

Anodorhynchus macaws as followers of extinct megafauna: an hypothesis

Carlos Yamashita¹

IBAMA - Al. Tiete, 637, 01417-020, São Paulo, SP, Brazil

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RESUMO. As araras *Anodorhynchus* seguidoras de megafauna extinta: uma hipótese. As araras deste gênero são alopátricas representadas pela araraúna *A. hyacinthinus*, arara-azul-de-lear *A. leari*, e recentemente extinta *A. glaucus*. São especialistas exclusivas de endosperma de palmeiras. São avistadas nas áreas de ocorrência com frequência, em grandes bandos, caminhando no solo desnudo, procurando cocos perfeitamente ruminados pelo gado bovino. Esse comportamento de descer ao solo para alimentar-se em áreas de ruminação noturna de gado vacum, como currais, pode sugerir que essas aves foram comensais, seguidoras da extinta megafauna neotropical, reproduzindo o mesmo comportamento depois da introdução do gado vacum nas áreas autóctones. A concentração de bandos de Psittacidae em barreiros deriva de alguma forma do uso ancestral dos pontos de arraso produzidos pela megamastofauna extinta. Após a extinção da megafauna neotropical, esses pontos arrasados de manada de megafauna são simulados ciclicamente em margens de grandes rios durante a estação seca. **PALAVRAS-CHAVE:** *Anodorhynchus*, arara, Caatinga, Cerrado, comportamento animal, megafauna, Neotrópico, palmeiras, Pantanal, Pleistoceno, predador de sementes, Psittacidae.

KEY WORDS: animal behavior, *Anodorhynchus*, Caatinga, Cerrado, ice age, macaw, megafauna, Neotropics, palm groves, Pantanal, Pleistocene, Psittacidae, seed predator.

The macaws are birds that usually forage in the canopy of the tallest trees. They are mainly arboreal seed predators (Jansen 1971, Sick 1986, Yamashita 1992), although *Anodorhynchus* macaws commonly walk on the ground (Sick *et. al.* 1987, Yamashita 1987, 1992). The mesocarp of the fruits is commonly discarded; *Anodorhynchus*

macaws are easy to detect from the piles of perfectly cracked palm nuts that accumulate under palm trees, tall trees used as perches and roosting stone ledges.

There are two species of living *Anodorhynchus* Macaws, Lear's Macaw *A. leari* in a restricted "Caatinga" (thorny scrub) area in northeastern Brazil and Hyacinth

1. Correspondence adress: R. Voluntários da Pátria 3714, apto 52, 02402-400, São Paulo, SP, Brasil. E-mail: cyana@nethall.com.br

Macaws *A. hyacinthinus*, with a wider distribution in woodland and savanna habitats (Sick et al. 1987, Yamashita 1987, 1992, Forshaw 1989, Brandt and Machado 1990, for vegetation description Veloso and Strang (1970), Eiten (1972) and Rizzini (1979)). Another known member of the genus, *A. glaucus*, became extinct recently in the XIX century (Yamashita and Valle 1993, Collar et al. 1994). The common specialization of all *Anodorhynchus* is the use of palm seeds as staple food, living only where palm groves occur (Munn et al. 1990, Brandt e Machado 1990, Yamashita and Valle 1993).

A co-evolution has been suggested between the preyed palms, which developed very hard nuts, and the predatory macaws, with their very powerful bill (Munn et al. 1990). The guild of palm species used by the macaws has, as main characteristics, sizable nuts smaller than the gnathotheca "chisel", continuous phenology, large palm stands, and extractable ligninless kernel (Yamashita and Valle 1993). Usually *Anodorhynchus* use palms with well developed trunks. However, in the northeastern Brazil, in the states of Bahia, Tocantins, Maranhão and Piauí, they feed mostly on trunkless species.

During the Pleistocene the mammalian fauna of North and South America was much more diverse, with over 45 genera of mammals over 10 kg (Martin 1984). The extinct megafauna in South America included a plethora of large megaherbivores that probably browsed the woodland-savanna vegetation in open areas, like present-day Cerrado and Pantanal (Simpson 1980). Two main hypotheses have been suggested to explain the demise of half of the mammalian genera exceeding 5 kg of body mass during the Pleistocene: climatic change resulting in habitat transformation; and recently, the more accepted hypothesis, human predation (Martin 1967, 1984, Owen-Smith 1987).

Although extinct, the Pleistocene megafauna left a legacy. Janzen and Martin (1982) hypothesized that some large-seeded species of living Neotropical trees were dispersed primarily by large vertebrates like mastodons, which became extinct during the end of the Pleistocene, about 10,000 years ago. Several extant palm species (e.g. *Acrocomia*, *Scheelea* and *Bactris*) show what is considered the "megafauna" syndrome, i.e. large fruit and seed size, tough epicarps, fibrous and sticky pulp, very hard endocarp and a trend to make piles of ripe fruits under the parent trees. Some of these palms are short-stemmed or trunkless, making their fruit accessible by terrestrial mammals. These palms typically form scattered monospecific stands which show little recruitment (pers. obs.). Young palms are heliophilous, becoming established only where they receive direct sunlight, that apparently accounts for the senescent status of most palm stands (Anderson et al. 1991, pers. obs.). These palm groves show accumulations of hundreds of thousands of seeds under the parent palms, suggesting a lack of seed dispersers consistent with the Janzen-Martin hypothesis.

Recent evidence suggests that domestic livestock could have an impact similar as the extinct herbivore megafauna, acting as seed dispersers for species left as "orphans" after the

late Pleistocene extinction and, by trampling plants, maintaining open areas important for the recruitment of heliophilous species (Janzen and Martin 1982, Jansen 1986, Skape 1991).

Domestic cattle, especially the more generalist Brahman races, readily ingest palm fruits. During the rumination process the seeds, stripped off the pulp, are regurgitated. This process occurs more commonly at specific sites where the animals congregate, usually at night, to rest and ruminate (figure 1). Due to continuous use and trampling the vegetation at these rumination sites is destroyed, making them easily recognizable as bare ground patches littered with manure with regurgitated seeds, which may germinate in such places and, provided they are not trampled, grow.

Besides dispersing megafauna-adapted seeds, cattle may be a surrogate to other species that interacted with the megafauna. In this paper I discuss the use of razed gaps created by domestic livestock by *Anodorhynchus* macaws, and the origins of the apparently commensal relationship between the macaws and cattle.

OBSERVATIONS

I first observed Hyacinth macaws foraging on the bare ground patches created by cattle at their rumination sites at Miranda Estância, Mato Grosso do Sul (19° 57' S, 56° 25' W) from January to February 1981, when I had the daily opportunity to watch a group of Hyacinth Macaw foraging on the ground looking for Acuri (*Attalea phalerata*) and Bocaiuva (*Acrocomia aculeata*) palm nuts wholly cleaned from their pulp by the cattle during rumination and regurgitated in a backyard corral. Later, during extensive work between 1981-1984 in several localities in the Pantanal, a seasonally flooded savanna (SUDECO 1979), I often saw flocking Hyacinth Macaws on the ground at places where cattle gathered during the night. I have always found many cracked nuts in these rumination sites everywhere in the Pantanal, wherever macaws occurred.

During the period of 1983-1986 I was seven times in the *A. leari* range. At several cattle rumination sites in the region used by the macaws I found hundreds of Lear's macaw-cracked nuts of the palm *Syagrus coronata* on the ground, nuts that had been previously perfectly cleaned by the cattle (figure 2).

THE HYPOTHESIS

Since the introduction of cattle in the New World, the Europeans introduced the free-ranging system in natural open habitats, cleared woodland and slash and burn-over forest land (Dean 1995). The cattle ranching activities were introduced as free-ranging system, and soon occupied naturally open habitats or slash-and-burned woodland (e.g. Caatinga, Cerrado and Pantanal), representing a landscape which only previously existed around 10,000 years ago, when the Megafauna was alive. The cattle have a very social herding behavior and large size (± 400 kg). When introduced into the open formation or provoking



Figure 1. Selective rumination by cattle. The perfect rumination produced by cattle digests the fruits mesocarp, leaving only the hard nut available. Large nuts are not swallowed by cattle. The rounded seed is Macaúba *Acrocomia aculeata* and the ellipsoid seed is Acuri *Attalea phalerata*. Photo: C. Yamashita



Figure 2. Cleanly opened nuts by Hyacinth and Lear's Macaws. Top left to right : The species of palm nuts are: piagava *Orbignya eichlerii*, catolé *Attalea* sp., inaja *Maximiliana maripa*, acuri *Attalea phalerata*, macaúba *Acrocomia aculeata* and from Lear's Macaw: licuri *Syagrus coronata*. Lower: cattle-digested mesocarp nuts cracked by Hyacinth and Lear's Macaws: acuri and licuri palms nuts. Photo: C. Yamashita

them from; trampling, seed dispersion, simulate a guild as an simulacrum of landscape regulator similar to the extinct megafauna.

Before the introduction of cattle in the XVI th century, the remnant mammals after Ice Age extinction included only a few species in Brazil that reach more than 20 kg (Peccaries *Tayassu* ssp, Tapir *Tapirus terrestris*, Capybaras *Hydrochoerus hydrochaeris* and some deer's). None of them weights more than 200 kg (Tapir), the majority barely reaching 30 kg. With the exception of the White-lipped Peccari (*Tayassu pecari*) in which herds reach more than 150 individuals, the others behave as solitary or family groups occurring in low density (Eisenberg 1981, Eisenberg and Redford 1982, Emmons and Feer 1990). Due to their body size and behavior, these remnant mammals do not drastically impact the landscape; e.g. trampling the vegetation, rather browsing lower branches and barks or the low chemical impact of dungs in small site; small sizes dungs in defined latrines (e.g. deers).

From these observations, I suggest that the habit of *Anodorhynchus* Macaws of following cattle herds is a primitive and conservative behavior, and probably occurred when the extinct megaherbivores were present at 10,000 years ago. The newly introduced cattle simulates the Neotropical megafauna extinct during the Ice Age as an agent for maintenance of landscape heterogeneity by grazing and generating bare soil gaps at the rumination sites. Cattle also digest the mesocarp of palm fruits and concentrate the nuts in these predictable and easily recognizable bare ground patches, a behavior that is quite probably similar to that of some of the extinct herbivores, if inferences can be made from the extant megaherbivores like elephants and rhinos.

Nowadays both Hyacinth and Lear's Macaw still keep this conservative behavior close to cattle corrals, present-day megafauna gathering places, even when many ripe racemes are available in surrounding palm trees. The behavior of flocking *Anodorhynchus* macaws of walking on the ground while searching the palm nuts can only be understood in the contexture of them being former followers of extinct megafauna (figure 3).

Behavioral adaptation. The macaws *Ara* and *Cyanopsitta* show no special anatomical adaptation to walk on the ground (e.g., long tail, short tarsimetatarsus, that touch the branch when perched). When walking the center of gravity is below the chest, the macaws swaying the body while crossing the feet, which are anatomically adapted for climbing. But the genus *Anodorhynchus* shows the conspicuous and unique "galloping". When they forage on the ground, their movements are walking insert the galloping. The galloping description is: they elevated the head, body and the wings up back and sequences of jumping move very fast in rhythmic movements. This behavior is not found in any other species of large macaws.

Among the *Ara* macaws, only Red-fronted Macaw *A. rubrogenys* conspicuously feeds on the ground, when

looking for peanut seeds after the harvest (Boussekey *et al.* 1991, pers. obs.) In this case the cause may be a lack of food supply, a recent adaptation of a new environment condition in its xeric habitat or a megafauna razed gap follower. Others species of the large genus *Ara*, sometimes walk on the ground, but the link between megaherbivores is not so obvious (e.g. *A. ararauna* in Emas National park, Goias state, pers. obs.). Its suggests that large top predator of seeds from xeric or relict habitats might show a preadapted behavior as a relict trait of when it was a megafauna follower during the Ice Age.

On the other hand, the xeric or relictual habitat species presents the sentinel behavior and distress call very conspicuous. (e.g. I observed a flock of 50 Hyacinthine Macaw foraging on the ground with sentinels perched on the top of close trees. When disturbed, the sentinels gives a distress call and the group keeps overflying the site. The same behavior had been noted in Lear's Macaw (Yamashita 1987) and Red-fronted Macaw (per. obs.).

The macaw's behavior of readily coming to the ground to look for palm seeds in bare ground patches has been used by man to trap them. Between the states of Bahia, Tocantins, Maranhão and Piauí, a region known as "Gerais", the local bird trappers burn a small area in a palm grove and bait this site with palm nuts, especially with mesocarp-free seeds and some cracked nuts. The macaws readily come to these burnt areas and are trapped. I witnessed that this method was very effective to attract *A. hyacinthinus* flocks (figure 3), but did not work for two other sympatric species in the area; *Ara chloroptera* and *A. ararauna*, which are not attracted by the bare ground patches.

Apparently other parrots use seeds gathered from dung left by present-day megafauna, congregating on the bare-soil patches created by them. This behavior had been recorded as a film. The BBC documentary "Who is talking?", made in the Central Africa Republic showed flocks of thousands of Grey Parrots (*Psittacus erythacus*) among elephant herds *Loxodonta africana* at a salt-lick, picking seeds and seedlings from the enormous dung piles accumulated at the site (May 1996).

Besides *Anodorhynchus*, other Neotropical parrots are known to associate with open bare soil patches (Roth 1984, Munn 1988). In the Floresta Nacional do Jari, Rondonia (9° 07' S, 62° 54' W) I observed flocks of the Golden-winged parakeet *Brotogeris chrysopterus*, the White-eyed-parakeet *Aratinga leucophthalmus*, the Dusky-headed parakeet *A. weddelli*, the Painted conure *Pyrhura picta*, the Crimson-bellied conure *P. p. perlata (rhodogaster)*, and the Red-bellied macaw *Ara manilata* (figure 4) arriving daily in early morning during the dry season in cattle salt lick to ingest soil from the surrounding cattle-denuded patch. The large parrot concentrations on salt licks could be derived somehow of ancestral use of razed gaps produced by extinct megafauna herds. After the extinction of the autochthonous megafauna these razed gaps are simulated along the river banks during dry season.



Figure 3. The behaviour of *Anodorhynchus* Macaws flocking on the ground searching mesocarp cleaned nuts is a common behaviour in the backyard cattle's corral where the genus occurs. A flock of *A. hyacinthinus* attracted in southern Maranhão by the traditional local method: burning a small spot in a local palm grove and baiting with palm seeds. The method simulates a megafauna razed gap with dispersed mesocarp-free seeds. Photo: Y. M. Barros



Figure 4. A flock of *Ara manilata* in a cattle's salt lick in the Floresta Nacional do Jamarí, Rondônia. Is this behaviour a following of extinct megafauna generated razed gaps? Photo: C. Yamashita

Although speculative, this work draws attention to the fact that the Neotropical fauna was, not long ago, still richer, and that complex interactions between the extinct species and the extant survivors existed, and these had an important role in shaping the behavior of many of the present-day species. Apparently odd behavioral characteristics may become fully reasonable once studied in the light of the not so distant past.

In *Anodorhynchus*, all species are zoogeographical megarepresentatives of local sympatric Psittacidae, suggesting that other megarepresentative of top seed predators were associated with recently extinct megamastofauna. Macaw extinctions are recently documented by H. Alvarenga (pers. com.) who found an extinct undescribed *Anodorhynchus* from Minas Gerais in Pleistocene deposits associated with a well documented megafauna fossil described by Cartelli (1994).

The most logical explanation for the behavior of the *Anodorhynchus*, following cattle herds and searching palm nuts on the ground is that this is a primitive conservative behavior, that ceased to occur after the extinction of the megaherbivores. After 10,000 years, a colonization of the new alien megaherbivores changed the landscape in South America and a predisposition to this primitive behavior found its place in this new scene.

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