests would minimize the lack of natural cavities and it would be a management alternative to increase the reproductive success (Guedes 1997, 1999 e 2000).

In 1997 it was finally found the pattern model and size more adequate for installation what was well accepted by Hyacinth Macaws. The artificial nests were made of ximbuva wood with a covering with a hinge. The measure pattern adopted was 60X50X40 cm with a 15 cm diameter opening, reinforced to avoid immediate damages caused by the action of the Macaws beaks. The boxes were installed following criteria based on the preference of the Hyacinth Macaws for high tree species, to stand out from vegetation, with a good view, stable, and with a good access for the Macaw. Until the end of 1998, 150 artificial boxes were installed in 22 ranches in an area that covers approximately 90 thousand hectares.

More than 50% of the boxes were immediately explored by Hyacinth Macaws, but only 10% were effectively used for reproduction. However, the objective of the Hyacinth Macaws Project was indirectly reached, because most boxes were used by more than 17 species that competed with Hyacinth Macaws for the natural cavities. The result was so immediate that in 1998 the number of chicks that flew from the Pantanal of Miranda increased in 200% , local where were installed most of boxes (see the table 1). Year after year the boxes are being incorporated to the landscape and a larger number of them are gradually being occupied by Macaws and other species.

Table 1 – Number of chicks that survived and the reproductive success of the Hyacinth Macaws in the Pantanal of Miranda during the period from 1996 to 2001 due the installation of the artificial nests.

Activities development	1996	1997	1998	1999	2000	2001
Active nests by Hyacinth Macaw	19	21	42	51	55	59
Nest with reproductive pairs	14	13	33	40	38	45
Nests with chicks	08	07	19	29	26	34
Number of chicks fledged (Nests)	06 (N=5)	07 (N=7)	19 (N=17)	25 (N=19)	26 (N=21)	35 (N=25)
Reproduction rate	0.42	0.54	0.57	0.62	0.68	0.77
Reproductive success	0.75	1.00	1.00	0.86	1.00	1.03

In the latest years, management and recuperation of the natural and artificial cavities were realized mostly of the potential nests that are those reused every year by the Hyacinth Macaws and/or red Macaws. Due the inclemency of meteorological conditions, termites or even by the use of them by birds, 3 to 5% of the cavities are lost every year.

In 2000, 81 cavities (38 natural and 43 artificial) were managed and recuperated in the South Pantanal. Around 47 % of these cavities were modified to reduce the opening to avoid the rain water entrance or predators; 18% had to be filled with wood stubs and sawdust because the base of the nest was too far from its opening, circumstance that could impede the chicks exit (as it was observed in the nest N.122 in 1997); 22% had their beds substituted for diminishing the entomofauna that cohabits inside the nests and that can cause the newborn chicks death. The substitution removed the vestiges of the occupation of other species that had left feathers, pieces of eggs shells and other animal cadavers. The remaining 13% received 2 or 3 types of management.

The result of this activity was immediate, 20 natural and 7 artificial cavities managed were reactivated by the Hyacinth Macaws with eggs laying and chicks births. Ten other natural cavities and 37 seven artificial ones were reactivated by other species like parrots (*Amazona aestiva*), owls (*Tyto alba*), muscovy ducks (*Cairina moschata*), falcons (*Falco rufigularis*), toucans (*Ramphatos toco*) and tamandua anteater (*Mirmecophaga tetradactyla*) that used the arboreous cavities as shelters.

Management of eggs and chicks

Besides the management of the nests from 2000 the first management experiences with eggs and chicks were initiated passing these studies through laboratory (Guedes 2000). This management was realized in nests with a previous detailed report of eggs predators and large non-synchronous eggs hatching and/or newborn chicks losses. Nests in which the chicks disappear immediately after hatching, had their eggs collected being substituted for hen eggs (small size) and taken to the laboratory where they were incubated in the last days. They were daily observed and after birth, the chicks were fed for 5 to 7 days with a special ration for newborn chicks, posteriorly reintroduced in their original nests or transferred for nests with individuals of the same age (Guedes 2001, 2002).

In 2000, in four of the managed nests there was a 100% success with the survival of all chicks. In 2001 the management initiated in the previous year had its continuity with transfers between the nests in which the chicks had a difference of 5 days of age. Among the 8 managed transferred nests, 75% presented success with the survival of the chicks. One egg

(nest N.254) resulted of the second laying was collected and taken to the laboratory after the losses of the first laying. In this case it was observed that the embryo had an inverted position inside the egg. The chick took 48 hours to break the shell totally, with a huge effort that caused luxation in the posterior part of the neck. The chick died a few hours after its birth in the laboratory.

The second unsuccess case happened after 5 days in relation to the first chick, it was taken to the laboratory where it was fed for 8 days and afterwards relocated to an artificial nest (N. 2090), substituting the eggs that had passed more than 40 days since the beginning of incubation. The female rejected and killed the chick immediately after the change.

Studies about predation and behavior.

Due the high predators actions of eggs and chicks, at the beginning of the project, many automatic cameras with infrared detectors were installed inside the nests in an attempt to identify nest predators (eggs and chicks predators). This activity did not have the expected success because most photographs were taken because of movements of the own Hyacinth Macaws that are very conspicuous and curious. Because of this relative unsuccess, most predators had to be discovered through a constant monitoring and observation of some nests.

In 2001 WWF-Brazil donated a complete professional microfilming equipment to be installed inside the nest. The complete equipment includes a microcamera with lens smaller than a covering pen, a monitor, a tape recorder, a video-cassette recorder and cables with a 100 m of extension to make possible for the reserchers the monitoring of the nests even they are in a considerable distance. These activities are in their initial phase but the preliminary results has been extremely important for showing, for the first time the behavior of the couples, chicks and the parents with their chicks, inside the nests.

The Green-wingeds Macaws

Around 80 natural nests that were cadastrated for the Hyacinth Macaws are now being shared or used by the Green-wingeds Macaws. So, since the beginning of the project the Green-wingeds Macaws (*Ara chloroptera*) have been studied, mainly in their reproductive biology.

During the period from July/2000 to June/2001, 18 monitored nests were used by Green-winged Macaws. Among them, 39% (N=7) were in 5 ranches in the Pantanal of Aquidauna, 33% (N=6) were installed in a ranch named Fazenda Baú in the Pantanal of the

Abobral, 22% (N=4) were in 2 ranches in the Pantanal of Nhecolândia and 6% (N=1) were in a ranch in the Pantanal of Miranda.

In a sample of 11 couples it was observed a 24 eggs laying, 64% with 2 eggs, 27% with 3 eggs and 9% with only one egg. Among the 11 nests with eggs one was a target of predators, in four of them 6 chicks were born and about the other 6 no information was obtained. Seven more nests were found only with chick (4 nests with 2 chicks and 3 with only one). At the end of the observation, 17 chicks fledged of their nests with a reproductive success of 1.54 chicks per couple.

In addition the opportunity of being in the field was exploited to collect more information about the reproductive biology of the Blue-and-yellow Macaws (*Ara ararauna*) that occur in the same region. Many Masters and Doctors thesis were defended thanks to the materials and samples collected in the Pantanal about large macaws (Pinho 1998, Faria 2000, Carciofi 2000 e Caparroz et al. 2001). Information about other birds species were also collected, especially about the avians that compete with the macaws for the nests such as toucans, falcons, owls and muscovy ducks.

Ecotourism and Environmental Education

During all the work in the field the approach and contact with the ranchers, “pantaneiros” residents of the Pantanal and local kids has been constant since the beginning of the project. Initially they were taught and explained the reason and motivation of the project, the threatens that can cause the specie extinction and the high especialization of the Hyacinth Macaws. It was reinforced the importance of the specie occurrence in the region, with the intention to make them feel proud of having the specie freely in nature. At the same time all the results of the as well the localization and occupation of the cavities by the Hyacinth Macaws has been informed to local inhabitants and since then they have become volunteer guardians of the nests and macaws. They after day the interest of local ranchers in keeping and incresing the number of Hyacinth Macaws in their properties is intensified. In spite of the traffic and illegal commercial exploitation for the pet trade, that if still present in the region, has diminished considerably, according to the reports of the Hyacinth Macaw Project and information from the local Environmental Police.

Ecological activities are developed mainly in the Visitation Center of the Hyacinth Macaw Project in the “Refúgio Ecológico Caiman” and in the IPPAN/UNIDERP where guests in small groups may acompany some activities developed by the project such as monitoring and manegement of nests and chicks. Lectures and explanations are also given

before going to the research field. In other six inns in the South Pantanal where the project is also realized, lectures and explanations are ministrated for special groups.

In addition, lectures are ministrated mainly for children, teachers, tour guides and opinion makers. The results of the research are published and informed for the scientific community in congresses, meetings or through articles in newspapers and magazines. The results of the researches have also been divulged through the written and spoken media, through TV and radio broadcastings for the communities, objectiving the preservation, conservation of the local populations of the Hyacinth Macaws and other important species that cohabit the Pantanal region. The main goal is the Pantanal conservation and the Project represents a parcel of contribution for this porpouse. The Project also hopes to contribute for the conservation of other psitacidae, mainly other species of Macaws whose populations are reduced and endangered like the Lear's Macaw (*Anodorhynchus leari*) and the little Blue Macaw (*Cyanopsitta spixii*).

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