Ararajuba

Revista Brasileira de Ornitologia

VOLUME 5, NÚMERO 2 - DEZEMBRO DE 1997

Ararajuba 5(2):97-113
dezembro de 1997

Rediscovery of the White-cheeked Parrot *Amazona kawalli* (Grantsau and Camargo 1989), with notes on its ecology, distribution, and taxonomy

Paulo Martuscelli[1] and Carlos Yamashita[2]

[1]Instituto Insularis, C. P. 194, 11750-970, Peruíbe, SP. Brazil. E-mail: insularis@coastalway.com.br
[2]IBAMA Rua Voluntários da Pátria 3714/52, São Paulo 02402-400, Brazil. E-mail:cyama@nethall.com.br

Recebido em 29 de abril de 1997; aceito em 11 de agosto de 1997

RESUMO. **Redescoberta do papagaio de cara-branca *Amazona kawalli* (Grantsau e Camargo 1989) na natureza, e notas sobre a sua ecologia, distribuição e taxonomia.** O papagaio-de-cara-branca *Amazona kawalli* (descrito primariamente como *Amazona farinosa* aberratio *rubricauda* Stresemann 1924), é uma das espécies de papagaios menos conhecida do mundo. A sua descrição foi baseada em poucos exemplares, coletados na natureza e de exemplares cativos com procedência desconhecida. O status taxonômico em relação as outras espécies de *Amazona* permanece incerto, sendo considerado por recentes autores como uma mera variação individual do papagaio-moleiro *A. farinosa*, sua espécie supostamente aparentada. Após a coleta do tipo em 1902 e um outro espécime em 1914, esta espécie nunca mais foi encontrada na natureza. Neste trabalho nós registramos as primeiras populações naturais do *Amazona kawalli* encontrado nas cabeceiras do Rio Tapajós e seus tributários, em uma área florestada isolada por serras ao sul da planície Amazônica Brasileira. A distribuição do *Amazona kawalli* esta relacionada com florestas periodicamente inundadas e hábitats de transição, não sendo encontrado em floresta de "Terra Firme" contínua e floresta "Semidecídua", não ocorrendo em simpatria com o papagaio-moleiro *A. farinosa*. Em campo é facilmente identificado por sua voz característica, coloração das partes nuas e morfologia geral. Baseados nestas características nós concluímos que *Amazona kawalli* é uma espécie válida, distinta do papagaio-moleiro *A. farinosa*, sendo as características de diagnose o anel perioftálmico cinza, prega de pele nua ao redor do bico, retrizes laterais tingidas de vermelho na sua parte interna, cerdas presente nos loros e cobrindo as narinas, servindo também para diferenciar os espécimes em museus. As principais ameaças para a sua conservação são a caça para alimentação humana, comércio ilegal, a mineração do ouro e cassiterita, a construção de usinas hidroelétricas e projetos de reforma agrária.
PALAVRAS-CHAVE: *Amazona kawalli, Amazona rubricauda*, ameaçado, conservação, distribuição, nomenclatura, reprodução, Rio Tapajós, taxonomia, vocalização.

ABSTRACT. The White-cheeked Parrot *Amazona kawalli* (first described as *Amazona farinosa* aberratio *rubricauda* Stresemann 1924) is one of the least-known parrots in the world. It was described from a handful of specimens, collected both in the wild and captives from unknown localities. Its taxonomic status in relation to other *Amazona* species remains unclear, being considered by some authors to represent individual variation within the Mealy Parrot *A. farinosa*, its supposed sister species. After the type specimens were collected in 1902 and another specimen in 1914, White-cheeked Parrots were not found again in the wild. In this paper we report the discovery of the first wild population of White-cheeked Parrots, found in the headwaters of the Rio Tapajós and his tributaries, in a forested area bounded by mountain massifs in the southern Brazilian Amazonian lowlands. The distribution of the White-cheeked Parrot is positively related to seasonally flooded forests and transitional habitats, but it does not occur in the adjacent uplands and semideciduous forest surrounding the lowlands, these habitats are occupied by *A. farinosa*. In the field it was easily identified by its distinctive voice, bare part colors and general morphology. Based on these characteristics we conclude that *A. kawalli* is a valid species distinct from the similarly sized Mealy Parrot *A. farinosa*. The main diagnostic character of *A. kawalli* are being the gray around the eye ring, white mandibular patch, outer rectrices tinged with red at the inner base, and blackish bristles on the lores and covering the nostrils. The main threats to its survival are hunting for food, the pet trade, gold and tin mining, hydroelectric projects, and colonization projects for landless farmers.

KEY WORDS: *Amazona kawalli*, *Amazona rubricauda*, breeding, conservation, distribution, endangered, nomenclature, Rio Tapajós, taxonomy, vocalization.

Supposedly aberrant Mealy Parrots (*Amazona farinosa*) have been described and even illustrated in the ornithological literature. Ihering (1904), referring to material collected in 1902 by E. Garbe on the Juruá River, Amazonas state, identified three parrots (Museu de Zoologia da Universidade de São Paulo - MZUSP 2727, 3478, 2258) as *Amazona inornata* (=*Amazona farinosa inornata*). Later, Ihering and Ihering (1907) relegated the same specimens as *A. farinosa*.

During the 1914 Roosevelt-Rondon Expedition, one specimen with divergent characteristics identified as *A. farinosa* was collected at the mouth of the Rio Castanho and is currently housed at the Museu Nacional do Rio de Janeiro (MN) (E. O. Willis pers. comm.).

Miranda-Ribeiro (1920), in his revision of the Brazilian parrots, described a Mealy Parrot from northern Mato Grosso with an unusual color pattern. He said (translated): "I also saw one (*A. farinosa*) from the mouth of the Rio Castanho, with red at the base of its tail feathers".

Later, *A. farinosa* aberr. *rubricauda* was described by Stresemann (1924) from a captive specimen of unknown origin sent from the Berlin Zoo to the Zoological Museum in Berlin (ZMB 23160). Despite the red base of its tail feathers, Stresemann considered it an aberration. Pinto (1935) and Pinto and Camargo (1954) also commented that two female *A. farinosa* collected by Garbe at the Juruá river (MZUSP 2727 and 3478) had red on their tail feathers, but attributed that character to individual, and age variation. Like Stresemann and Miranda-Ribeiro, Pinto (1935) Pinto and Camargo (1954) did note notice other distinctive characteristics in the museum specimens. Although the distinctive tail coloration of *Amazona kawalli* had been already noticed many decades ago, its diagnostic value was not recognized, because other key morphological characteristics of the taxon, like soft parts, structure, and color, were not noticed in museum skins.

Some of these distinctive Mealy Parrots were also pictured several times up to the early 1980's. Sick (1961), photographed a captive specimen identified as *A. farinosa* at a Munducurú indian village, on the right bank of the Cururú river, in the foothills of the Serra do Cachimbo, Pará state. Bosch and Wedde (1984) also pictured a captive bird identified as *Amazona farinosa inornata*. Both pictures clearly show an Amazona with a large white skin patch at the base of the bird's mandible and a dark eye-ring, both characters not present in typical Mealy Parrots.

The answer for the problem of aberrant Mealy Parrot came in the middle 1980's, when Nelson Kawall, an experienced Brazilian aviculturist, received a few unusual *Amazona* individuals, said to come from the lower Tapajós River. Kawall's discovery led to the description of *A. kawalli* (Grantsau and Camargo 1989). According to the description, nine characters distinguish *A. kawalli* from *A. farinosa*, the main ones being a bare white skin patch at the base of the lower mandible, exactly like the birds pictured by Sick (1961) and Bosch and Wedde (1984), and the red base of the tail feathers. The original description was based on Pinto's red-tailed "*farinosa*" specimens from the Juruá river, one former captive specimen from Grantsau's collection (RG 7577 - paratype), and two live birds in Kawall's collection. Grantsau and Camargo (1989) also mentioned another specimen, (Museu Paraense Emilio Goeldi MPEG 14804), said by them to come from Santarém, Pará, but this was not used in the species description. None of the known specimens has precise locality data, except for the two MZUSP specimens and the MPEG bird, which was actually collected by J. Hidasi on 7 November 1955 at Itaituba, Pará (Oren and Parker, in press), and not Santarém as pointed by Grantsau and Camargo (1989). Grantsau and Camargo (1990) republished the 1989 description, with the addition of a table of measurements of *A. kawalli* and a map plotting the distribution of *A. kawalli*, showing two localities 1,700 km apart.

The species' validity has not been unanimously accepted. Bosch (1991) and Parker *et al.* (1996) considered *A. kawalli* an individual variation of *A. farinosa*. Teixeira (pers. comm. 1993) was the first to mention the specimen described by Stresemann, which he assumed to be a Mealy Parrot identical to *A. kawalli*, and concluded that the later taxon is not valid. He noticed that the diagnostic characteristics of *A. kawalli* occurred singly or simultaneously in several *A. farinosa* specimens he examined. The mandible skin patch was considered to be of no diagnostic value, because it almost disappears in prepared skins, and similar-looking skin folds could be observed in museum skins of *A. farinosa* and even in some Orange-winged Parrots *A. amazonica*.

The name validity has caused controversy. After the description by Grantsau and Camargo (1989), Teixeira (pers. comm., 1993) not considered the name *kawalli*. Collar and Pittman (1996), studying the type of *rubricauda* designed by Stresseman found that *kawalli* must prevail over *rubricauda*.

Vuilleumier *et al.* (1992), commenting on new species of birds described from 1981 to 1990, considered that more information was needed to prove the validity of *A. kawalli*. They said: "We feel that there is no evidence at present to decide what the status of this form is, hence our classification as *Species Inquirendae*". Nevertheless, Sibley and Monroe (1993) included this species in their review of the birds of the world. Also, several publications have mentioned the species, without offering new data (Low 1990, 1992, Arndt 1991, Bosch 1991).

More recently, cytotaxonomic analysis of Brazilian species of the genus *Amazona* made by Duarte and Caparroz (1995) found differences between *A. kawalli* and *A. farinosa* in chromossomes two and three.

In this paper we report the discovery of free-living parrots agreeing with the description of *A. kawalli*, describe their habitat, distribution, voice, aspects of their ecology, and population status, and we evaluate their taxonomic status.

METHODS

Three expeditions were made in search of *A. kawalli*, the first two to Apiacás Ecological Station (approximately 8°20'S, 57°40'W), northern Mato Grosso state, during a Rapid Assessment Program (RAP) to generate data to subsidy the station's management plan. The expeditions were made from 22 July to 15 August and 28 October to 12 November 1995 on the lower courses of the Rio Teles Pires and Rio Juruena, and the upper reaches of the Tapajós river. The third expedition was from six to 20 March 1996, when we explored the Tapajós river from the town of Itaituba to the junction of the of the Rio Teles Pires and Rio Juruena, including some of its tributaries (figure 1).

The species' distribution was assessed by visiting localities with seemingly suitable habitat, as suggested on localities where we had previously observed the species, and also adjacent areas harboring different plant communities.

Amazona parrots were detected by walking transect lines cut through natural vegetation patches, and we also made boat transects along the rivers. The transects were surveyed daily from early morning (05:30) until after sunset (18:30). Every parrot observed or heard during this time was recorded, along with additional data na group size and habitat type (Semideciduous Forest, Terra Firme Forest, Floodplain Forest, Buritizal, and Campinarana or sand-ridge woods); habitat categories follow RADAMBRASIL (1975). Whenever a group of *Amazona* was observed perched or feeding, group size, number of juveniles, plant food species, part eaten (flower, seed, fruit, pulp or whole fruit), and general behavior. Each time a group was found eating, we recorded a feeding bout. Different groups congregating at a food source could generally be separated as they arrived or departed. One feeding bout was recorded for each group. We considered only the instances when birds were definitely seen feeding, and discounted indirect evidence and second-hand reports.

During the three field expeditions, the distribution and population size of *A. kawalli* was assessed through searches throughout the riverine areas in the headwaters of the Tapajós river and its tributaries (figure 1). In areas where the species was located, local populations were censused at night roosts. We made at least one count at each roost. During censuses, the direction of flight of birds arriving at and departing from a given roost was the same for all birds, although they did not all arrive and depart at the same time. This direction was recorded and assumed to indicate the location of the general foraging areas of each group of parrot population. We used this information to establish ranges and to identity different populations. During censuses we also counted family groups (adults and juveniles) to estimate recruitment. Juveniles were easily identified when flying with their parents, keeping with them but always somewhat behind.

To estimate the relative abundance of *A. kawalli* populations, transects were conducted following the techniques of Ralph and Scott (1981,1993). Total transect distances, measured *in situ* or taken from maps, were 77 km overland and 180 km by boat in July-August 1995, 68 km overland and 110 km by boat in October-November 1995, and 64 km overland and 435 km by boat in March 1996. In all, we walked 47 km at about two km/hr, through Semidecidous Forest, 38 km in Terra Firme Forest, 30 km in transitional habitats between Terra Firme to Floodplain forests, 42 km in Floodplain Forest, 23 km in Campinarana, seven km in Buritizal, 22 km in disturbed areas, and 725 km along rivers by boat. Transect width was about 100 m in Semidecidous Forest, Terra Firme Forest, Buritizal, and Foodplain Forest. In Campinarana the transect width was 150 m. Boat transects, conducted at speeds of five-eight km/hr, detected *Amazona* flying overhead or perched only along the margins.

Tape recording of *Amazona* calls were made with a Sony TCN 5000EV cassette-recorders and a Sennheiser 80-E directional microphone, and were analyzed with a UNISCAN II digital sonograph at the Laboratory of Bioacoustics of the Universidade Estadual de Campinas-UNICAMP. We made comparative analyses of the "flight call" of *A. kawalli*, because this call has been considered a species-specific character among *Amazona* parrots (Vielliard 1994). Voucher recordings of *A. kawalli* were deposited in the "Arquivo Sonoro Neotropical" (ASN) at the Universidade Estadual de Campinas, and in the Libary of Natural Sounds, Cornell Laboratory of Ornithology.

Breeding data were obtained through partial monitoring of two nests. Another five nests were discovered at different stages of the breeding cycle, and for these, the habitat, species, genus and size of the nest tree, height,

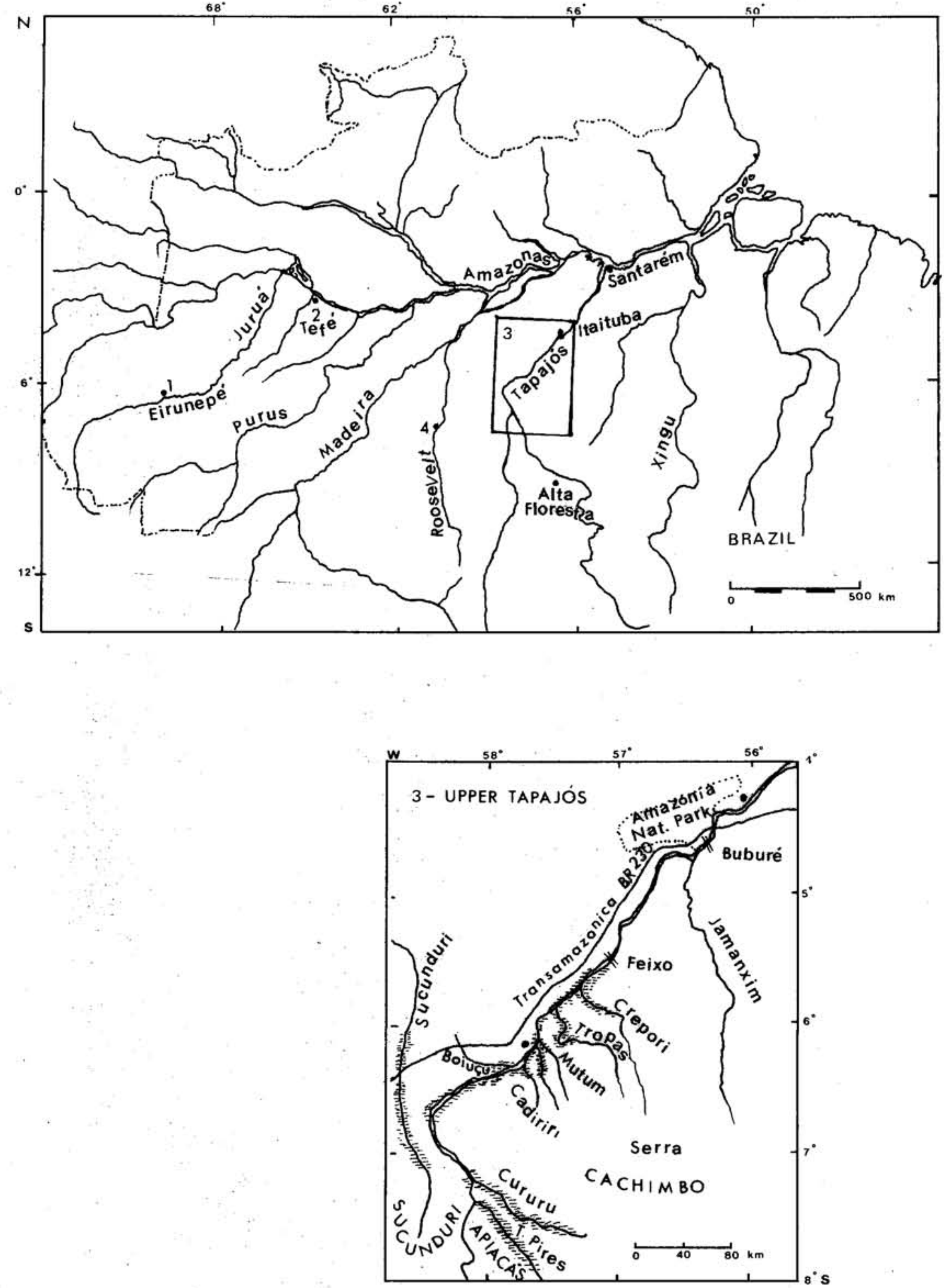

Figure 1. Above. The distribution of *Amazona kawalli* in Amazon region, Brazil. Numbers by locality points (1-Eirunepé, 2-Tefé, 4- mouth of Rio Roosevelt) were based on records in the literature and museum specimens. Bellow. Detail of the upper Rio Tapajós study site, shows the distribution of flooded forest based on RADAMBRASIL (1975).

number of eggs or nestlings, were recorded.

Specimens (collection abbreviations in appendix) of *A. kawalli* (N = 8) and *A. farinosa* (N = 33) at MZUSP, MPEG, Museu Nacional do Rio de Janeiro (MN), Roberto Antonelli Filho collection (RAF), and Rolf Grantsau collection (RG) were examined and measured with calipers to the nearest millimeter. Measurements taken were wing and tail length, culmen (from bill tip to cere), bill width, bill height, bill tip to tooth, tooth to base of upper mandible, and width, height, length and chisel width of the lower mandible (table 1). The morphology and characteristics of nestling and adult *A. kawalli* were observed from 22 chicks of several ages taken from their nests by Mundurucú Indians, and 78 adult *Amazona* kept as pets by local people. We analyzed the measurement data with *t*-test (SAS Institute, Inc. 1988) that compared the mean differences and s.d. of variables between *A. kawalli* and *A. farinosa* (table 1).

To evaluate the extent of the species' habitat, we used the methodology described by Sobrevila and Bath (1992), standard for Rapid Ecological Assessments, a survey methodology for unstudied ecosystems with previous satellite maps (Landsat TM5, scale 1:100,000) defined as different habitat characterization types. The field multidisciplinary survey team check each of previous defined habitats with same effort. Nineteen flight hours were spent, doing aerial surveys by airplane over the entire region between the mouth of the Rio Juruena and Rio Teles Pires and headwaters of the Rio Tapajós.

RESULTS AND DISCUSSION

Distribution and habitat. We found *A. kawalli* in northernmost Mato Grosso (known as Pontal Matogrossense) at the border with Pará and Amazonas states, along the lower reaches of the Rio Teles Pires and the Rio Juruena, and in the headwaters of the Rio Tapajós and its tributaries: Rio das Tropas, Rio Creporí, Rio das Almas, Rio Preto, Rio Cururú, Rio Mutum, Rio Pacú, Rio Saicinza, Rio Cadiriri, Rio Cabitutu, and Rio Buiuçú (figure 1). The species was observed as far north as Feixo, on the Rio Tapajós, 200 km upstream from Itaituba (figure 1). Feixo is a 200 m-high, rocky massif cut by the Tapajós (from 4°40'767''S and 56°42'693''W to 4°58'830''S and 56°46'776''W) along a 38 km steep-walled valley with no floodplain. The southern limit of distribution is the Serra dos Apíacás (peaking at 350 m a.s.l.), an eroded Pre-Cambrian quartzite range cut both by the Rio Teles Pires and Rio Juruena at 9°S. This range marks na area of major ecological change, because its sandy, poor soils support a low, savanna vegetation belt 200 km wide. Similar disruption occurs west and east of the Pontal region, where another two Pre-Cambrian massifs (Sucunduri, 350 m-high; and Cachimbo, at 650 m the highest massif in the region) form areas of much drier habitat that in a way surround the mesic, forest-covered basins of the Rio Juruena, Rio Teles Pires, and upper Rio Tapajós (RADAMBRASIL 1975).

The distribution of the *A. kawalli* was associated to certain plant communities, most of which were contained in Floodplain forests. Overall, *A. kawalli* is fairly easily found wherever there is Floodplain Forest along the lower reaches of the Rio Teles Pires, Rio Juruena, and the upper Rio Tapajós, and their tributaries, down to the town of Jacareacanga. This region includes the main areas of floodplain forest along Rio Tapajós and its tributaries (RADAMBRASIL 1975, Oliveira *et al.* 1993). Downstream from Jacareacanga city the floodplain forest is replaced by Semidecidous Forests and Upland Forests growing in the Pre-Cambrian massif, appearing again only about 300 km downriver where its waters meet the Amazonas river. The region forms the headwaters of the Rio Tapajós, a typical clear-water river, with low to medium productivity. Rapids and waterfalls form a line along the border between the Central Brazilian Shield and the Amazon Basin (RADAMBRASIL 1975).

Yellow or red latossols predominate in the region, associated in well drained, but still humid, lower areas with Terra Firme Forests, the tallest forest found in the area. On the slopes, due to better drainage, a Dry Forest grows. Over shallow, stony, and extremely poor soils atop the hills one finds savanna communities dominated by species with xeromorphic adaptations. Riverine terraces, formed by deposits of material carried by large rivers, form a special habitat. They are found in the lower, seasonally flooded areas at 80-100 m asl. Those terraces, when made of quartzite sands, support patches of low Campinarana vegetation, whereas seasonally flooded forest grows over clay or silt deposits (Prance 1976).

The region harbours a complex mosaic of different vegetation types rarely matched elsewhere. The following five vegetation types may be distinguished in the field, although ecptones between them add further heterogeneity. More detailed informations about floristic composition are present by Prance (1980), Pires and Prance (1985), and Rodrigues (1996).

Upland Evergreen Forest (Terra Firme Forest) has a multilayered closed canopy 30 m high, (tallest trees over 35 m), with *Bertholletia exelsa* (Lecythidaceae), *Dinizia excelsa* (Leguminosae), *Pouteria* sp. (Sapotaceae), *Euterpe precatoria, Astrocaryum vulgare,* and *Bactris gasipaes* (Palmae), all of which are abundant. Other representative species are *Hevea brasiliensis* (Euphorbiaceae), *Manilkara* sp. (Sapotaceae), *Parkia pendula* (Leguminosae), *Protium* sp. (Burseraceae) and cocoa trees *Theobroma cacao* (Sterculiaceae). Vines (mainly *Philodendron* spp.) and lianas are common on the largest trees.

Upland Semidecidous Forest (Dry Forest) has a open canopy reaching 25 m, with occasional emergents reaching 40 m with trunks three m in girth.The predominant tree species is *Ceiba petandra* (Bombaceae). Others characteristic tree species are *Hymenaea courbaril* (Leguminosae), *Hura crepitans* (Euphorbiaceae), *Vochysia* sp. (Vochysiaceae), and *Tabebuia* sp. (Bignoniaceae). The

Table 1. Body and bill measurements (mm) of *Amazona kawalli* and *Amazona farinosa*; see text for discussion.

Species	Sex	N*	Wing length	Tail length	Culmen length	Width upper mandible	Heigth upper mandible	Tip/Tooth distance upper mandible	Base tooth lower mandible	Width lower mandible	Heigth lower mandible	Length lower mandible	Chisel lower mandible
Amazona farinosa	F	(10-8)	237.8 (SD=8.8)	122.7 (SD=11.0)	37.5 (SD=1.7)	20.5 (SD=0.5)	20.0 (SD=0.6)	14.4 (SD=1.0)	20.4 (SD=2.2)	24.0 (SD=0.7)	18.3 (SD=0.7)	21.9 (SD=0.8)	9.9 (SD=0.8)
	M	(23-11)	248.4 (SD=7.7)	127.4 (SD=8.3)	38.7 (SD=3.0)	21.3 (SD=0.9)	20.1 (SD=0.7)	15.2 (SD=0.9)	21.3 (SD=1.3)	24.8 (SD=1.4)	19.6 (SD=1.3)	22.6 (SD=1.6)	10.0 (SD=0.7)
		Pooled	245.2 (SD=9.4)	126.0 (SD=9.5)	38.3 (SD=2.7)	21.09 (SD=0.8)	20.1 (SD=0.7)	15.0 (SD=1.0)	21.0 (SD=1.7)	24.5 (SD=1.3)	19.2 (SD=1.3)	22.5 (SD=1.5)	10.0 (SD=0.7)
Amazona kawalli	F	(5-3)	247.6 (SD=10.5)	122.4 (SD=10.9)	37.0 (SD=1.6)	18.3 (SD=0.5)	18.6 (SD=0.4)	12.8 (SD=0.6)	19.3 (SD=1.1)	22.7 (SD=1.3)	15.7 (SD=1.4)	20.6 (SD=0.9)	9.5 (SD=0.1)
	M	(2-2)	250.0 (SD=11.3)	133.0 (SD=15.5)	37.0 (SD=3.8)	18.5 (SD=0.4)	19.5 (SD=1.3)	12.2 (SD=1.2)	18.0 (SD=2.9)	23.0 (SD=1.9)	16.8 (SD=0.0)	22.1 (SD=0.6)	9.5 (SD=1.5)
		Pooled	248.2 (SD=9.8)	125.4 (SD=12.1)	37.1 (SD=2.0)	18.4 (SD=0.5)	18.9 (SD=0.7)	12.6 (SD=0.7)	18.9 (SD=1.6)	22.8 (SD=1.3)	16.0 (SD=1.3)	21.0 (SD=1.0)	9.5 (SD=0.6)
t - test**			t=0.75 p>0.20	t=0.14 p>0.20	t=3.83 p>0.01	t=7.55 p>0.001	t=3.96 p>0.01	t=5.55 p>0.001	t=3.96 p>0.01	t=3.00 p>0.01	t=5.60 p>0.001	t=0.87 p>0.20	t=1.63 p>0.10

* Sample sizes in parentheses (total specimens – total localities).

** Paired Student's *t-test* comparison of means for *A. kawalli* and *A. farinosa*.

palm *Orbygnia speciosa* is common, some reaching 18 m. Lianas and epiphyties are also common. This habitat is found mainly along the Rio Juruena.

Seasonally Inundated Evergreen Forest (Floodplain Forest) is an evergreen formation growing on quartzitic sand deposits along the rivers. This forest borders the rivers in bards up to 300 m wide. The canopy (20-25 m high) is usually continuous and dense, with a few more open patches. *Inga* sp. (Leguminosae), *Macrolobium acaecifolium*, *Pithecelobium racemosum* (Leguminosae), and *Tapirira guianensis* (Anarcadiaceae) are abundant. There are many microepiphytic species and lianas. This forest remains flooded from November to March or April.

Campinarana (Sand-ridge wood) is a community that grows on quartzite sandy soils not subject to flooding. It has a sparse ground cover, with 30-cm-high grass clumps, interspersed with bare soil. A dense cover of low trees, two-four m high, characterizes this formation. Trees reaching up to seven m are occasionally found. This formation is found mainly on the Serra dos Apiacás, the Sucundurí massif, and the Cachimbo massif.

Palm Forest is an almost monospecific formation entirely dominated by *Mauritia flexuosa* in wet soils, or by *Orbignya martinica* and *Oenocarpus bacaba* in dry soils. This formation occurs patchily amid other forest types.

Climate in the region is seasonal. The average annual precipitation is approximately 2,500-2,800 mm. The rainy season extends from November to March, with the peak in February with na average of 450-550 mm. During the wettest period, mean temperature ranges from 23°C to 26°C, and relative humidity from 90 to 95%. The dry season lasts from June to September, with less than 100 mm of rain per month. August is the driest month, with almost no precipitation. Differences in the levels of the rivers can be marked between the dry and rain season, with up to four m recorded from water marks on seasonally flooded forest trees (RADAMBRASIL 1975).

The distribution of Floodplain Forests along the Rio Tapajós and its tributaries correspond with the highest rainfall isolines on the southern Amazonian forests (2,500-2,800 mm) (RADAMBRASIL 1975, Uhl *et al.* 1990). From the middle Rio Aripuanã to the upper Rio Tapajós (Madeira-Tapajós center, Cracraft, 1985), the main Floodplain Forest areas occur south of the Amazon. Outside this isoline, rainfall is lower and semideciduous vegetational zones occur between the Tapajós-Xingu and Aripuanã-Madeira rivers. Indicative of this replacement, Mahogany *Sweitenia macrophilla* (Melliaceae) a typical species of semideciduous forests, occurs in isolines below 2,000 mm. (RADAMBRASIL 1975, Oliveira *et al.* 1993) and was not recorded by us at the headwaters of the Tapajós.

Group size and population densities. We made 86 sightings of *A. kawalli* in 32 field days (27 in the first expedition, three in the second and 56 in the third expedition), totaling 168 individual records. *A. kawalli* were in pairs or small flocks. Flock size in August ranged from one to eight, whereas in October-November ranged from two to six parrots. In March 1996, flock size ranged from one to two parrots. Differences among expeditions are due to the fact that activities in the second period were concentrated at the Rio Juruena valley, na area dominated by Semidecidous Forests, where the species does not occur (see below). We found *A. kawalli* in the Rio Juruena valley only near its junction with the Rio Tapajós, a transitional area between Semidecidous Forest and Terra Firme Forest (RADAMBRASIL 1975). During the March 1996 censuses the *A. kawalli* were breeding and seen only in pairs.

No *A. kawalli* was observed along 23 km of Campinarana transects neither along the seven km in Buritizal forest. Also, none was observed along 22 km through secondary vegetation and logged forest. In Semidecidous Forest along the Rio Juruena, we surveyed 140 km by boat, finding three parrots (0.3 ind/sq.-km). No *A. kawalli* were observed along 47 km of foot transects in the same area.

In 38 km surveyed in Terra Firme Forest, we found eight parrots (2.1/sq.-km). In 30 km of transitional habitats between Terra Firme and Floodplain Forests, we found 18 parrots (6.0/sq.-km). In the Floodplain Forest we walked 42 km, finding 74 parrots (17.6/sq.-km). We also rode 190 km by boat in the same habitat, finding 65 parrots (3.5/sq.-km).

In March 1996 we surveyed 395 km by boat from Itaituba to Feixo (Jacareacanga) along the Rio Tapajós dominated by Terra Firme Forest and Semidecidous Forest, no *A. kawalli* were observed.

The results on surveys along pasture and disturbed areas suggest that *A. kawalli* can not persist or breed in small forest fragments (see under Conservation).

Sympatric Psittacidae species. We recorded 18 species of Psittacidae in the range of *A. kawalli* (Martuscelli and Yamashita, *in prep*). The only other *Amazona* parrot in the region surveyed is the Orange-winged Parrot (*A. amazonica)*, but they do not roost with *A. kawalli* in the communal roosting trees along the Rio Teles Pires or Rio das Tropas. Other Psittacidae species found with *A. kawalli* are listed in table 2.

White-cheeked Parrot was also common in comparison to other Psittacidae of our study sites. Only three (*A. amazonica,* Vulturine Parrrot *Pionopsita vulturina,* and Golden-winged Parakeet *Brotogeris chrysopterus*) of the 18 other Psittacidae species in the Rio Tapajós headwaters were more abundant than *A. kawalli* during all observation periods (table 2). *Amazona kawalli* was the only conspicuous species restricted to Floodplain Forest habitat.

We found *A. farinosa* at four localities on the periphery of the range of *A. kawalli* (figure 2): 30 km from Itaituba, on the Itaituba-Transamazonica road; at Parque Nacional da Amazônia (Amazonia National Park), at Buburé Falls; and together with Yellow-headed Parrot *A. ochrocephala* at Alta Floresta, 100 km south of the Serra dos Apiacás; and in the southeastern foothills of the Cachimbo mountains, Pará.

Table 2. Species of Psittacidae sympatric with *Amazona kawalli* at the upper Rio Tapajós. DF-Dry Forest, TF- Terra Firme Forest, AF- Floodplain Forest, CA- Campinarana, PF- Palm Forest. N – total individuals observed of each specie

	Habitat					Total
Species	DF	TF	AF	CA	PF	(N)
Ara chloroptera Red-and-green Macaw	27%	48%	25%			56
Ara ararauna Blue-and-yellow Macaw	89%	8%			3%	75
Ara macao Scarlet Macaw	58%	42%				78
Ara severa Chestnut-fronted Macaw		70%	30%			113
Ara manilata Red-bellied Macaw					100%	112
Aratinga garouba Golden Parakeet		100%				5
Aratinga pertinax Brown-throated Parakeet	100%					45
Aratinga leucophtalmus White-eyed Parakeet		62%	38%			55
Pyrrhura rhodogaster Crimson-bellied Parakeet		100%				15
Pyrrhura picta Painted Parakeet	25%	75%				12
Forpus cf. *sclateri* Dusky-bellied Parrotlet	100%					2
Brotogeris chrysopterus Golden-winged Parakeet	17%	51%	14%	13%	5%	245
Pionites leucogaster White-bellied Parrot	20%	80%				5
Pionopsitta barrabandi Orange-cheeked Parrot		13%	87%			16
Pionopsitta vulturina Vulturine Parrot		44%	56%			176
Amazona kawalli White-cheeked Parrot	2%	14%	84%			166
Amazona amazonica Orange-winged Amazon	14%	30%	56%			459
Pionus menstrus Blue-headed Parrot	20%	47%	33%			115
Deroptyus accipitrinus Red Fan Parrrot		33%	67%			6

Literature and museum records of the Mealy Parrot from the region come from Parque Nacional da Amazônia on the Rio Tapajós, upstream from Buburé Falls, 50 km south of Itaituba (Forrester 1993, Oren and Parker *in press*) and from Caxiricatuba (02°50'S, 55°08'W) and Fordlândia (03°40'S, 55°30'W), both on the lower course of the Rio Tapajós, Pará (specimens housed at MZUSP and MPEG). Roth (1984) found *A. farinosa* on the upper Rio Aripuanã, Mato Grosso. Zimmer *et al.* (*in press*) also found *A. farinosa* and *A. ochrocephala* at Alta Floresta.

Diet and foraging behavior. We observed *A. kawalli* feeding on 10 plant species (N = 15 feeding bouts), all restricted to Floodplain Forest and its ecotone with Terra Firme Forest. Most records were seeds (60 %), pulp, fruits, leaves and flowers were also eaten in most instances (table 3).

On one occasion four *A. kawalli* were seen feeding on young leaves of the rubber tree *Hevea brasiliensis* along with eight Painted Parakeets *Pyrrhura picta*. This feeding aggregation was observed in the same spot during three consecutive days. In another instance in the mouth of the Rio das Tropas we observed *A. kawalli* and eight Painted Parakeets feeding on the flowers of *Erythrina* sp. A species with abundant nectar that also attracted other parrots species such as *B. chrysopterus* and *P. vulturina*. The parrots spent a half-hour picking one flower at a tine, chewing around its base, discarding it, and then repeating the process.

Amazona kawalli was never observed feeding near human dwellings, despite the availability of fruiting mango and jackfruit trees. The only Psittacidae observed in those areas were *B. chrysopterus* and Crimson-bellied Parakeet *Pyrrhura rhodogaster*.

We observed *A. kawalli* every day spent in flooded forest on headwaters of Tapajós river, usually flying in pairs or small family groups during early morning and afternoon, its "weeóu" flight call making it conspicuous. Like other *Amazona* (Whitney 1996), *A. kawalli* is noisy, and groups were usually first noticed by its calls. In February, when fledglings were present, their continuous begging was the best clue to located groups.

Amazona kawalli travel in small groups (often in pairs, rarely more than eight birds). Flying *A. kawalli* can be recognized in the field by its shallow wing beat, direct and slow flight. The pairs follow a tight parallel flight path, usually just above the canopy. This characteristic is clearly distinct from *A. amazonica* (the only sympatric *Amazona*), whose flight is rapid and sinuous, usually above the canopy like *Pionopsitta* (Whitney 1996).

Breeding biology. During the July-August and October-November expeditions we found no sign of breeding by *A. kawalli.* We found breeding activity signs of others species of Psittacidae in the headwaters of the Tapajós in early November 1995. On 2 November at the Rio Teles Pires, we observed a flock of 34 *P. vulturina* perched in a tree. Nine were being feeding by their parents and showed their heads colored by yellow, a typical plumage of this species' fledged young birds. On 10 November, we observed two *A. amazonica* searching cavities in Dry Forest along the Rio Juruena, and a pair of Red-and-green macaws *Ara*

Table 3. Species of plant eaten by *Amazona kawalli*. FF: Flooded Forest, TFF: "Terra Firme" Forest

Plant species	Parts eaten	n° feeding bouts	Habitat
Maximiliana maripa	Fruit and pulp	2	FF
Eichelera sp.	Seed	1	FF
Joanesia sp.	Seed	1	FF
Leguminosae *indet*	Seed	1	FF
Inga sp.	Pulp and seed	2	FF
Callophylum brasiliense	Pulp and seed	1	FF
Euterpe oleracea	Pulp	1	FF
Tapirira guianensis	Seed	1	FF
Hevea brasiliensis	Leave	4	TFF
Erytrina sp.	Flower	1	FF

chloroptera had na active nest in a dead *Bertholetia* tree. At Barra de São Manuel, Amazonas state, we found nestlings of *B. chrysopterus* and Blue-headed Parrot *Pionus menstrus* during the same season.

Courtship behavior of *A. kawalli* was observed at the Tropas river on 18 March 1996. At 09:00, after heavy rains, a presumed male (larger and vocalizing more actively) was observed on a 14-m tall legume tree, two m to the side of a small individual. The larger individual vocalized intensely in bouts of 10 sec duration, simultaneously raising its head feathers, opening its tail showing the red feathers, and keeping the wings half-opened. The other parrot seemed indifferent and fed on seed pods. The displaying bird repeated this behavior every two minutes, for a total of 20 min of observation. After that, it approached the female, raised and lowered its head rapidly, started to pick twigs with his bill, vocalized and dropped the twig, before picking another one and starting again to vocalize. The female then called with the male, both flying to the canopy soon after. During three days we observed presumed same pair *A. kawalli* in the same legume tree.

The first active, probably attended the same individuals, nest was discovered nearby on 15 March 1995. The nest hole was in a 10-m tall dead tree in floodplain forest two km upstream from mouth of the Rio das Tropas, near the bank. The hole was about eight m above the water. The nest was discovered at 07:30 due to intensive vocalization of the chicks. Two adults were perched nearby. As the boat goting closer to the nest tree, one parrot flew five m without any vocalization straight toward the nest, while the other one remained perched. With the arrival of the adult, the chicks increased their level noise. A few minutes later, the other parrot flew to the nest hole. At this moment, the chicks stopped calling and one adult emerged from the cavity and perched at its opening.

We found six more nests, all in Floodplain Forest during the wet season (December to April), when the rivers rise four-seven m above normal, flooding their banks. Nest heights ranges from 6.5 to 25 m, and cavity depths ranged from 1.3 to 3.5 m. Five nests were in dead trees, found throughout this seasonally flooded habitat. Only three nest trees could be identified: two *Ficus* sp. and one *Hevea* sp.

We examined 22 nestlings that ranged in age from two-three to 50-55 days old. The youngest nestlings had a dull, creamy white bill. At age 10-15 days, a dark patch appears on the sides of the upper bill, stretching from the nostrils to the bill tip. At age 50-55 days, the patch has grown to cover most of the upper bill, similar to the pattern observed in adult birds, which have na even darker and more extensive patch, except for a lateral area between the tooth and the base of the bill, which remains dull creamy white. The white skin patch at the base of the mandible is already evident in nestling two-three days-old, being more wrinkled and tougher than the surrounding skin. The tongue is pale pink with a black tip, a character also observed in adults. The eye-ring is quite evident by 10-15 days of age, showing a dark gray color also observed in adults. At this age the iris is already red. Also, at this age, chicks show a loral patch densely covered by dark bristles, forming a well-marked area, obvious in the adults. Older nestlings, at 50-55 days, show plumage similar to the adults, with the bases of the outer tail feathers red and no of red at the wing bend. The cere on the fledging is exposed, but becomes partly covered with green feathers with age.

The number of fledged young was estimated during July-August and March 1996. In July–August 14 out of 27 contacts with *A. kawalli* were of pairs followed by young. Eight pairs were observed with one young, five pairs with two young and one pair with three young. During the following period five out of 56 contacts were of pairs with young, four pairs were observed with one young and one pair with two young. During this period most nests were still active with nestlings.

Vocalizations. Like other *Amazona* (Vielliard 1994), *A. kawalli* has a vocal repertoire that includes a stereotyped and loud "flight call" and a large diversity of varied calls. We follow Vielliard (1994) in considering the *Amazona* "flight call", which can be given also when perched, as the acoustic communication signal serving the species-specific recognition function, equivalent to the advertising song of territorial Passerines.

The flight call sounds like "weeóu" and is made of a single complex note (figure2). The first half of this note is a pure whistle; its frequency rises quickly, and then stabilizes at about 1.6-1.8 kHz. In the second half, seems to be a "double-voice phenomenon" (Greenewalt 1968) in the form of two harmonically unrelated pure whistles: one frequency continues around 1.8 kHz, whereas the other rises up to ca. 2.4 kHz, and then joins the first one in a sharp decrease to c. 1.0 kHz, where they diverge again, one continuing at around 1.0 kHz, the other decreasing to *ca.* 0.6 kHz. This complex structure gives a lower tone and a peculiar timbre to the end of the note. The total duration is about 0.4 s (figure 3 A).

This sound structure has been compared by Vielliard (pers. comm) with the "flight calls" of eight other *Amazon* taxa in the "Arquivo Sonoro Neotropical" (ASN *in* Kettle 1989). Mealy Parrot, Turquoise-fronted Parrrot *A. aestiva,* Orange-winged Parrot, Red-crowned Parrot *A. rhodocorytha,* Vinaceus-breasted Parrot *A. vinacea,* Yellow-faced Parrot *A. xanthops,* Red-tailed Parrot *A. brasiliensis,* and Red-spectacled Parrot *A. pretrei* were discussed by Vielliard (1994). Although this is only a fraction of the species in the genus, it allows us to examined the distinctiveness of *A. kawalli* and to predict its taxonomic relationships because the comparison is being made among homologous species-specific sounds (Vielliard 1995).

The flight call (ASN from Serra do Navio, Amapá state) of *A. farinosa,* the nearest morphological relative of *A. kawalli,* is a composite note with a softly modulated harmonic structure (figure 1 B), different from that of *A. kawalli.* Mealy Parrot appears to form a natural group with *A. rhodocorytha* (but not *A. brasiliensis*), *A. aestiva,* and *A. vinacea* (Vielliard 1994). It is clear at least by call-note structure, that *A. kawalli* does not belong to this species-group. By the unique structure of its double voice, it differs

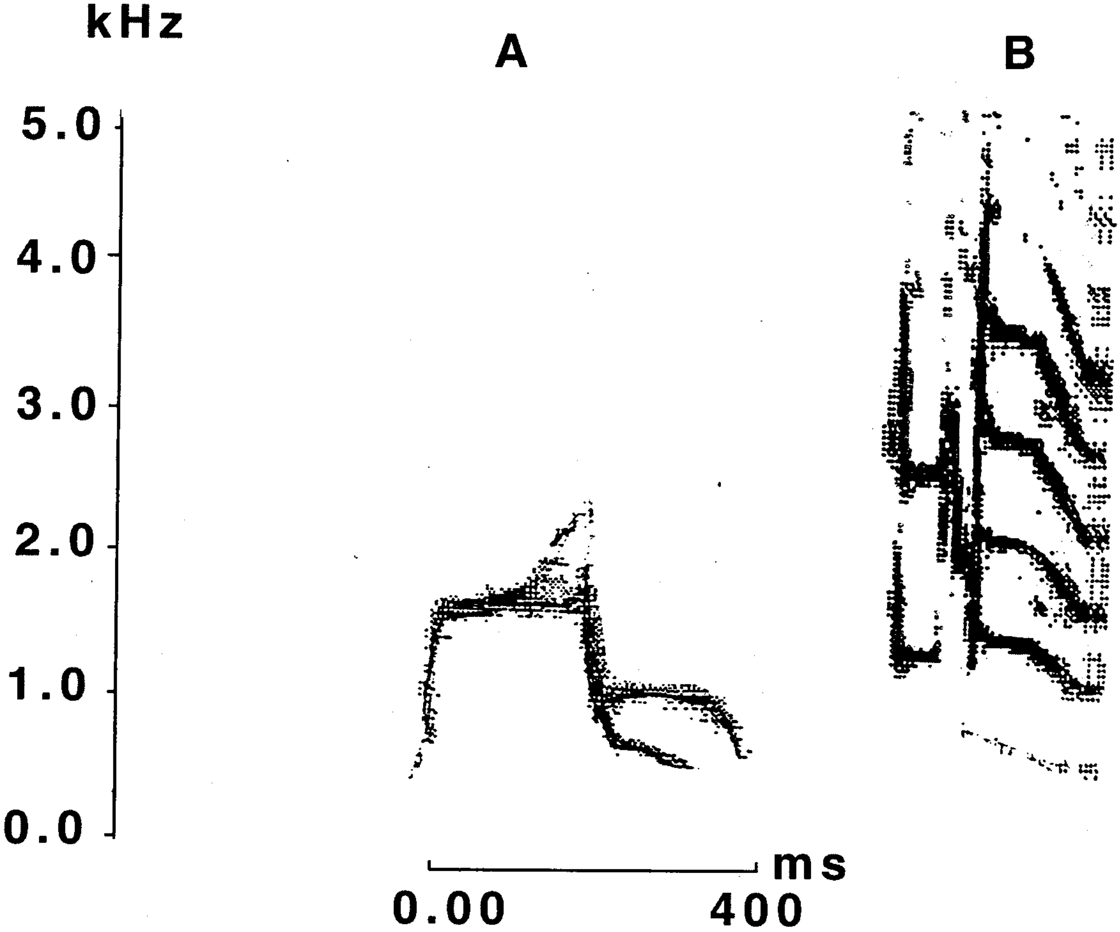

Figure 2. Sonograms of the "flight calls" of: A) *Amazona kawalli* (Rio das Tropas, Pará, Brazil, in ASN) (redrawn from original recording to eliminate reverberation and back ground noise); B) *A. farinosa* (Serra do Navio, Amapá, Brazil, in ASN). Our analysis is based on a long sequence we recorded on 29 November 1995 of a group of two perched birds. In this recording, we selected only the few "flight calls" that we had previously recognized by ear.

from all other *Amazona* studied by Vielliard (1994), and its relationships remain undetermined (Vielliard pers. comm.).

Karyology. Karyotypic analyses has demonstrated a strong similarity among various species of the *Amazona* genus, suggesting great chromosomic conservation in this group (Lucca *et al.* 1991, Duarte and Caparroz 1995).

Cytotaxonomic analysis of Brazilian species of the genus *Amazona* made by Duarte and Caparroz (1995) showed a great similarity of karyotype structure observed among 11 species analyzed (*A. kawalli, A. farinosa, A. aestiva, A. amazonica, A. brasiliensis, A. autumnalis, A. festiva, A. ochrocephala, A. pretrei, A rodocorytha, A vinacea*). A few divergent characteristics in chromosomes two and three among these 11 species led to the spliting of these species in two groups. Chromosome pair three is subtelocentric in *A. kawalli, A aestiva, A. amazonica, A. brasiliensis,* and *A. rodocorytha* and submetacentric in *A. farinosa, A. festiva, A. ochrocephala,* and *A. vinacea.*

Although the karyotypic analysis has demonstrated strong similarity among various species of the *Amazona* genus, the slight differences found by Duarte and Caparroz (1995) between *A. kawalli* and *A. farinosa* is further evidence for treat these two *Amazona* as separate species.

Patterns of plumage and individual variation. During the course of assessment of the relationship of *A. kawalli* with *A. farinosa,* we critically examined all specimens of *A. farinosa* and *A. kawalli* (including the MZUSP 2727 holotype and MZUSP 3478 and RG 7577 paratypes) in Brazilian museums except for the specimens housed at the Museu Nacional (table 1). We found that *A. kawalli* differs significantly from *A. farinosa* in five bill measurements. The most striking result of the analyses of the measurements is the clear-cut separation of *A. kawalli* (at significance level of $p < 0.001$) from *A. farinosa* in culmen length, width of the upper mandible, height of the upper mandible, tip of the bill to tooth length, and distance from tooth to base of the lower mandible (table 1). In general, the bill of *A. kawalli* is disproportionately smaller than that of *A. farinosa*. It also has more heavily keratinized lateral patches on the upper bill. This keratinized area is seen as a thick "plate" with multi-layered defoliating, irregular edges covering the pale patch of the parrot's upper bill. This character is easily observed in both wild and captive adult birds.

We carefully observed 19 different pairs of *A. kawalli* at their nests or flying with their young during the breeding season. One member, probably the male, was always larger. We think that the larger birds are males because we observed a large bird courting a smaller one (see above) and because during observations of pairs, he larger bird spend more time outside the nest, calling, while the smaller one stayed in the nest hole. This sex-related size difference, nevertheless, could not be confirmed from museum specimens. It was not possible to separate *A. kawalli* from *A. farinosa* using tail and wing measurements (table 1). Although captive adults of *A. kawalli* are noticeably larger than *A. farinosa* (pers. obs.), measurements failed to show this in our sample, probably because of its small size.

The most obvious differences between *A. kawalli* and *A. farinosa*, however, lie in plumage patterns and coloration (figure 1): 1- *A. farinosa* of any described subspecies always shows a complete and large white bare eye-ring, whereas *A. kawalli* shows a gray and smaller eye-ring. The eye-ring is already present in nestling *A. kawalli*, but absent from young *A. farinosa* (Whitney 1996); 2- *A. kawalli* has a well developed bristly loral patch reaching the nostrils, whereas only a few *A. farinosa* have scattered bristles. This bristly patch give the face a blackish color, even in nestlings (see Breeding biology); 3- the tongue of *A. kawalli* is light pink with a black tip, whereas that of *A. farinosa* is entirely black; 4- *A. kawalli* is, so far, unique among *Amazona* parrots, in having a bare skin patch at the base of the mandible; 5- The bill of *A. kawalli* (smaller than in *farinosa*) is dark gray with a lateral, dull creamy- white patch, more heavily keratinized, absent from entirely smooth bill of *A. farinosa*; 6- The lateral rectrices of *A. kawalli* are basally red (and displayed by the male when courting the female), a character absent in *A. farinosa*, which belongs to the parrots with no red in their tails (Salvadori 1891, Forshaw 1989, Hoppe 1992); 7- the edge of folded wing is light yellowish-green without the red of *A. farinosa*; 8- general color plumage in *A. kawalli* is brighter than in *farinosa* in live birds, with na emerald hue.

We examined 78 captive *A. kawalli* in its range, most being young one-two years old. Because of the conditions in which they were kept, which probably resulted in abnormal growth patterns, their measurements were not used in this paper. All, nevertheless, showed the same plumage colors and patterns, with the lateral rectrices being basally red, a green wing-bend, a gray eye-ring, red iris, a white skin patch at the base of the mandible, a pale pink tongue with a black tip, and a bristly loral patch. All those characters were constant in the captive individuals, showing no variation.

All *A. kawalli* observed had red on the base of tail, regardless of age (fledglings to adults). Thus, this character shows no ontogenetic change, as pointed by Pinto and Camargo (1954). Also, all other Brazilian *Amazona* species, such as *A. brasiliensis, A aestiva, A. amazonica, A. ochrocephala,* and others, which have the base of tail tinged with red, have this character constant at fledging, and it does not change with age (pers. obs.). Our observations agree with those of Salvadori (1891) that *A. farinosa* does not have red on the base of tail (*contra* Teixeira pers. comm., 1993).

In the wild, when perched in the canopy, the most conspicuous character of *A. farinosa* is the white eye-ring, whereas the most important one of *A. kawalli* is the white patch at the base of the mandible. Perhaps these characters are used by the birds for species recognition. Also, the distinctive contact call, different from any other *Amazona*, is another strong character separating *A. kawalli* from other species.

These constant quantitative and qualitative differences lead us to conclude that *A. kawalli* is a valid species, not na aberrant *A. farinosa* (contra Bosch 1991, Teixeira pers. comm., 1993, Parker *et al.* 1996). The observed levels of difference are consistent with species-level differences in the Psittacidae (Salvadori 1891, Smith 1975) and support that *A. kawalli* is a full species, somewhat similar to, but distinct from *A. farinosa.*

Museum specimens of *A. kawalli* lose their characteristics of tongue, eye-ring and, sometimes, mandibular skin patch due to skin preparation, although feather colors remain unchanged. Due to these factors, specimens of *A. kawalli* in several museums (MZUSP, MN, MPEG, ZMB, BMNH) were pooled with the similar *A. farinosa*, which, nevertheless, lack all the above characters (N. Kawall, pers. comm.).

Of the seven examined museum specimens of the *A. kawalli*, RAF 1331 shows two central rectrices without the terminal part of the rachis. The type of *A. farinosa* aberr. *rubricauda* (ZMB 23.160) shows 14 rectrizes (Stresemann 1924). Of 78 young individuals of the *A. kawalli* observed (see Introduction), three also had 14 rectrices, one had central rectrizes without raquis on its terminal portion, and three had deformed toes with joined bases, probably a congenital problem.

Taxonomy. Stresemann (1924) described the *Amazona farinosa* aberratio *rubricauda* based on a specimen housed at the Zoological Museum in Berlin (ZMB 23160), which lived at the Berlin Zoo from June 1910 to September 1923. Stresemann noticed that the Berlin specimen had some reddish tail feathers, but he considered this characteristic as a mutation. After Stresemann (1924), Teixeira (pers. comm., 1993) was the first author to consider the name "*rubricauda*" and did not recognize it as a species (see Introduction).

We examined a photograph of the Berlin specimen (ZMB 23160) used by Stresemann (1924) in his description. Based on the photograph and original description, we concluded that *A. farinosa* aberratio *rubricauda* is the same taxon as *A. kawalli* described by Grantsau and Camargo (1989). The Berlin specimen shows clearly a bare skin patch at the base of the mandible, gray eye-ring and basally red lateral rectrices. Despite the brief description, Stresemann's taxon can be easily recognized from the description, as signaled by the name itself note. No other *Amazona* similar in size to *A. farinosa* has red on the tail.

Apart from the Caribbean *Amazona* sp., *A. farinosa* is the only *Amazona* that is up to 38 cm in lenght and up to 600 g in weight. *Amazona* species that show red on their tail, such as *A. amazonica*, *A. ochrocephala*, Scaly-naped Parrot *A. mercenaria*, and *A. brasiliensis*, are smaller than *A. farinosa* (Forshaw 1989, Arndt 1991, Low 1992).

Collar and Pittiman (1996) shows some evidence that *kawalli* must prevail over *rubricauda*, based his conclusion in the International Code of Zoological Nomenclature.

The International Code of Zoological Nomenclature (1985) is not clear with regard to the usage of *rubricauda*, a name that has not been used in the last 50 years, which is a *nomen oblitum*. Nowadays there is a strong trend to consider the *nomen oblitum*, especially the descriptions made before the Nomenclature Code. In our opinion, if *rubricauda* is referable to *kawalli* Grantsau and Camargo (1989), then we suspect that *rubricauda* should be used. If *rubricauda* is valid, and so takes precedence over *kawalli* is a question beyond our scope and better solved by the International Committee of Zoological Nomenclature.

Since the redescription of *A. kawalli* by Grantsau and Camargo (1989), the English name "Kawall's Amazon" (Papagaio de Kawall) has been widely applied (Arndt 1991, Low 1992), regarding to Nelson Kawall's discovery (see Introduction). Sick (1997) applied the name "Papagaio dos Garbes", following Willis and Oniki (1991), in honor of its first collector, E. Garbe (Ihering 1904). Currently, to use a person's name to in the common name of a new species is being avoided by researchers, with morphological and geographical attributes more frequently used. In the headwaters of Rio Tapajós, local people call *A. kawalli* "Papagaio da Cara Branca", meaning "White-cheeked Parrot" (the common name adopted in this paper). The Mundurucú Indians have a specific name for *A. kawalli* as "Puruché" and a generic one "Arú" (Indian language), used for all species of parrots.

Type locality and range. Stresemann (1924) stated that the type specimen of *A. farinosa* aberr. *rubricauda* (ZMB 23160) was a captive bird of unknown origin. Grantsau and Camargo (1989) considered the type locality of *A. kawalli* to be Seringal (rubber plantation) Mato-Piri, by the Rio Juruá close to the city of Eirunepé, Amazonas state, based on the MZUSP specimens and the description of the itinerary of E. Garbe in Ihering (1904). Grantsau and Camargo (1989) also used information from wildlife traders to describe "100 km south of Santarém, on the right bank of the Rio Tapajós" as the locality of one of the paratypes of *A. kawalli* (RG 7577).

During the last 20 years, most *A. kawalli* that appeared in the pet trade came from the bush pilot, Mr. Viê, who lived at Itaituba city, Pará state, but also kept a home at Santarém, both on the southern bank of the Rio Tapajós. Mr. Viê is still remembered by many bird collectors, mostly Indians, throughout the range of *A. kawalli,* where he both transported gold miners and bought live animals to resell. That explains some of the known specimens (like RG 7577) reportedly coming from Santarém or Itaituba, the towns where the dealer operated.

The region of Santarém is relatively well-known to ornithologists (Snethlage 1908, 1914, Pinto 1978, Oren and Parker *in press*), *A. kawalli* being recorded only a few hundred kilometers south of the town (see Distribution and Habitat). Besides the specimen at the MPEG, it has never been recorded at Itaituba or Parque Nacional da Amazônia. Oren and Parker (*in press*) published an annotated list of the birds of the Parque Nacional da Amazônia, based on observations made in the area and over 2,000 specimens collected there and at Itaituba since the beginning of the century. The only *Amazona* recorded by Oren and Parker (*in press*) in the region were *A. amazonica*, *A. ochrocephala*, and *A. farinosa*.

Aparently the probable *A. kawalli* records error from Santarém by Forrester (1993), Collar and Pittman (1996), that considering it "accidental, with no more than two records since 1960 and hence involves predominantly migrant birds", comes from Grantsau and Camargo (1989) records.

Itaituba is a river port serving boats coming to and from the upper Rio Tapajós. Its airport is also used by small planes coming from gold-prospecting camps at the same area. This town has a FUNAI (National Foundation of Brazilian Indians) office. In this area about 40 Mundurucu Indians live. Many *A. kawalli* are kept as pets in the town (we located 36 in one visit), being brought there by Munducuru Indians trading the birds or by gold prospectors.

Examining the MPEG *A. kawalli* specimen we found it to be a young bird, as determined by the lack of the keratinized patch at the sides of the bill. That, and the lack of other records of *A. kawalli* from around the town, led us to conclude that the specimen was a former captive.

Fernando Pacheco (pers. comm., Sick 1997) recorded the species five km south of Tefé, southern bank of the Rio Amazonas (figure 2), observing and tape-recording the calls of two individuals. His recordings are virtually identical to ours. Interestingly, Pacheco (1995) found four sympatric *Amazona* (*A. festiva*, *A. farinosa*, *A. amazonica*, and *A. autumnalis*) at Estação Ecológica Mamirauá (Mamiruá Ecological Station), on the northern bank of the Rio Amazonas, only 10 km from where the Tefé record was made. That Mamirauá is one of the largest expanses of Floodplain Forest in the Amazon Basin suggests that habitat is not limiting the occurrence of *A. kawalli* there. Perhaps the southern bank of the Amazonas river is the northern limit of its distribution.

According to F. Pacheco and P. Auricchio (pers. comm., and photographs), *A. kawalli* is found as pets at Tefé, reportedly being captured as nestlings at the mouth of the Rio Juruá, about 300 km downriver from the type locality. Other than Garbe's specimens (Ihering 1904), no *A. kawalli* was recorded at Rio Juruá, despite several surveys carried in this river (Gyldenstope 1945, B. M. Whitney, D. C. Oren and K. S. Brown pers. comm.).

There is one old record of *A. kawalli* from Rio Castanho. During the Roosevelt-Rondon Expedition, one specimen of *A. kawalli* was collected at the mouth of the Rio Castanho on 22 March, 1914. This specimen, housed at Museu Nacional, was identified as *A. farinosa*, and clearly shows the red base of its tail feathers and white skin patch at the base of the bird's mandible (E. O. Willis pers. comm.). According to Naumburg (1930) and Vanzolini (1992), Rio Castanho is a name used by rubber gatherers which reffers to the Rio Roosevelt (07°35'S, 60°20'W).

The Museu Nacional specimen apparently was ignored or overlooked during the description of the birds secured by the Roosevelt-Rondon Expedition and studied by Naumburg (1930). In number 833 of his checklist, Naumburg (1930) pointed: *A. farinosa farinosa*... no specimens were collected. Miranda Ribeiro and Soares (1920), also ignored the MN specimen during the description of the Psittacidae collected by Expedição Rondon in 1908-1916.

Aparently the probable *A. kawalli* record from Rio Castanho (see Introduction) cited by Miranda Ribeiro (1920) is based on the MN specimem and not on a wild observation. According to the itinerary of Roosevelt-Rondon Expedition (Museu Nacional 1943) while Miranda Ribeiro took part (from March 1909 to December 1910), the expedition did not reach Rio Castanho.

There is no record of the *A. kawalli* south of the Serra dos Apiacás (figure 2). Novaes (1976) and Roth (1984) at the Rio Aripuanã, Zimmer *et al.* (*in press*) at Alta Floresta, Novaes and Lima (1991) at the Rio Peixoto de Azevedo, and Pinto and Camargo (1957) at Serra do Cachimbo, found only *A. farinosa*, *A. amazonica*, and *A. ochrocephala*. The Serra dos Apiacás also acts as a limit between subspecies of the Painted Parekeet *Pyrrhura picta* complex. *Pyrrhura picta amazonun* occurrs in the headwaters of the Rio Tapajós in sympatry of *A. kawalli*, where as *P. picta microtera* is found at Alta Floresta, Mato Grosso state, about de 250 km away (Martuscelli and Yamashita, unpubl. data.). This suggests that the Serra dos Apiacás, covered by savanna and campinarana vegetation, is a natural ecological barrier limiting the southmost distribution of *A. kawalli*. The reasons for the distinctness of the avifauna of river-created habitats are probably both ecological and historical. One ecological factor is the enormous difference in habitat structure between terra firme forest and all river-created habitats (Remsen and Parker 1983)

Amazona kawalli and *A. farinosa* are similar size. That they have never been observed in the same areas suggests habitat segregation. *Amazona farinosa* is a typical Terra Firme species (Remsen and Parker 1983, Roth 1984, Forshaw 1989, pers. obs.). During the last years, of the nine nests of *A. farinosa* we found in Rondônia, Amazonas, and São Paulo states, all were in terra firme forest (pers. obs.), whereas *A. kawalli* nests in flooded forest. *Amazona festiva* and *A. brasiliensis* are the only species besides *A. kawalli* to nest in hollow trees over water and preferring flooded forest as breeding habitat (Forshaw 1989, Arndt 1991, Martuscelli 1995, pers. obs.).

One must consider that the distribution of floodplain forest along the Rio Tapajós headwaters is not continuous, with large gaps, the above being a maximum value (see distribution). During our field work at the Tapajós headwaters, we found many species restricted to river-created habitat (Remsen and Parker 1983), such as Amazonian Umbrellabird *Cephalopterus ornatus*, Bare-necked Fruitcrow *Gymnoderus foetidus*, Slate-colored Hawk *Leucopternis shistacea* and Long-billed Woodcreeper *Nasica longirostris*. The caiman lizard *Crocodilurus lacertinus*, which extended its distribution more than 600 km. Two new taxa of marmosets (*Callithrix* *mauesi* and *C. saterei*) have been described during recent years from the Rio Aripuanã-Tapajós area. This region has the greatest diversity of Callithrichidae in the Amazonian region. The river-created habitat restricted to the Middle Rio Aripuanã - Upper Rio Tapajós, surrounded by upland forest, have the structural habitat complexity with many lianas and epiphytes that can explain this high richness of marmosets (Rylands *et al.* 1993), and this region is also home for *A. kawalli.*

Conservation. Several factors have negatively influenced the population of *A. kawalli.* Hunting and trade are the most immediate threat to its survival. We found signs of human perturbation in every locality visited. These ranged from obvious signs of logging, gold-mining, and slash-and-burn agriculture to the absence of *A. kawalli* from areas of seemingly suitable habitat near settlements and Indian villages. We suspect that this absence to be due to hunting pressure both by indians and gold-prospectors.

Local people consider large macaws (Scarlet Macaw *Ara macao*, *A. chloroptera,* and Blue-and-yellow Macaw *A. ararauna*) and large *Amazona* (*A. kawalli*) to be preferred game, second only to the cracids. The meat of *A. kawalli* is considered tastier and more palatable than macaw meat. Hunting has severely depleted the populations of the larger parrots which are now abundant only far from settlements. Areas used by indians or gold-miner as camps years ago still have very small or no macaw and *A. kawalli* populations. Local indians, who depend partly on hunting for their subsistence, use firearms, enabling them to have, together with gold-miners, a heavy impact on the *Amazona* and *Ara* populations. Depletion of Psittacidae populations by subsistence hunters has been also reported by Thomsen and Brautigan (1991).

Local people also have a strong tradition of keeping *Amazona* parrots as pets. During the last expedition to the area, we saw 150 nestlings of *A. kawalli* being offered for sale, mostly supplied by indians. Nest trees are usually felled, resulting in the destruction of nesting areas and often killing nestlings. The mortality of young parrots kept as pets is very high. During this study we found no pet *A. kawalli* older than two years. Because the total population of the species is probaby small, such commerce must be considered a serious threat to it.

Others threats include gold and tin mining which destroys large areas of *A. kawalli* habitat. On 1960, 30 km upper the mouth of the Rio das Tropas, a place named Maloquinha was colonized by tin miners, in Pará State, and now represents one of the biggest Cassiterit bed in the Brazilian Amazon (Santos 1981). Because tin mining totally destroys a river's border, it effects flooded forest downstream, the main habitat of *A. kawalli.*

For the 1980's 50,000 km² on the Medium Rio Tapajós, corresponding to the "Auriferous Province of Medium Tapajós River", was known to be the largest Brazil gold mining region (Santos 1981). The number of miners believed to live and work there was about 35,000. Until now almost all of the region's rivers (mainly Rio das Tropas and Rio Creporí, see Distribution) have been dredged, and extensive forests along the rivers' courses destroyed by mining. This also happened in the headwaters of the Rio Tapajos, the Rio Juruena, the Rio Teles Pires and Rio Cururú, where about 10,000 miners lived (Santos 1981).

If is unlikely that *A. kawalli* will receive protection soor. Agricultural settlements and hydroelectric projects are being planned in its remain habitat. Between the Rio Teles Pires and the Rio Cururú in Pará state, 150,000 ha are being planned to serve as an agricultural settlement.

Three dams along the Rio Tapajós (at Buburé Falls, Feixo, and mouth of the Rio Cururú) and another at the lower course of the Teles Pires are planned (CEDI 1996). These projects will flood a huge area and will change the hydrological patterns of the river, which will destroy an estimated 90 % of the total extent of habitat of *A. kawalli* on the upper Rio Tapajós. Alteration of seasonal water flow patterns that would destroy these habitats could potentially exterminate 64 species of Amazonian river-created habitat specialists (Remsen and Parker 1986).

The known extent of the habitat used by *A. kawalli*, based on the distribution of Floodplain Forest, stretches for 910 km along the lower Rio Teles Pires, Rio Juruena and headwaters of Rio Tapajós and its tributaries. For the Tapajós basin, the Floodplain Forest forms a belt of variable width, averaging 150 m. Based on available maps (RADAMBRASIL 1975) and satellite imagery (Landsat, figure 4), there is at most 136,500 ha of Floodplain Forest in the region. The areas occupied by the species on the southern bank of the Rio Amazonas, at the Rio Juruá and the Rio Roosevelt remain to be surveyed. According to RADAMBRASIL (1975) floodplain forests along the Rio Sucunduri and Rio Abacaxis in Amazonas state are extensive, these being potential sites for the species.

The only protected area where *A. kawalli* occurs is the 110,000-ha Apiacás Ecological Station, at the confluence of the Rio Teles Pires and Rio Juruena. This small reserve is, nevertheless, still a "paper park" waiting to be implemented.

About 60 % of the known range of the *A. kawalli* is in Munducurú indian reservation at Pará state. The total Munducurú population is a 5,617 people (CEDI 1996, FUNAI pers. comm.). Considering their hunting activities and their hole on regional trade of living animals, these reservation offers no assurance of protection for the species.

The headwaters of the Rio Tapajós are a "corner" of distribution on many bird species and one of the least-know region in the Amazon (Oren and Albuquerque 1991, Haffer 1992, Oren 1992). Surveys of the Amazonian Forest have been conducted mostly along the main river systems. Only after the 1970's have a few roads like the Transamazônica and the Cuiabá-Santarém highways crossed large portions of Highland or "Terra Firme" forest making accessible the tributaries with poor navigational possibilities and may rapids and waterfalls. Several endemic taxa such as Golden-crowned Manakin *Pipra vilasboasi*

Figure 3. LANDSAT 1994 satellite imagery of Upper Rio Tapajós, Amazon basin, Brazil, showing the extend of *Amazona kawalli* habitat. The arrows shows the meandering course of the Rio Cururú, a typical floodplain river. The dark gray is upland forest "Terra Firme" and Dry Forest. The white color represented Campinarana and bare sands areas.

and Tapajós Brown-throated Parakeet *Aratinga pertinax paraense,* are restrict to the headwaters of Rio Tapajós and Rio Cururú (Sick 1959a, 1959b, Haffer 1992). Except for Sick's bird collection, made in the 1950's, little information about these species is available. Recent ornithological surveys of Floodplain Forest in Rio Tapajós headwaters revelated the existence of 352 bird species (Martuscelli, unpubl. data). Poorly know Amazonian species such as Golden Parakeet *Aratinga guarouba*, White-browed Hawk *Leucopternis kuhli*, Crested Eagle *Morphnus guianensis*, White-tailed Cotinga *Xipholena lamellipenis*, and Amazonian Umbrellabird *Cephalopterus ornatus* were recorded in this region.

From the available knowledge, *A. kawalli* can be considered, at least, a vulnerable species (IUCN 1994), perhaps even qualifying for endangered status, depending on the status of populations probably occurring between the Rio Roosevelt-Rio Tapajós and Rio Juruá. Further pressure on this species such as increased international traffic caused by the bird becoming popular in aviculture, as happened with other *Amazona* species, may add to this species' problems in the near future if effective measures are not taken to protect the wild populations and to avoid smuggling from Brazil.

ACKNOWLEDGMENTS

We are extremely grateful to Fundação O Boticário de Proteção a Natureza and Fundação Estadual do Meio Ambiente do Estado do Mato Grosso (FEMA) for providing financial support and field assistance for the three expeditions. Special thanks to M. Milanelo for her patience, and to G. Borges and R. Silva e Silva for their help and friendship during fieldwork. Dr. J. Vielliard provided the sonographic analysis of our recordings, and helped with its interpretation and comparison. Drs. N. Papavero and U. Martins de Souza helped with the Code of Zoological Nomenclature. We thank N. Kawall, E. O Willis, R. Antonelli Filho, F. Pacheco, and P. Auricchio for useful data. We also thank the following people and institutions for allowing us to examine their specimens: H. Camargo, Museu de Zoologia da Universidade de São Paulo (MZUSP). The Roberto Antonelli Filho collection (RAF); D. Oren, Museu Paraense Emílio Goeldi (MPEG); and the Rolf Grantsau collection (RG). F. Olmos, E. O. Willis, J. W. Wiley and J.V. Remsen made the final revision on the manuscript.

REFERENCES

Arndt, T. (1991) *Lexicon of Parrots*. Bretten: Arndt-Verlag.

Bosch, K. (1991) Eine neue Amazonenart? *Haltung und Zucht, Gefied. Welt* 115:190-191.

___ and U. Wedde (1984) *Encyclopedia of Amazon Parrots*. New Jersey: T. F. H. Publications.

CEDI (1996) *Povos Indígenas no Brasil*. 1991/1995. São Paulo: Instituto Socioambiental.

Cracraft. J. (1985) Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemism, p. 49-84. *In*: P. A. Buckley, M. S. Foster, E. S. Morton, R. S. Ridgely and F. G. Buckley (eds.) *Neotropical Ornithology*. Washington: American Ornithologist's Union (Ornithological Monographs 36).

Collar, N. J. and A. J. Pittman (1996) *Amazona kawalli* is a valid name for a valid species. *Bull. Brit. Orn. Club* 116:256-265.

Duarte, J. M. B. and R. Caparroz (1995) Cytotaxonomic analysis of Brazilian species of the genus *Amazona* (Psittacidae, Aves) and confirmation of the genus *Salvatoria* (Ribeiro, 1920). *Braz. J. Gen.* 18:623-628.

Forrester, B. C. (1993) *Birding Brazil. A Check-list and site Guide*. Scotland: John Geddes.

Forshaw, J. M. (1989) *Parrots of the World*. Third edition.

London: Blandford Press.

Grantsau, R. and H. F. A. Camargo (1989) Nova espécie de *Amazona* (Aves, Psittacidae). *Rev. Brasil. Biol.* 49:1017-1020.

___ and __ (1990) Eine neue Papageienart aus Brasilien, *Amazona kawalli* (Aves, Psittacidae). *Trochilus* 11:103-108.

Greenewalt, C. H. (1968) *Bird song: acoustics and physiology*. Washington: Smithsonian Inst. Press.

Gyldenstolpe, N. (1945) The bird fauna of Rio Juruá in western Brazil. *Kungl. Svenska Veyeenskapsakad. Handl.* 22:3.

Haffer, J. (1992) On the "River Effect" in some forest birds of Southern Amazonia. *Bol. Mus. Para. Emílio Goeldi, sér. Zool.* 8:217-245.

Hoppe, D. (1992) *The World of Amazon Parrots*. New Jersey: T. F. H. Publ.

Ihering, H. (1904) O Rio Juruá. *Rev. Mus. Paulista* 6:385-460.

___ and R. Ihering (1907) *As aves do Brasil. Catálogos da Fauna Brasileira*. São Paulo: Diário Oficial de São Paulo. XXXVIII + 458 p. *International Code of Zoological Nomenclature* (1985) Third Ed. California. Univ. California Press.

IUCN (1994) *IUCN Red List Categories*. Switzerland: Gland Publisher.

Kettle, R (1989) Major wildlife sound libraries. *Bioacoustics* 2:171-176.

Low, R. (1990) New species of Amazon parrot described. *Avic. Magazine* 96:190-191

___ (1992) *Parrots in aviculture: a photo reference guide*. London: Blandford.

Lucca, E. J., L. R. Shirley and C. Lanier (1991) Karyotype studies in twenty-two species of parrots (Psittaciformes - Aves). *Braz. J. Gen.* 14:73-98.

Martuscelli, P. (1995) Ecology and conservation of Red-tailed Amazon *Amazona brasiliensis* in south-eastern Brazil. *Bird Conserv.Intern.* 5:405-420.

Meyer de Schauensee, R. (1970) *A Guide to the Birds of South America*. Philadelphia: Acad. Nat. Sc. Philadelphia.

Miranda Ribeiro, A. (1920) Revisão dos psitacídeos brasileiros. *Rev. Mus. Paulista* XII :58.

___ and E. Soares (1920) Os psittacídeos da Commissão Rondon. *Publ. Comm. Linhas Telegr. Estrat. Matto-Grosso ao Amazonas.* Anexo 63. 5:6-14.

Museu Nacional. (1943) Alípio Miranda Ribeiro. Necrológico. *Arq. Mus. Nac.* 37:11-49.

Naumburg, E..M..B. (1930) The birds of the Matto Grosso, Brasil. *Bull. Am. Mus. Nat. Hist.* V. 60.

Novaes, F. C. (1976) As aves do Rio Aripuanã, estado do Mato Grosso. *Acta Amaz.* 6:61-85.

___ and M. F. C. Lima (1991) As aves do Rio Peixoto de Azevedo, Mato Grosso, Brasil. *Rev. Bras. Zool.* 7:351-381.

Oren, D. C. (1992) Conservação da natureza na Amazônia brasileira: uma orientação sobre prioridades baseada em aves. *Bol. Mus. Para. Emílio Goeldi, sér. Zool.* 8:259-268.

___ and H.G. Albuquerque (1991) Priority areas for new avian Collections in Brazilian Amazonia. *Goeldiana Zool.* 6:1-11.

___ and T.A. III Parker (*in press*). Avifauna of the Tapajós National Park and Vicinity, Amazonian, Brazil. *Neotrop. Orn.*

Pacheco, J. F. (1995) Os Psitacídeos da Estação Ecológica Mamirauá, Amazonas. *Atualidades Ornitológicas* 63:3.

Parker, T. A. III, D. F. Stotz and J. W. Fitzpatrick (1996) Ecological and distributional databases. p.131-407. *In*: D.F. Stotz, J.W. Fitzpatrick, T.A.Parker III and D.K. Moskovits (eds.). *Neotropical Birds. Ecology and Conservation*. Chicago: Univ. Chicago Press.

Paynter, R. A. Jr. and M. A. Jr. Traylor (1991) *Ornithological Gazetteer of Brazil*. Massachusetts. Mus. Comp. Zool. Harvard.

Pinto, M. O. O. (1935) Aves da Bahia. *Rev. Mus. Paulista* XIX:1-325.

___ and E. A. Camargo (1954) Resultados ornitológicos de uma expedição ao teritório do Acre pelo departamento de Zoologia. *Pap. Avulsos. Zool. São Paulo* 11:371-417.

___ and __ (1957) Sobre uma coleção de aves da região de Cachimbo (sul do estado do Pará). *Pap. Avulsos. Zool. São Paulo* 13:51-69.

___ and __ (1978) *Novo catálogo das aves do Brasil.* São Paulo: Empresa Gráfica dos Tribunais.

Pires, J.M. and G. T. Prance (1985) The vegetation types of the Brazilian Amazon. p.109-145. *In*: G. T. Prance, T. E. Lovejoy (eds.) Amazonia. Oxford: Pergamon Press.

Prance, G. T. (1976) The fitogeographic subdivision of Amazonia and influence on selection of biological reserves. p.132-145. *In*: G. T. Prance (ed.) *Extinction is Forever*. New York: The New York Botanical Garden.

___ (1980) A terminologia dos tipos de florestas amazônicas sujeitas a inundação. *Acta Amazônica* 10:495-504.

RADAMBRASIL (1975) *Folha SB.21 Tapajós*. Rio de Janeiro: Depart. Nac. Produção Mineral-DNPM.

Ralph, C. J. and M. J. Scott (1981) Estimating numbers of terrestrial birds. Lawrence: Cooper Ornithological Society (Studies in Avian Biology 6).

___, G. R. Geupel, P. Pyle, T. E. Martin and D. F. DeSante (1993) Handbook of field methods for monitoring landbirds. *Gen. Tech. Rep. PSW-GTR*-144. Albany: Pacific Southwest Research Station, Forest Service, U.S. Depart. Agric.

Remsen, V. Jr. and T. A. III Parker (1983) Contribution of River-created habitats to Bird Species Richness in Amazonia. *Biotropica* 15:223-231.

Rodrigues, W. A. (1996) A cobertura florestal da Amazônia Brasileira. p. 57-78. *In*: C. Pavan (ed.) Uma estratégia Latino Americana para a Amazônia. 2:57-78. Brasília. Min. Meio Amb., Rec. Hídricos Amaz. Legal. São Paulo: Memorial.

Roth, P. (1984) Repartição do habitat entre Psitacídeos simpátricos no sul da Amazônia. *Acta Amaz.* 14:175-221.

Rylands, A. B., A. F. Coimbra-Filho and R. A. Mittermeier (1993) Systematics, distributions and some notes on the conservation status of the Callitrichidae. p.11-77. *In*: A. B. Rylands (ed.) *Marmosets and Tamarins. Sistematics, Behaviour and Ecology*. Oxford: Oxford Univ. Press.

Salvadori, T. (1891) *Catalogue of the Psittaci or Parrots in the collection of the British Museum*. London: XX:XVII.

Santos, B.A. (1981) *Amazônia. Potencial Mineral e Perspectivas de Desenvolvimento*. São Paulo: Ed. Univ. São Paulo.

SAS Institute, INC (1988) *SAS/STAT™. User's Guide, release 6.03 edition*. North Carolina: SAS Inst. Inc.

Sibley, C. G. and B. L. Jr. Monroe (1993) *A supplement to distribution and taxonomy of Birds of the World*. New Haven: Yale Univ. Press.

Sick, H. (1959a) Zur Endteckung von *Pipra vilasboasi*. *J. Orn.* 100:404-412.

___ (1959b) Ein neuer Sittich aus Brasilien: *Aratinga cactorun paraensis*, subsp. nova. *J. Orn.* 100:413-416.

___ (1961) *Tukani*. Barcelona: Labor.

___ (1997) *Ornitologia Brasileira*. Rio de Janeiro: Ed. Nova Fronteira.

Snethlage, E. (1908) Ornithologisches vom Tapajós und Tocantins. *J. Orn.* 56:493-539.

___ (1914) Catálogo das aves amazônicas. *Bol. Mus. Paraense Emílio Goeldi* 8:1-465.

Smith, G. A. (1975) Systematics of parrots. *Ibis* 117:18-68.

Sobrevila, C. and A. Bath (1992) *Evaluacion Ecologica Rapida. Un Manual para Usuarios de América Latina Y el Caribe*. Edición Preliminar. Programa de Ciencias para América Latina. Washington: Nat. Conserv.

Stresemann, E. (1924) Eine *Amazona farinosa* (Boddaert) mit roter Schwanz-basis. *Orn. Mitt.* 32:43-44.

Thonsen, J.B. and A. Brautigan (1991) Sustainable use of Neotropical parrots. p.359-379. *In*: J.G. Robinson and K.H. Redford (eds.) *Neotropical Wildlife Use and Conservation*. Chicago: Univ. Chicago Press.

Uhl, C., J. B. Kauffman and E. D. Silva (1990) Os caminhos do Fogo na Amazônia. *Ci. Hoje* 11:24-32.

Vanzolini, P. E. (1992) *A Supplement to the Ornithological Gazetteer of Brazil*. São Paulo: Mus. Zool. Univ. São Paulo.

Vielliard, J. (1994) Bioacoustics and phylogeny among *Amazona* Parrots. p.634-647. *In*: *Acta* XXI Intern. Orn. Cong. Vienna: Hofburg.

___ (1995) Phylogeny of bioacoustic parameters in birds. *Bioacoustics* 6:171-174.

Vuilleumier, F., M. LeCroy and E. Mayr (1992) New species of birds described from 1981 to 1990. *Bull. Brit. Orn. Club* 112A:267-309.

Zimmer, K. J., T. A. III Parker, B. M. Whitney, M. Isler and P. Isler (*in press*) The Birds of Alta Floresta, Brazil. *In*: *Neotropical Ornithology*.

Willis, E. O and Y. Oniki (1991) *Nomes Gerais para as Aves Brasileiras*. São Paulo: Gráfica da Região. Américo Brasiliense.

Whitney, B. M. (1996) Flight behavior and other field characteristics of the genera of Neotropical parrots. *Cotinga* 5:32-42.

APPENDIX

The following specimens were examined. Owing to incomplete growth, damage, only a subset of measurements were included in any given comparison.

Amazona kawalli. Brazil: Rio Juruá, Amazonas MZUSP 3478, 2727 (2 Females - Holotype and Paratype). Pará ? RAF 1331 (1 male). Itaituba-PA ?, MPEG 14804 (1 female). Pará RG 7577, 9097, 9279 (1 male, 2 females). Rio Roosevelt, Mato Grosso MN (s/n).

Amazona farinosa. Brazil: Rio Juruá, Amazonas MZUSP 21012, 20473, 2258, 21001, 21302 (4 males, 1 female). Amazonas, Lago Batista MZUSP 21003, 20930, 20474 (2 males, 1 female). Amazonas, Iguarapé Ambá MZUSP 20563 (1 female). Pará, Capim MZUSP 44039, 44041, 44035, 44038, 44036, 44037, 44040 (5 males, 2 females). Pará, Rio Tapajós MZUSP 44039, 20510, 20566, 21013, 20995 (4 males, 1 female). Pará, Fordlândia MZUSP 58367 (1 male). Pará, Óbidos MZUSP 10617 (1 male). Pará, Belém MZUSP 12807 (1 male). Acre, Rio Iquirá MZUSP 35608 (1 male). Espírito Santo MZUSP 6398 (1 female). Espirito Santo, Rio Doce MZUSP 6731 (1 male). Espírito Santo, Rio São José MZUSP 28648, 28649 (2 males). Bahia, Ilheus MZUSP 33058 (1 male). Bahia, Rio Jucurucú MZUSP 14019 (1 female). Minas Gerais, Rio Matipó MZUSP 10359 (unsexed). São Paulo, São Sebastião MZUSP 11623, 14019 (2 females).

Ararajuba 5(2):115-126
dezembro de 1997

Seasonal abundance and feeding ecology of parrots and parakeets in a lowland Atlantic forest of Brazil

Mauro Galetti[1]
Wildlife Research Group, Department of Anatomy, University of Cambridge, Cambridge CB2 3DY, UK

Recebido em 17 de março de 1997; aceito em 10 de agosto de 1997

RESUMO: **Abundância sazonal e ecologia alimentar de papagaios e periquitos em uma floresta de baixada no Brasil.** A sazonalidade e dieta de seis psitacídeos simpátricos foi estudada em uma floresta de baixada na Mata Atlântica no Brasil. O objetivo desse estudo foi investigar como essas espécies partilham os recursos e elucidar os principais fatores que determinam a abundância sazonal dos psitacídeos. A comunidade de psitacídeos foi observada consumindo 31 espécies de plantas na área, sendo Myrtaceae e Euphorbiaceae as famílias de plantas mais utilizadas. As principais diferenças entre as espécies de psitacídeos foram dieta e uso de hábitat. Houve uma correlação positiva entre massa corpórea e dureza do fruto, sugerindo que espécies maiores podem usar frutos mais duros enquanto espécies menores são forçadas a usar apenas frutos moles. Ambos periquitos, (*Brotogeris tirica* e *Pyrrhura frontalis*), com tamanho semelhante mostraram dieta similar quanto à dureza do fruto, mas diferiram quanto às plantas consumidas. Exeto *Forpus crassirostris*, nenhuma espécie mostrou marcada variação em abundância. Essa espécie é possivelmente uma espécie que migra altitudinalmente na Serra do Mar, aumentando sua abundância nas matas de baixada durante o inverno e primavera. Nenhuma espécie de psitacídeo mostrou especialização quanto a dieta, mas *Triclaria malachitacea* consumiu várias espécies de Myrtaceae. Fortes evidências sugerem que esse papagaio não é dependente dos frutos do palmito, *Euterpe edulis*, como sugerido previamente.

PALAVRA-CHAVE: dieta, Mata Atlântica, papagaio, predação de sementes, Psittacidae.

ABSTRACT. The seasonality and diet of six sympatric psittacids were studied in a lowland Atlantic forest in Brazil. The aim of this study was to investigate how these species partition resources and to elucidate the main factors that determine the seasonal abundance of psittacids. The parrot community was observed eating 31 plant species in the area, being Myrtaceae and Euphorbiaceae the most commonly consumed plant families. Psittacid species differed principally in diet composition and habitat use. Body mass and fruit hardness were found to be correlated, suggesting that large parrots can use both soft and hard fruits, while smaller species are forced to use only soft fruits. Parakeets with similar body size, (*Brotogeris tirica* and *Pyrrhura frontalis*), used fruits of similar hardness, but they differed in the plant species eaten. Except for *Forpus crassirostris* no species showed marked seasonal changes in abundance. This species is possibly an altitudinal migrant, increasing its abundance in the lowlands during winter and spring. No species showed diet specialization, but *Triclaria malachitacea* consumed several species of Myrtaceae. Strong evidence suggests that this parrot is not dependent on *Euterpe edulis* fruits, as suggested previously.

KEY WORS: Atlantic forest, diet, parrot, Psittacidae, seed predation.

Tropical frugivorous birds are known to have large seasonal population fluctuations following changes in food resources (e.g. Wheelwright 1982, Leighton and Leighton 1983, Loiselle and Blake 1993), rainfall (Poulin *et al.* 1992, 1993) and breeding season (Poulin *et al.* 1993). Granivorous birds are particularly sensitive to seed availability and marked fluctuations of abundance have been frequently observed (Grant and Grant 1980, Olmos 1996). Although several studies have focused on seasonal fluctuation of "legitimate" frugivores (sensu Snow 1981) or passerine granivores (mainly finches), very little is known about the seasonality and diet of one of the most diverse and abundant bird family in the Neotropics, the Psittacidae (Chapman *et al.* 1989, Pizo *et al.* 1995, 1997).

Although morphologically very uniform, feeding habits among psittacids varied from frugivore-granivores (e. g. Amazons, Martuscelli 1995) to frugivore-nectarivores (e. g. Lorikeets, Cannon 1984), frugivore-herbivores (Kakapo, Best 1984) and even frugivore-carnivores (Keas, Jackson 1963).

In general, Neotropical parrots are mainly seed predators (Janzen 1981, Galetti and Rodrigues 1992), but

---

[1] Present address: Departamento de Botânica, UNESP, C.P. 199, 13506-900, Rio Claro, SP, Brazil - E-mail: mgaletti@life.ibrc.unesp.br

they also include flowers, nectar, leaves and invertebrates in their diet (Forshaw 1989). In this region most year-round studies on psittacid ecology have concentrated on highly-endangered taxa (e. g. Munn 1988, Varty *et al.* 1994, Martuscelli 1995) and the common species are usually ignored (Roth 1984, Galetti 1993, Pizo *et al.* 1995, Galetti and Pedroni 1996).

The seasonal abundance and feeding ecology of six sympatric psittacids in a lowland Atlantic forest of Brazil are discussed in this paper. The main aim of this study was to answer the following questions: What are the possible roles of abiotic factors (temperature, rainfall) and biotic (food abundance, food selection and habitat use) for allowing sympatric parrots to coexist? How does fruit availability influence parrot abundance? Does fruit hardness determine fruit choices by each parrot species?

STUDY AREA AND METHODS

The present study was carried out at the Parque Estadual Intervales, Base do Saibadela (hereafter Saibadela forest), municipality of Sete Barras in the state of São Paulo, Brazil (24°14'S, 48°04'W). The Parque Estadual Intervales is 380 Km^2 of protected forest, established in 1986. It was managed by the Fundação Florestal do Estado de São Paulo until 1995. In June 1995 the area was declared a "Parque Estadual" (State Park) and another 110 Km^2 were added to the reserve. This reserve is surrounded by three other reserves; Carlos Botelho, Petar and Xituê parks comprising more than 1.200 Km^2 of protected forests. Now, the area comprises one of the largest blocks of "typical" coastal Atlantic forest in Brazil.

In the Saibadela area there was a seasonal distribution of rain: the wettest months are January, February and March and the driest months, June, July and August (figure 1). The annual rainfall in 1994 and 1995 was 4,244 mm and 3,958 mm, respectively. A striking characteristic of Parque Intervales is that while rainfall reached more than 4,000 mm in the lowland (70 m a.s.l.), only 1,600 mm were recorded at higher elevations (900 m a.s.l). Moreover, the Saibadela region received much more rain than the nearest city, Sete Barras, 42 km distant (c. 2,500 mm annual rainfall).

Temperature was more variable throughout the year at Saibadela. The hotter and wetter season ran from October to March (mean of 26.8°C) and the colder and drier season from April to September (21.1°C). Minimum temperatures rarely drop below 5°C (winter 1994) (figure 1). The annual mean temperature was about 24°C with the maximum temperature of 42°C and the minimum of 3°C (figure 2).

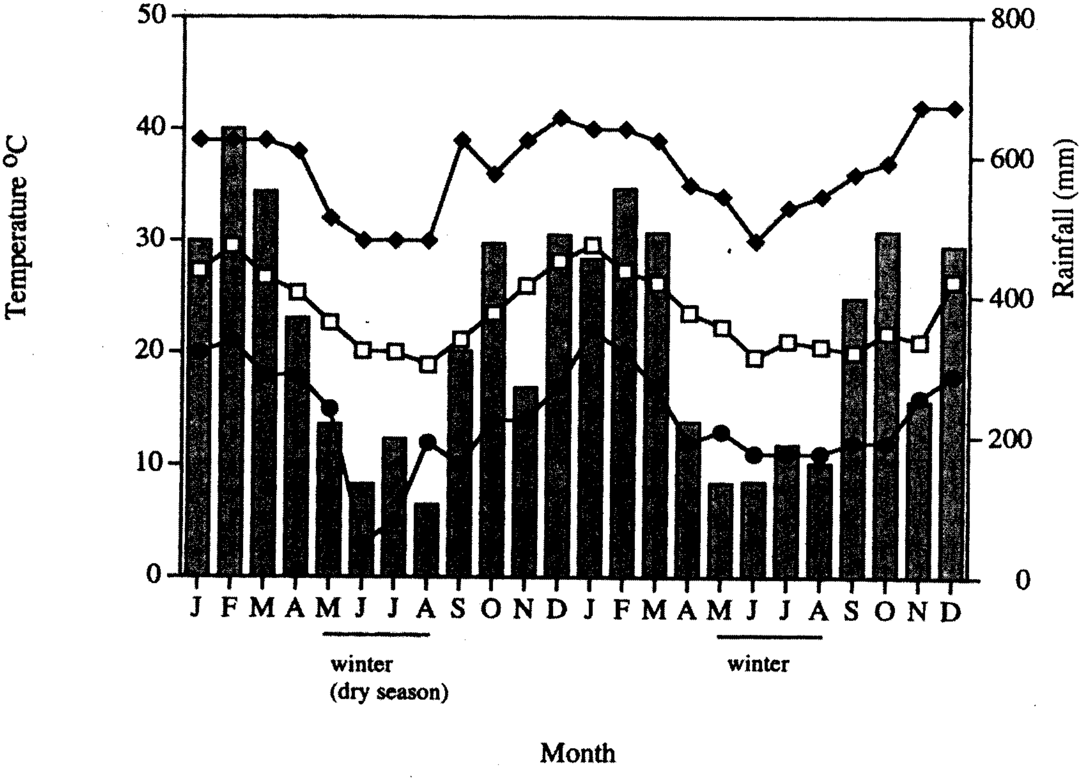

Figure 1. Climatic diagram of Saibadela site, Sete Barras, São Paulo (bars are rainfall and lines are maximim, mean and minimum temperature).

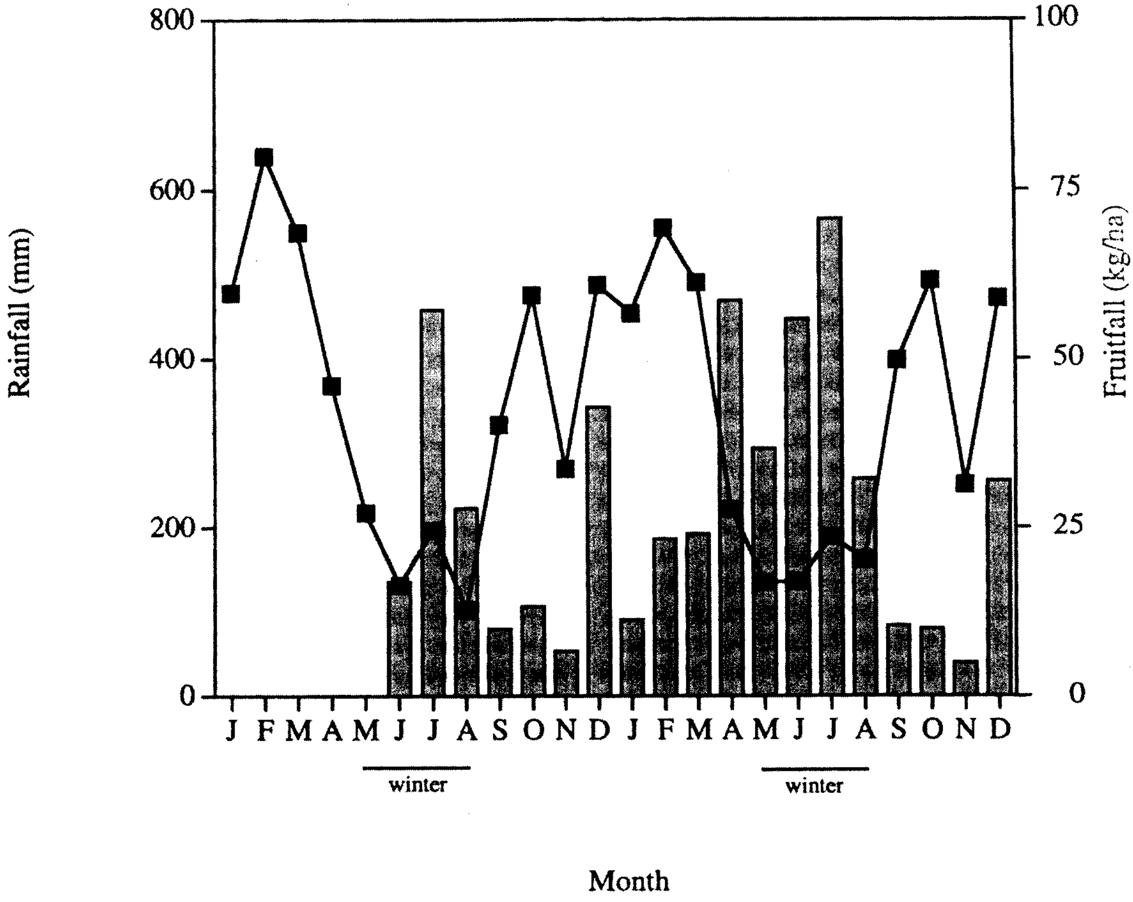

Figure 2. Seasonal fruitfall (lines) and rainfall (lines) during the study period at Saibadela site. There are no data on fruitfall from January to May 1994.

Temperatures below freezing, also known as "geadas" (frost) occur every four-five years in the state of São Paulo (Guix 1995). In the higher elevations of Intervales (Carmo and Sede stations), temperatures can drop below 0°C (e. g., July 1994).

Species studied. Eight parrot species occur in the lowlands at the Saibadela site: the Blue-winged Parrotlet *Forpus crassirostris*, Plain Parakeet *Brotogeris tirica*, Reddish-bellied Parakeet *Pyrrhura frontalis*, Red-capped Parrot *Pionopsitta pileata*, Blue-bellied Parrot *Triclaria malachitacea*, Scaly-headed Parrot *Pionus maximiliani*, Black-eared Parrotlet *Touit melanonota*, and Vinacea Amazon *Amazona vinacea* (Aleixo and Galetti 1997). *Touit melanonota* and *A. vinacea*, however, were rarely observed in the study site and they were excluded from the analysis presented here.

Forpus crassirostris (Blue-winged Parrotlet, Tuim) - The Blue-winged Parrotlet is one of the smallest Psittacidae known (26 g, 12 cm) (Sick 1993). It occurs north-eastern, eastern and south-eastern Brazil to Paraguay, Bolivia and also in the Peruvian Amazon (Sick 1993). Although extremely common in captivity and in the wild, the biology of this genus is poorly known (Waltman and Beissinger 1992, Pizo *et al.* 1995).

Brotogeris tirica (Plain Parakeet, Periquito). The Plain Parakeet is one of the commonest psittacids in the Atlantic forest (Pizo *et al.* 1995) occurring in both primary and secondary vegetation and also in urban areas (pers. obs.). This parakeet weighs 70 g, and is about 16 cm in length. It is endemic to the Brazilian Atlantic forest, occurring from Bahia to Santa Catarina (Sick 1993). Previous studies of this species showed that its population declines in the summer (wet season) in the highlands of the Atlantic forest (Pizo *et al.* 1995).

Pyrrhura frontalis (Reddish-bellied Parakeet, Tiriva) - This parakeet (also known as Reddish-bellied Conure) is the second most abundant psittacid in the Brazilian atlantic forest (Pizo *et al.* 1995). It occurs from Bahia to Rio Grande do Sul, southern Mato Grosso in Brazil and Uruguay, Paraguay and Argentina. This medium-sized parakeet weigh about 72-94 g and is 29 cm long. Besides fruits this species is also known to eat insect galls (Martuscelli 1994).

Pionopsitta pileata (Red-capped Parrot, Cuiú-cuiú) - This species is a medium-sized parrot (98-120 g, 21 cm) and it occurs from southern Bahia to Rio Grande do Sul, Argentina (Misiones) and Paraguay (Sick 1993). This parrot was observed eating fruits of *Podocarpus* and *Myrcia* sphaerocarpa (Sick 1993) and *Gallesia gorazema* (Guix 1995). The reproduction of this parrot has been studied by Scherer-Neto and Muller (1984). The ecology of this genus is poorly documented and there are scanty data about their feeding behavior (Eitniear *et al.* 1994).

Pionus maximiliani (Scaly-headed Parrot, Maitaca) - The Scaly-headed Parrot is the second largest psittacid at Saibadela (233-293 g, 27 cm). It occurs in north-east and east to southern Brazil, also in Bolivia, Paraguay and Argentina. This species is a generalist and also eats large amounts of flowers. The diet of the Scaly-headed Parrot in a semi-deciduos forest in Brazil was studied by Galetti (1993).

Triclaria malachitacea (Blue-bellied Parrot, Sabiá-cica) - The Blue-bellied Parrot is considered one of the most secretive parrot (Pizo *et al.* 1995). It is a relatively large parrot (110-155 g, 29 cm). It occurs from southern Bahia and Minas Gerais to Argentina (Misiones) (Sick 1993, Whitney 1996). Collar *et al.* (1992) considered this species to be associated to *Euterpe edulis* palms. The rapid decline of this parrot population is due to the over-harvesting of *Euterpe* palm, their main food source (Collar *et al.* 1992, 1994). Altidudinal migration is suggested by Collar *et al.* (1992), Sick (1993) and Whitney (1996).

Seasonal abundance of psittacids. Parrots are highly mobile and an accurate census is extremely difficult (see Bibby *et al.* 1992, Pizo *et al.* 1995, 1997). Also, their green camouflage makes them very difficult to detect in the forest canopy.

Most methods used for psittacid censuses rely on the index of abundance rather than on density estimates. In general, five methods have been widely used to estimate parrot density (or abundance): counts from vantage points (Lambert 1993), variable circular plots (Marsden 1992, 1995), transect counts or encounter rates (Pizo *et al.* 1995, 1997), counts at roosts (Chapman *et al.* 1989) and capture-mark release (Cannon 1984).

The seasonal abundance of parrot species at Saibadela was assessed by encounter rates along transects. Eight different transects were walked each month, ranging from one to 10 km. Each encounter (visual or aural) with an individual or a flock was recorded as one encounter. The overall abundance was estimated by frequency of encounter hour or field work. This method does not provide an accurate estimate of parrot density, because it does not distinguish differences in flock size. The aim in this study was, however, to detect marked seasonal fluctuations of intra-specific abundance throughout the year, rather than estimating parrot densities. Because of the poor visibility of the flocks it was assumed that flock size did not differ between seasons, although this is probably bias (see Pizo *et al.* 1997).

Diet and fruit availability. The diet of parrots and parakeets was based on observed feeding bouts. Each time that a single parrot or a flock was observed eating a determined plant species it was recorded as one feeding bout. If the birds moved to another food source, a new independent bout was recorded (Galetti 1993, Pizo *et al.* 1995). For each feeding bout, the number of birds foraging, the plant consumed, and the part eaten (e. g., seeds, pulp, flowers) were recorded. The stratum used by each species for fruit foraging was recorded. Four main strata used by parrots for foraging were distinguished: forest edge (along rivers), canopy (emergent trees over 20 m), subcanopy (trees between 10 to 20 m height) and understory (trees below 10 m) vegetation.

The collected fruit eaten by parrots were weighed, measured and the number of seeds, fruit size, and fruit hardness were recorded (Galetti 1996). Fruit hardness was categorized as soft (berries, arils and drupes, such as Myrtaceae, Burseraceae), medium (*Ficus gomeleira, Ficus insipida*) and hard (leguminous pods, such as *Inga*, and capsules, such as *Sloanea*).

Fruit availability. To estimate the fruitfall availability in Saibadela forest, 30 fruit traps of 0.25 m^2 were distributed along forest trails, spaced every 25 m, from June 1994 to January 1996. Each trap consisted of a fiber box with a fine mesh to collect even tiny seeds (0.1 mm), such a *Ficus* spp.

Once a month all the fruits found in the traps were collected, identified up to the highest possible taxonomic level and weighed (wet weight). Non-zoochoric fruits were rare, but when present in the traps they were not included in the sample weighed. Monthly fruitfall is based on the sum of fruit weigh of all 30 traps and then extrapolated to kilograms per hectar.

Statistical analysis. The distribution of the monthly abundance of each parrot species was tested for normality using Wilk-Shapiro test. Because all species, abundances were found to be statistically different from a normal distribution, non-parametric statistics were used in all analyses. Spearman-rank correlation was used to relate parrot abundance to rainfall, temperature and fruit production. Producto momentum correlation (Pearson) was used to relate fruit hardness to percentage of such fruits in the diet of parrots.

All statistics used followed Sokal and Rohlf (1995) and were analyzed using the Statistical Package for Social Sciences-SPSS (Norusis 1994).

RESULTS

Fruit availability. Fruitfall in the Saibadela forest was estimated to be 625.2 kg/ha/year (figure 2). Peak fruit availability ocurred during the winter (April-August) and declined in the spring (August-October; the short dry season). In June and July 1994 frost ocurred when temperatures dropped to 3° and 5° C, and fruit production was lower in 1994 than in 1995.

Fruitfall was higher in winter (252 kg/ha) than in summer (116 kg/ha; complete annual data for 1995 only). There was a statistical difference in fruitfall between seasons (log-transformed data, t-test, t = 4.18, d.f. = 6, p = 0.005). Most fruits collected in the winter were *Euterpe edulis* fruits (about 80 % of the fruit biomass). Fruits of Myrtaceae made a substantial contribution to the fruitfall biomass during the winter.

Abundance and seasonality. A total of 1,306 contacts with parrots were recorded during the 20-month study period. The most abundant species was *B. tirica*, followed by *P. maximiliani, T. malachitacea, P. frontalis, F. crassirostris* and *P. pileata.*

The number of contacts per hour was higher in the second year (1995) than in the first year (1994), both in the winter and in the breeding season (table 1). Most of the species were more abundant in winter 1995 than in winter 1994. The lowest fluctuation was in *P. maximiliani* (twice) and the highest in *P. frontalis* (6.3 times). During the breeding season (August to December) all species were more abundant in 1995. *Pyrrhura frontalis* was 1.6 times more abundant in this year and *T. malachitacea* was 3.1 times more abundant.

It was impossible to have an accurate estimate of the flock size detected due to the poor visibility, but *T. malachitacea* generally ocurred in small flocks (2-5 birds/flock), *F. crassirostris* (4-6 birds/flock), *P. frontalis* (6-12 birds/flock), *P. maximiliani* (2-12 birds/flock), and *B. tirica* (6-10 birds/flock).

There was a negative correlation between *Forpus* abundance in each month and mean temperature (r_s = -0.58, $p < 0.05$), and minimum temperature (r_s = -0.628, $p < 0.001$). *Brotogeris* abundance per month showed a positive correlation with maximum temperature (r_s = 0.501, $p < 0.05$). The abundance of other parrot species did not show any correlation with the parameters analyzed (temperature, rainfall, fruitfal and number of fruiting plants). *Forpus* was more abundant in the winter and spring (September-November), declining in the summer (figure 4). Because *P. pileata* had an extremely low abundance it is not shown in figure 4.

Diet. The parrot community at Saibadela was observed to consume 31 plant species of 19 families (table 2). Most feeding bouts were on fruit pulp or seeds and only one on flowers (*B. tirica* eating *Pseudobombax* sp., Bombacaceae). No animal matter was observed being ingested by any parrot species.

Forpus was observed eating only seeds or pulps of soft fruits, while *Brotogeris* consumed pulp/aril in 61 %, flowers in 8.5 % and seeds in 30.4 % of feeding bouts. *Pyrrhura* consumed pulp (50 % of feeding bouts) and seeds (50 %). The larger parrots (*Triclaria* and *Pionus*), on the other hand, rarely consumed pulp and their diets were based mainly on seeds.

Pulp of *Cryptocarya moschata* (Lauraceae) was a particulary important food source for both parakeets, comprising 30 % of their diets. *Brotogeris tirica* can forage for up to one hour eating *Cryptocarya* pulp, dropping the intact seeds below the fruiting tree. *Cryptocarya moschata* bears ripe fruits in the winter and is important for large arboreal frugivores (capuchin and woolly spider monkeys) (pers. obs.) Pulp was also ingested by *Triclaria* and *Forpus*, but comprised a minor part of their diets (7.7 % and 16.7 % respectively).

Brotogeris tirica was observed consuming 12 species (23 feeding bouts), *P. frontalis* 12 species (20 feeding bouts), *P. maximiliani* seven species (14 feeding bouts), *T. malachitacea* eigth species (13 bouts), *F. crassirostris* four species (six bouts) and *P. pileata* only one species (one feeding bout) (table 2). The number of species observed in the diet of each parrot is correlated with the number of feeding bouts (r_s = 0.87, p = 0.05), suggesting that the overall diet of all species is far from the being complete for any psittacid species. The low number of feeding bouts for some spęcies (*Forpus* and *Pionopsitta*) constrain any further analysis.

Apparently, none of the parrot species showed strict specialization to a plant species or a family, as observed in macaws (see discussion). Nevertheless, Myrtaceae was the family most used by parrots, especially for *T.*

Table 1. Annual and seasonal differences in parrot abundance (contact/hour) at Saibadela forest.

	1994		1995			
Parrot species	Winter[1]	Breeding[2]	Winter[1]	Breeding[2]	Total contacts	Contacts/h
Brotogeris tirica	1.40	2.41	2.89	2.92	840	2.30
Pionus maximiliani	0.35	0.68	0.52	0.73	203	0.56
Triclaria malachitacea	0.21	0.25	0.25	0.79	97	0.27
Pyrrhura frontalis	0.08	0.21	0.50	0.34	82	0.22
Forpus crassirostris	0.11	0.21	0.27	0.28	58	0.16
Pionopsitta pileata	0.15	0.08	-	-	26	0.07

[1] Winter: May to August

[2] Breeding season: September to December

Table 2. Characteristics of plant species eaten by parrots and parakeets at Saibadela, Parque Estadual Intervales.

Family/Species	Habit	Part eaten	Fruit hardness	Fruiting	Density	Parrot	% Diet
ARACEAE							
Heteropsis oblongifolia	E	seeds	S	Jan-Feb	-	Tr	*
ARALIACEAE							
Dendropanax sp.	T	seeds	S	Feb	-	Pi	7.14
BOMBACACEAE							
Pseudobombax sp.	T	flowers	-	-	>1.9	Br	4.34
Spirotheca passifloroides	E	seeds	S	Aug-Nov	-	Br	4.34
						Py	*
BORAGINACEAE							
Cordia sylvestris	T	seeds	S	Feb-Apr	1.9	Py	5
BURSERACEAE							
Protium widgreni	T	seeds	H	Dec-Jan	>1.9	Pi	7.14
						Py	5
CECROPIACEAE							
Cecropia pachystachia	T	seeds	S	Jan-Apr	1.9	Fo	66.7
						Br	8.7
Pouroma guianensis	T	seeds	S	Feb	5.8	Pi	7.14
ELAEOCARPACEAE							
Sloanea monosperma	T	seeds	H	Jul	9.6	Tr	15.4
EUPHORBIACEAE							
Alchornea triplinervia	T	seeds	H	Nov-Jan	25	Py	10
Hyeronima alchorneoides	T	seeds	S	Jan-Mar	21.1	Py	*
Margaritaria nobilis	T	seeds	H	Jan-Apr	>1.9	Pi	14.3
Tetrorchidium rubrivernium	T	seeds	H	Dec-Jan	7.7	Py	*
LAURACEAE							
Cryptocarya moschata	T	pulp	S	May-Jul	15.4	Py	30
						Br	30.43
						Tr	7.7
LEGUMINOSAE-CAESALPINIACEAE							
Copaifera trapezifolia	T	seed	S	Jun-Oct	>1.9	Br	4.34
LEGUMINOSAE-MIMOSOIDAE							
Inga edulis	T	seeds	H	Jan		Pi	28.6
						Py	5
MARCGRAVIACEAE							
Macgravia polyantha	L	pulp?	S	May-Jun	6	Fo	16.7
MENISPERMACEAE							
Abuta selloana	L	seeds	H	Apr-Jul	-	Br	13
Hiperbaema sp.	L	seeds	S	Aug-Oct	-	Br	4.34
MORACEAE							
Brossimum sp.	T	seeds	S	all year	3.8	Br	*
Ficus insipida	T	pulp/seeds	M	Oct-Apr	1.9	Py	10
Ficus obtusiuscula	T	pulp/seeds	M	-	1.9	Py	5
						Br	8.7
Ficus enormis	T	pulp	M	Feb	-	Fo	16.7
						Py	5
Sorocea bomplandii	T	seeds	S	Nov-Dec	7.7	Tr	*

Table 2. Continued.

Family/Species	Habit	Part eaten	Fruit hardness	Fruiting	Density	Parrot	% Diet
MYRISTICACEAE							
Virola oleifera	T	capsule	H	May-Aug	9.6	Tr	7.7
MYRTACEAE							
Campomanesia neriiflora	T	seeds	S	Jan-Feb	7.7	Tr	23
Campomanesia sp.	T	seeds	S	Dec	>1.9	Tr	15.4
Eugenia sp1	T	seeds	S	-	-	Tr	7.7
Eugenia sp2	T	seeds	S	-	-	Br	4.34
Eugenia cambucarana	T	seeds	S	Sep	-	Pi	7.14
Eugenia multicostata	T	pulp	S	Feb-May	5.8	Br	4.34
Myrceugenia reitzii	T	seeds	S	Aug-Nov	1.9	Tr	7.7
PALMAE							
Euterpe edulis	T	seeds	S	May-Sep	255.6	Py	15
						Br	8.7
					Tr	15.4	
PHYTOLACCACEA							
Phytolacca dioica	T	seeds	S	Mar-Apr	>1.9	Pp	100
						Py	5
SAPINDACEAE							
Matayba elaeognoides	T	aril	H	Dec-Jan	-	Br	4.34
ULMACEAE							
Trema micrantha	T	seed	S	Nov-Mar		Fo	16.7
						Py	5

Habitat: T = tree, S = srub, E = epiphyte, L = liana.
Fruit hardness: S = soft, H = hard, M = medium.
Density = individual/ha (from Almeida-Scabbia 1996).
Parrot species: Fo = *Forpus crassirostris*, Pp = *Pionopsitta pileata*, Br = *Brotogeris tirica*, Py = *Pyrrhura frontalis*, Tr = *Triclaria malachitacea*, Pi = *Pionus maximiliani*.
* = species recorded by local people or Pizo *et al.* (1995).

malachitacea (54 % of the diet). This family is also the most diverse and abundant in the Saibadela forest (Almeida-Scabbia 1996).

Triclaria malachitacea, which was previously considered to be dependent on *E. edulis* fruits (Collar *et al.* 1992) was rarely observed eating this palm in this study. Although palms are very abundant in the study site (mainly *E. edulis*, 255 individuals/ha) their fruits were moderately consumed, varying from 8.7 % (for *Brotogeris*) to 5.4 % (for *Triclaria*). Even the *Ficus* species were not so heavily consumed by parrots, as observed elsewhere (Janzen 1981, Jordano 1983).

Fruit characteristics. The fruits eaten by parrots ranged from tiny berries (*Hyeronima alchorneioides*, 0.5 cm lenght) to large pods (*Inga edulis*, 11 cm length). The proportion of hard fruits in the parrot diet was correlated with parrot body mass (r = 0.90, p = 0.032), but body mass was not correlated with soft (r = -0.539) and medium fruits (r = 0.355) (figure 4). This suggests that hard fruits (such as Leguminosae and capsules) can be consumed only by large parrots, but soft fruits are also exploited by large parrots. Seeds of hard fruits, such as *Inga* and *Protium*, are eaten by large species (*Pionus*). Smaller species such as the parakeets can consume dehiscent hard fruits only when the capsules are open, ingesting the aril or even the seed (e. g., *Matyba* and *Copaifera*).

Habitats used for foraging varied among species, although both parakeets (*Brotogeris* and *Pyrrhura*) overlapped in proportional use the habitats (figure 5). *Forpus crassirostris* was observed eating only at the forest edge. *Triclaria malachitacea* is the only psittacid that was observed feeding on the understory (Myrtaceae berries) and also using orchards to consume the seeds of oranges (Pizo *et. al.* 1995, pers. obs.).

DISCUSSION

The main characteristics allowing the coexistence of six parrots in the lowland Atlantic forest were the differences in fruit diet and stratum used. Although there were a high overlap of habitat use and fruit hardness in both parakeets with similar body mass (*Brotogeris* and *Pyrrhura*), their diets were divergent in terms of species consumed. Only three fruit species were consumed by both parakeets, but

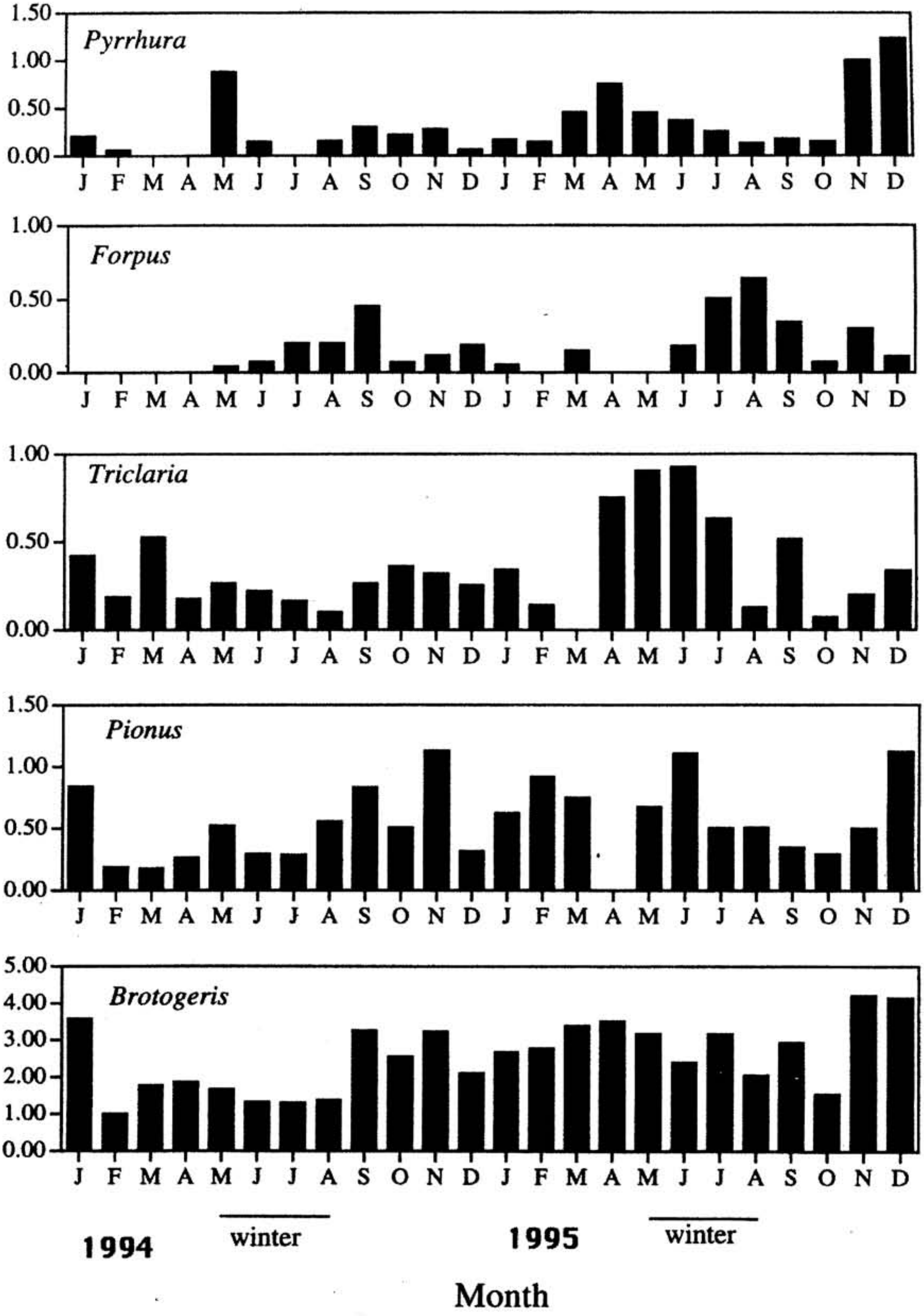

Figure 3. Seasonal fluctuation in psittacid abundance at Saibadela site.

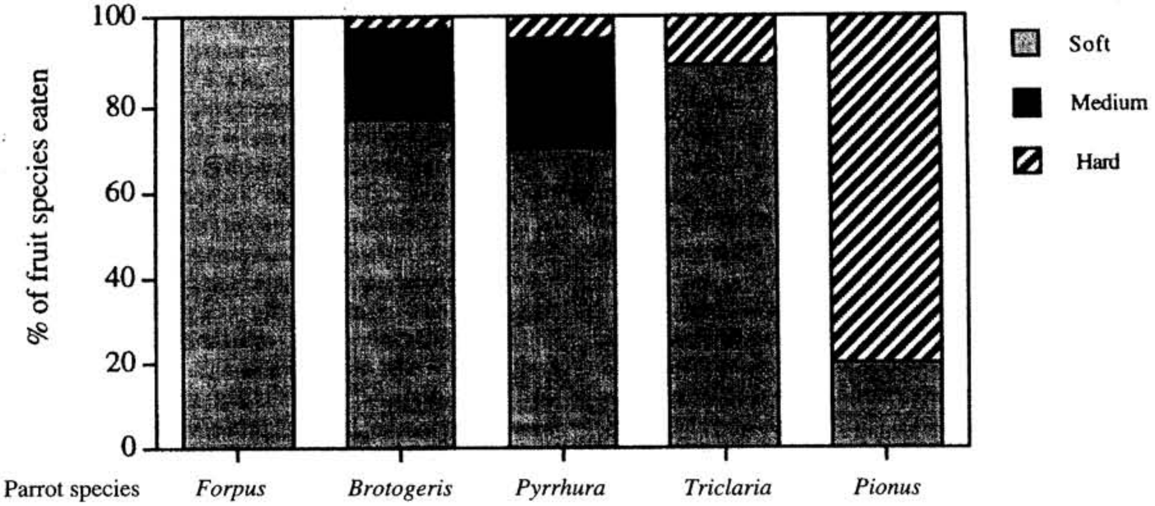

Figure 4. Percentage of fruit hardness in the diet of the Psittacidae at Saibadela (body size increase from *Forpus* to *Pionus*).

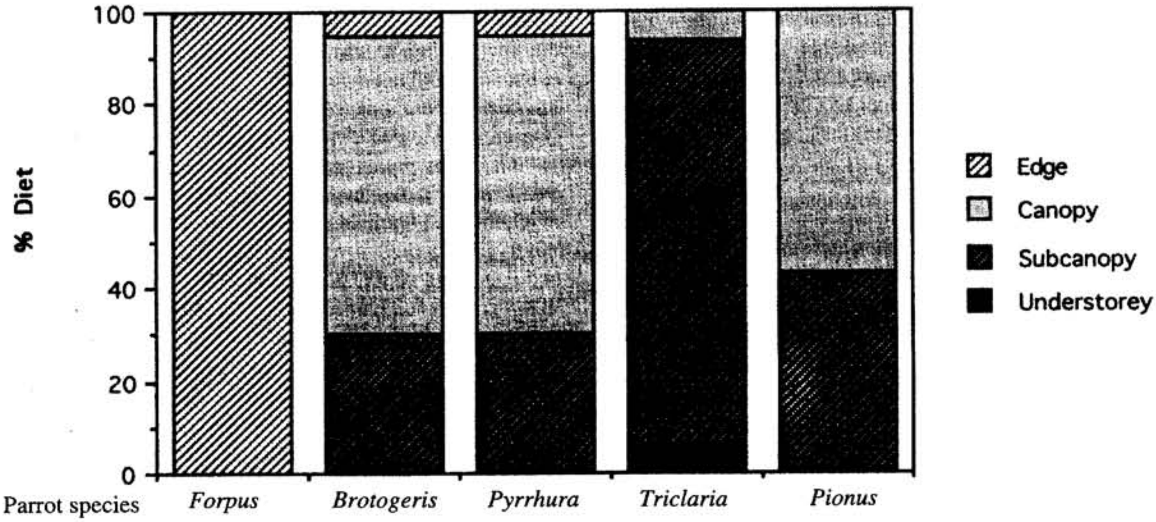

Figure 5. Percentage of the diet in each vegetation strata of the parrots of Saibadela.

all of them produce large fruit crops (*C. moschata, E. edulis* and *Ficus* spp.).

The results presented here indicate that it is very difficult to determine psittacid diet in dense primary forest and many years are needed to detect most of fruits used by the parrot community. It seems likely, however, that larger parrots may include a wider diversity of fruit in their diets and they can use both hard and soft fruits, but smaller species appear to be restricted to consuming seeds of berries and soft drupes. Roth (1984) studied niche overlap among 16 sympatric psittacid species in Amazon forests and also found the same pattern. Both differences in body mass and habitat use seem to be the predominant characters that allow the coexistence of phygenetically related species (Diamond 1973, Crome 1975, Schoener 1982).

Fruit hardness has been found to be important in dietary divergence among large seed predator specialists, such as peccaries and Pithecine monkeys (Kiltie 1982, Kinsey and Norconk 1993). The same relationship was expected to occur among parrots. Abbott *et al.* (1977)

found that seed hardness was important in determining diet divergence in Darwin's finches. In fact, parrot beak size is correlated with body mass, large psittacids with strong beaks are the only psittacids that can exploit very hard fruits such as palm nuts (Roth 1984). This allows large species (e. g. macaws) to specialize on fewer plant species (Yamashita and Valle 1993). It is also known that granivorous finches choose the seeds based on their nutritive values (Díaz 1994, 1996), but this character was not assessed in this study.

Roth (1984) divided the community of psittacids in Amazon into three groups: diet specialists (*Ara manilata*), partial specialists (*Brotogeris chrysopterus, Pionopsitta barrabandi, Ara ararauna* and *A. severa*) and generalists (*Amazona ochrocephala, A. farinosa, Aratinga weddellii, A. leucophthalmus,* and *Deroptyus acciptrinus*). At Saibadela, there were no diet specialist, mainly because there is no fruit that is produced all year round. All species showed a generalist diet but some trends seemed evident.

Fifty-four percent of the diet of the *Triclaria* parrot was composed of seeds of the Myrtaceae family. This family is the most abundant in the Atlantic forest (Mori *et. al.* 1983) and at least one species bears fruits each month. It is difficult to know if *Triclaria* is a specialist on Myrtaceae fruits, or if they are just using the most abundant resource. Collar *et al.* (1992) suggested that *T. malachitacea* is dependent on fruits of the palm *E. edulis*, but no evidence was found in this study. Bencke (1996) also found that *Euterpe* fruits are not important for *T. malachitacea* in Rio Grande do Sul, but that Myrtaceae fruits were more common in the diet.

Another intriguing point was that seeds of the genus Campomanesia (Myrtaceae), which are considered toxic for vertebrates (Landrum 1986), were commonly consumed by *T. malachitacea.* As pointed out by Bozinovic and Martínez del Rio (1996), other aspects such as physiology and anatomy of the birds, must be considered in foraging studies.

Seeds comprise an important source of carbohydrates, but are usually poor in lipids and protein (Díaz 1996). Therefore, it is expected that parrots should look for lipids in the fruit pulp of arillate fruits, such as *Virola* spp. The only fruit pulp consumed frequently by parrots (*C. moschata*), however, is rich in carbohydrates (84 % of the pulp dry mass), and poor in lipids (4.17 %) and proteins (1.2 %) (Galetti 1996). Proteins could be obtained from invertebrates and has indeed been recorded for some species studied here (Martuscelli 1994). It is not known where the parrots studied can obtain enough lipids since there are no data on seed chemical compositon of the study site.

Although some authors considered parrots as seed dispersers (Fleming *et al.* 1985, Bohning-Gaese *et al.* 1995), here they acted mainly as seed predators by destroying the seeds or by dropping the fruits below the parent tree.

Altitudinal differences. Pizo *et al.* (1995) carried out a similar study on the diet and abundance of psittacids in the highlands (c. 900 m a.s.l.) of Parque Estadual Intervales. One of the main differences observed in the diet of parrots in the lowland is that flowers were rarely used. This difference, however, could be an artefact of the sample size. In seasonal dry forests, parrots consume large amounts of flowers when fruits are not available (Galetti 1993, Wermundsen 1997). Fruit (and consequently seeds) were available throughout the year in the study site and there was no extreme fuit scarcity for seed predators.

Altitudinal migratory movements due to fruit availability is well known for some frugivorous birds in Costa Rica (Blake and Loiselle 1991, Loiselle *et al.* 1991). A similar pattern has been suggested for frugivorous birds in the Brazilian Atlantic forest, but there is no study that has addressed this question in detail. *Triclaria malachitacea* is the only parrot species considered to make altitudinal migration (Collar *et al.* 1992, Sick 1993, Whitney 1996), but the species was never studied year round. In fact, the evidence presented here shows that *T. malachitacea* is a year round resident, and the same result was found by Benche (1996) studying this parrot in Rio Grande do Sul.

Forpus crassirostris showed marked fluctuation in abundance between seasons in the study site being more common during the winter in the lowlands when compared to the highlands. *Brotogeris tirica* and the *F. crassirostris*, however, are more common during the wet season (December-March) (Pizo *et al.* 1995).

The data presented here indicate that the parrot community in the lowland Atlantic forest has similar mechanisms to allow coexistence among species as observed elsewhere in bird communities, such as body size and foranging strata (Wiens 1989). Seasonal fluctuations in abundance of parrot species in the lowlands is less marked than in the highlands of Serra de Paranapiacaba and such fluctuations seem to be related more to an abiotic (temperature and rainfall) than to a biotic (fruit/seeds availability) factor.

ACKNOWLEDGMENTS

I am grateful to Fundação Florestal for logistical support. V. Zipparo, G. Bencke, A. Aleixo, M. A. Pizo, and M. Paschoal for field assistance. Financial support was provided by the Wildlife Conservation Society, World Wildlife Fund-Brasil, John and Catherine T. MacArthur, Fundation (through Fundação O Boticário de Proteção a Natureza), U. S. fish and Wildlife Service (through ICBP-PACS), and Fundação MB. To Departamento de Botânica at UNESP-Rio Claro through Dr. L. P. C. Morellato for permission to use their facilities and to Dr. David Chivers for general discussions. In Cambridge I received a fellowship from the Brazilian Science Council (CNPq). B. Loiselle and an anonymous referee greatly improved the manuscript.

REFERENCES

Abbott, I. L. K. Abbott and P. R. Grant (1977) Comparative ecology of Galapagos ground finches (*Geospiza Gould*): evaluation of the importance of floristic diversity and interspecific competition. *Ecol. Monogr.* 47:151-184.

Aleixo, A. and M. Galetti (1997) The conservation of the avifauna in a lowland Atlantic forest in Brazil. *Bird Conserv. Intern.* 7:235-261.

Almeida-Scabbia, R. (1996) *Fitossociologia de um trecho de Mata Atlântica no sudeste do Brasil.* MSc thesis, Rio Claro: Univ. Est. Paulista.

Bencke, G. A. (1996) Projeto ecologia e conservação do sabiá-cica *Triclaria malachitacea* em fragmentos remanescentes de floresta no Rio Grande do Sul. p. 91-93. *In*: Anais V Congr. Bras. Ornit. Campinas: Univ. Est. de Campinas.

Best, B. A. (1984) The foods of Kakapo on Stewart island as determined from their feeding sign. *New Zealand J. Ecol.* 7:71-83.

Bibby, C. J., N. D. Burgess and D. A. Hill (1992) *Bird census techniques.* London: Academic Press.

Blake, J. G. and B. A. Loiselle (1991) Variation in resource abundance affects capture rates of birds in three lowland habitats in Costa Rica. *Auk* 108:114-130.

Bohning-Gaese, K., B. H. Gaese and S. B. Rabemanantsoa (1995) Seed dispersal by frugivorous tree visitors in the Malagasy tree species *Commiphora guillaumini. Ecotropica* 1:41-50.

Bozinovic, F. and C. Martínez del Rio (1996) Animals reject our foraging models eating what they should not. *Rev. Chilena Hist. Nat.* 69:15-20.

Cannon, C. E. (1984) The diet of lorikeets *Trichoglossus* spp. in the Queensland-New South Wales border region. *Emu* 84:16-22.

Chapman, C. A., L. J. Chapman and L. Lefebre (1989) Variability in parrot flock size: possible functions of communal roosts. *Condor* 91:842-847.

Collar, N. J., M.J. Crosby and A. J. Stattersfield (1994) *Birds to Watch 2: the world list of threatened birds.* Cambridge: Birdlife Conservation Series nº 4.

___, L. P. Gonzaga, N. Krabbe, A. Madroño-Nieto, L. G. Naranjo, T. A. Parker III., and D. C. Wege (1992) *Threatened Birds of the Americas.* Cambridge: ICBP.

Crome, F. H. J. (1975) The ecology of fruit pigeons in tropical Northern Queensland. *Austr. J. Wild. Res.* 2:155-185.

Diamond, J. M. (1973) Distributional ecology of New Guinea birds. *Science* 179:759-769.

Díaz, M. (1994) Variability in seed size selection by granivorous passerines: effects of seed size, seed nutritive value and bird morphology. *Ibis* 99:1-6.

___ (1996) Food choice by seed-eating birds in relation to seed chemistry. *Comp. Bioch. and Physiol.* 113ª:239-246.

Eitniear, J. C., S. McGhee and W. Waddell (1994) Observations on the feeding upon *Psittacanthus calyculatus* by brown-hooded parrots *(Pionopsitta haematotis). Ornitologia Neotropical* 5:119-120.

Fleiming, T. H., C. F. Williams, F. J. Bonaccorso and L. H. Herbst (1985) Phenology, seed dispersal, and colonization in *Mutingia calabura*, a Neotropical pioneer tree. *Am. J. Bot.* 72:383-391.

Forshaw, J. M. (1989) *Parrots of the world.* 3rd edition. Willoughby: Lansdowne Press.

Galetti, M. (1993) Diet of the Scaly-headed Parrot (*Pionus maximiliani*) in a semideciduous forest in southeastern Brazil. *Biotropical* 25:419-425.

___ (1996) *Fruits and frugivores in a Brazilian Atlantic forest.* PhD thesis. Cambridge: Univ. Cambridge.

___ and F. Pedroni (1996) Feeding behaviour of Peach-fronted Parakeet at Serra do Cipó, Minas Gerais, Brazil. *Cotinga* 6:59-60.

___ and M. Rodrigues (1992) Comparative seed predation on pods by parrots in Brazil. *Biotropical* 24:222-224.

Grant, P. R. and B. R. Grant (1980) Annual variation in finch numbers, foraging and food supply on Isla Daphne Major, Galápagos. *O ecologia* 46:55-62.

Guix, J. C. (1995) *Aspectos da frugivoria, disseminação e predação de sementes por vertebrados nas florestas nativas do Estado de São Paulo, sudeste do Brasil.* Ph. D. thesis. Barcelona: Univ. Barcelona.

Jackson, J. R. (1963) Do Keas attack sheep? *Notornis* 10:33-38.

Janzen, D. H. (1981) *Ficus ovalis* seed predation by an Orange-chinned Parakeet *(Brotogeris jugularis)* in Costa Rica. *Auk* 98:841-844.

Kiltie, R. A. (1982) Bite force as a basis for niche differentiation between rain forest peccaries (*Tayassu tajacu* and *T. Peccari*). *Biotropical* 14:188-195.

Kinsey, W. G. and M. A. Norconk (1993) Physical and chemical properties of fruit and seeds eaten by *Pithecia* and *Chiropotes* in Surinam and Venezuela. *Intern.* J. Primatol. 14:207-227.

Lambert, F. R. (1993) Trade, status and management of three parrots in the North Moluccas, Indonesia: White Cockatoo *Cacatua alba*, Chattering Lory *Lorius garrulus* and Violet-eared Lory *Eos squamata. Bird Conserv. Intern.* 3:145-168.

Landrum, L. R. (1981) A monograph of the genus *Campomanesia* (Myrtaceae). *Flora Neotropical* nº 29 New York: New York Botanical Garden.

Leighton, M. and D. R. Leighton (1983) Vertebrate responses to fruiting seasonality within a Bornean rainforest p. 181-209 *In: Tropical rainforests: ecology and management.* S. L. Sutton, T. C. Whitmore and A. C. Chadwick (eds.). Oxford: Blackwell Sci. Publ.

Loiselle, B. A. and J. B. Blake (1993) Spatial distribution of understory fruit-eating birds and fruiting plants in a Neotropical lowland wet forest. *Vegetatio* 107/108:177-190.

___ and ___ (1991) Temporal variation in birds and fruits along an elevatonal gradient in Costa Rica. *Ecology* 72:180-193.

Marsden, S. J. (1992) The distribution, abundance and habitat preferences of the Salmon-crested *Cockatoo Cacatua moluccensis* on Seram, Indonesia. *Bird Conserv. Intern.* 2:7-14.

___ (1995) *The Ecology and Conservation Status of the Parrots of Sumba, Buru ans Seram, Indonesia.* Ph, D. thesis, Manchester: Manchester Metrop. Univ.

Martuscelli, P. (1994) Marron-bellied Conures feed on gall-forming homopteram larvae. *Wilson Bull.* 106:769-770.

___ (1995) Ecology and conservation of the red-tailed Amazon *Amazona brasiliensis* in south-easten Brazil. *Bird Conserv. Intern.* 5:225-240.

Mori, S. A., B. M. Boom, A. M. Carvalino and T. dos Santos (1983) Ecological importance of Myrtaceae in an eastern Brazilian wet forest. *Biotropical* 15:68-70.

Munn, C. A. (1988) Macaw biology in Manu National Park, Peru. *Parrot Letter* 1:18-21.

Norusis, M. J. (1994) *SPSS for Windows: Base System User's Guide, realase 6.0. SPSS* Inc., Chicago.

Olmos, F. (1996) Satiation or deception? Mast-seeding *Chusquea* bamboos, birds and rats in the Atlantic forest. *Rev. Brasil. Biol.* 56:391-401.

Pizo, M. A., I. Simão and M. Galetti (1995) Diet and flock size of sympatric parrots in the Atlantic forest of Brazil. *Ornitologia Neotropical* 6:87-95.

___, ___ and ___ (1997) Daily variation in activity and flock size of two parakeets species from southeastern Brazil. *Wilson Bull.* 109:343-348.

Poulin, B., G. Lefebvre and R. McNeil (1992) Tropical avian phenology in relation to abundance and exploitation of food resources. *Ecology* 73:2295-2309.

___, ___ and ___ (1993) Variations in bird abundance in tropical arid and semi-arid habitats. *Ibis* 135:432-441.

Roth, P. (1984) Repartição do habitat entre Psitacídeos simpátricos na Amazonia. *Acta Amazonica* 14:175-221.

Scherer-Neto, P. S. and J. A. Muller (1984) Aspectos bionômicos de cuiu-cuiu Pionopsitta pileata (Scopoli, 1769) (Psittacidae, Aves). *Arq. Biol. E Tecnol. do Paraná* 27:391-399.

Schoener, T. W. (1982) The controversy over interspecific competition. *Am. Scient.* 70:586-595.

Sick, H. (1993) *Birds in Brazil.* Princeton: Princeton Univ. Press.

Snow, D. W. (1981) Tropical frugivorous birds and their food plants: a world survey. *Biotropical* 13:1-14.

Sokal, R. R. and F. J. Rohlf (1995) *Biometry.* 3rd edition. New York: W. H. Freeman and Company.

Varty, N., G. Bencke, L. M. Bernardini, A. S. Cunha, E. Dias, C. S. Fontana, D. L. Guadagnin, E. Kindel, M. M. Raymundo, M. Richter, A. Rosa and C. Tostes (1994) Conservação do papagaio-charão *Amazona petrei* no sul do Brasil: um plano de ação preliminar. *Divul. do Museu de Ciênc. e Tecnol.* 1:1-70.

Waltman, J. R. and S. R. Beissinger (1992) Breeding behaviour of the Green-rumped parrotlet. *Wilson Bull.* 104:65-84.

Wermundsen, T. (1997) Seasonal change in the diet of the Pacific Parakeet *Aratinga strenua* in Nicaragua. *Ibis* 139:566-568.

Wheelwright, N. T. (1982) Fruits and the ecology of resplendent quetzals. *Auk* 100:286-301.

Whitney, B. M. (1996) Flight behaviour an other field characteristics of the genera of Neotropical parrots. *Cotinga* 5:32-42.

Wiens, J. A. (1989) *The ecology of bird communities.* Vol. 1. Cambridge: Cambridge Univ. Press.

Yasmashita, C. and P. M. Valle (1993) On the linkage between *Anodorhyncus* macaws and palm nuts and the extinction of the *glaucous* macaw. *Bull. Brit. Orn. Club* 113:53-61.

Ararajuba 5(2):127-133
dezembro de 1997

DNA Fingerprinting applied to parrot captive breeding programs

Cristina Yumi Miyaki[1], Sérgio Luiz Pereira[1], Iara Biasia[2] and Anita Wajntal[1]
[1]*Departamento de Biologia, Universidade de São Paulo, Rua do Matão, 277, 05508-900, São Paulo, SP, Brazil*
[2]*Parque Ecológico do Tietê, Rua Ira Acangatara, 70, 03719, São Paulo, SP, Brazil. E-mail: cymiyaki@usp.br*

Recebido em 20 de março de 1997; aceito em 12 de agosto de 1997

RESUMO. **"DNA fingerprinting" (identificação individual pelo DNA) aplicada a programas de reprodução em cativeiro de psitacídeos.** A reprodução em cativeiro de papagaios do gênero *Amazona* é um evento raro no Brasil. Um dos fatores desta falta de sucesso poderia estar ligado ao endocruzamento. Nós estudamos este problema utilizando as sondas de minissatélite multilocos 33.6 e 33.15 e concluimos que a população cativa estudada ainda possui variabilidade genética e, portanto, outros fatores podem estar afetando a baixa taxa de reprodução. Nós também pudemos confirmar a filiação de dois filhotes de *A. brasiliensis*, três filhotes de *A. ocrocephala xantholaema* e seis filhotes de *A. aestiva* nascidos em cativeiro. Estes são os primeiros nascimentos ocorridos nestas espécies que foram documentados com o método de identificação individual pelo DNA.

PALAVRAS-CHAVE: *Amazona*, confirmação de filiação, papagaio, Psittacidae, reprodução em cativeiro, variabilidade genética.

ABSTRACT. Captive breeding of *Amazona* parrots is a rare event in Brazil. One of the possible reasons is that these birds may be inbred. We evaluated this problem using the human minisatellite multilocus probes 33.6 and 33.15 and concluded that this captive population still retains genetic variability. Other factors must be influencing their low rate of reproduction. We also confirmed the parentage of two chicks of the endangered *A. brasiliensis*, three chicks of *A. ocrocephala xantholaema* and six chicks of *A. aestiva*, born in captivity. This is the first time that DNA fingerprinting has been applied to document the birth of chicks of these species in Brazil.

KEY WORDS: *Amazona*, captive breeding, genetic variability, parentage assignment, parrot, Psittacidae.

Twenty nine species of the genus *Amazona* occur in the American continent from Mexico to Paraguay (Forshaw 1989). In Brazil, there are 11 species (Sick 1993), some of which have a broad distribution, as *Amazona aestiva*, while some inhabit restricted areas, as is the case of *Amazona brasiliensis*.

Recently, two taxonomic modifications have been proposed: a new species, *Amazona kawalli*, was characterized (Grantsau and Camargo 1989, Collar and Pittman 1996), and it has been concluded that *Amazona xanthops* should be excluded from the genus, based on karyotype, morphology and mitochondrial DNA differences (Valentine 1990, Birt *et al.* 1992, Duarte and Caparroz 1995) and its previous scientific name should be adopted (*Salvatoria xanthops*; Duarte and Caparroz 1995).

Twelve American amazons are threatened (Collar *et al.* 1992) and four Brazilian species (*A. brasiliensis*, *A. pretrei*, *A. rhodocorytha* and *A. vinacea*) are listed in Appendix I of CITES (Convention for the International Trade of Endangered Species). Habitat destruction, which affects nest-sites and food availability and which fragments populations, and illegal trading, are the most threatening factors causing the decrease in population sizes. Small populations can lose their genetic variability due to genetic drift. Also consanguineous matings frequently result in low fertility, resulting in extinction of local populations (Gilpin and Soulé 1986, Lacy 1987, Lacy *et al.* 1989).

Preservation programs *in situ* and captive reproduction are recommended by conservation specialists. Captive breeding in a safe environment should be established before the population is at risk. Although some parrots reproduce easily in captivity, amazons in general are difficult to breed. Even with a high input of effort and money, the rate of reproduction in captivity is usually low (Derrickson and Snyder 1992). One possible reason for the failure of these programs could be the low genetic variability and high consanguinity of the remaining populations.

With the exception of some Zoological Gardens, such as the Sorocaba Zoo, there is no official captive breeding program of parrots in Brazil. The best results are obtained by some private aviculturists, but they do not have the credibility of official institutions which have no means of discriminating between true breeders and those who use their activities to obscure pouching.

DNA techniques can be used to estimate genetic variability of wild and captive populations, as well as to determine parentage, confirm successful breeding and prove illegal trading (Mathé *et al.* 1993, Ruth and Fain 1993). They are also important for monitoring genetic variability and to prevent consanguineous matings in captive populations. DNA fingerprinting, using the human minisatellite multilocus probes, was applied in captive breeding of amazons (Brock and White 1992). This technique is also useful to sex parrots of the genus *Aratinga* (Miyaki *et al.* 1992, 1995), *Ara* (Miyaki *et al.* 1993) and *Anodorhynchus* (Miyaki *et al.* 1997). The sex determination of parrots is essential for the success of captive breeding programs since there is no sexual dimorphism in many species.

In this work we present our results of DNA fingerprinting using human minisatellite multilocus probes 33.6 and 33.15 (Jeffreys *et al.* 1985a) in eight Brazilian species of the genus *Amazona*. We also present evidence for the success of captive breeding of *A. aestiva*, *A. brasiliensis* and *A. ochrocephala xantholaema* with the same method.

METHODS

The blood samples from presumably unrelated individuals were collected from birds belonging to aviculturists and official establishments in São Paulo, Brazil by venipuncture. Thirteen *Amazona aestiva aestiva*, four *A. aestiva xanthoperyx*, five *A. amazonica*, six *A. brasiliensis*, two *A. ochrocephala*, ten *A. pretrei*, eight *A. vinacea* and four *A. xanthops* were studied. Besides these birds, small families were available for *A. aestiva* (couple and six chicks), *A. brasiliensis* (couple and two chicks) and *A. ochrocephala* (couple and three chicks). The sex of some of the birds of each species was identified by karyotyping or laparoscopy.

The protocols applied to obtain multilocus fingerprints have been described in detail elsewhere (Bruford *et al.* 1992). Five µg of genomic DNA from each bird were digested with the restriction enzyme *Mbo*I. The fragments were separated by electrophoresis through a 30 cm long 1% horizontal agarose gel. Electrophoresis was stopped when the 2 kilobase (kb) marker had migrated to the bottom of the gel. The fractionated DNA fragments were transferred onto a nylon membrane (Hybond Nfp, Amersham) by capillary Southern blotting (Sambrook *et al.* 1989).

The human minisatellite multilocus probes 33.15 and 33.6 (Jeffreys *et al.* 1985a) were oligolabelled with [α-^{32}P]dCTP or [α-^{32}P]dATP. Pre-hybridization was undertaken by incubation in 0.263M NaPhosphate, 1 mM EDTA, 7% SDS, 1% BSA (Westneat 1990) at 65°C for four hours. One probe at a time was added to the solution and left overnight at the same temperature. The membrane was washed in 2X SSC, 0.1% SDS and in 1X SSC, 0.1% SDS at 65°C. The filter was then autoradiographed for one to ten days at -70°C using x-ray film and one or two intensifying screens.

Only the scorable bands were considered. The coefficient of band sharing (index of similarity) between individuals was calculated using the formula: $X = 2N_{AB}/(N_A + N_B)$, where N_A and N_B are the number of bands present in individuals A and B, respectively, and N_{AB} is the number of bands shared by A and B (Wetton *et al.* 1987, Bruford *et al.* 1992).

Assuming that the bands scored are independent markers, we can estimate the mean probability that all **n** bands in an individual's fingerprint are present in a second random individual conservatively as $< x^n$ (Bruford *et al.* 1992).

The probability (I) that all the chick's bands are shared with a couple by chance, is estimated as: $I = (1-(1-X)^2)^n$ (Jeffreys *et al.* 1985b), where **n** is the number of bands in common between the chick and putative parents.

Segregation analysis of the bands of six chicks of *A. aestiva* was performed as described by Miyaki *et al.* (1995).

RESULTS

The band patterns observed after the hybridization using probes 33.6 and 33.15 are characterized by a large number of bands (figure 1). Table 1 presents, for each species studied, the mean number of bands, the mean index of similarity, the mean band frequency and the expected probability of individual band pattern for unrelated birds using probes 33.6 and 33.15.

In the family of *A. brasiliensis*, all the bands present in both chicks' patterns are present in their parents; approximately 50% of the bands detected by probes 33.6 and 33.15 are shared with the mother and the other 50% are of paternal origin. The mean probabilities of this couple sharing all the bands with the chicks only by chance are 3.7×10^{-3} for probe 33.6 and 2.71×10^{-8} for probe 33.15. It was also possible to confirm the parentage in the families of *A. aestiva* and *A. ochrocephala*. All bands in the chicks detected with both minisatellite probes were also visualized in the parents; however, most of the bands detected with probe 33.6 were of paternal origin in *A. ochrocephala*.

The segregation analysis in the *A. aestiva* family showed that at least 9 maternal and 11 paternal loci were detected by probe 33.6 (figure 2).

DISCUSSION

DNA fingerprinting is being applied as a powerful tool for individual identification and paternity testing in different species of birds (Burke and Bruford 1987, Wetton *et al.* 1992). This technique can be applied to estimate consanguineous relationships between individuals and potentially can be used to monitor the genetic variability of captive birds (Brock and White 1992). Besides, it can be used to determine the sex of some parrots, including *Aratinga* spp (Miyaki *et al.* 1992, 1995), *Ara* spp (Miyaki *et al.* 1993), *Anodorhynchus* spp and *Cyanopsitta spixii* (Miyaki *et al.* 1997). It was also used to determine the sex

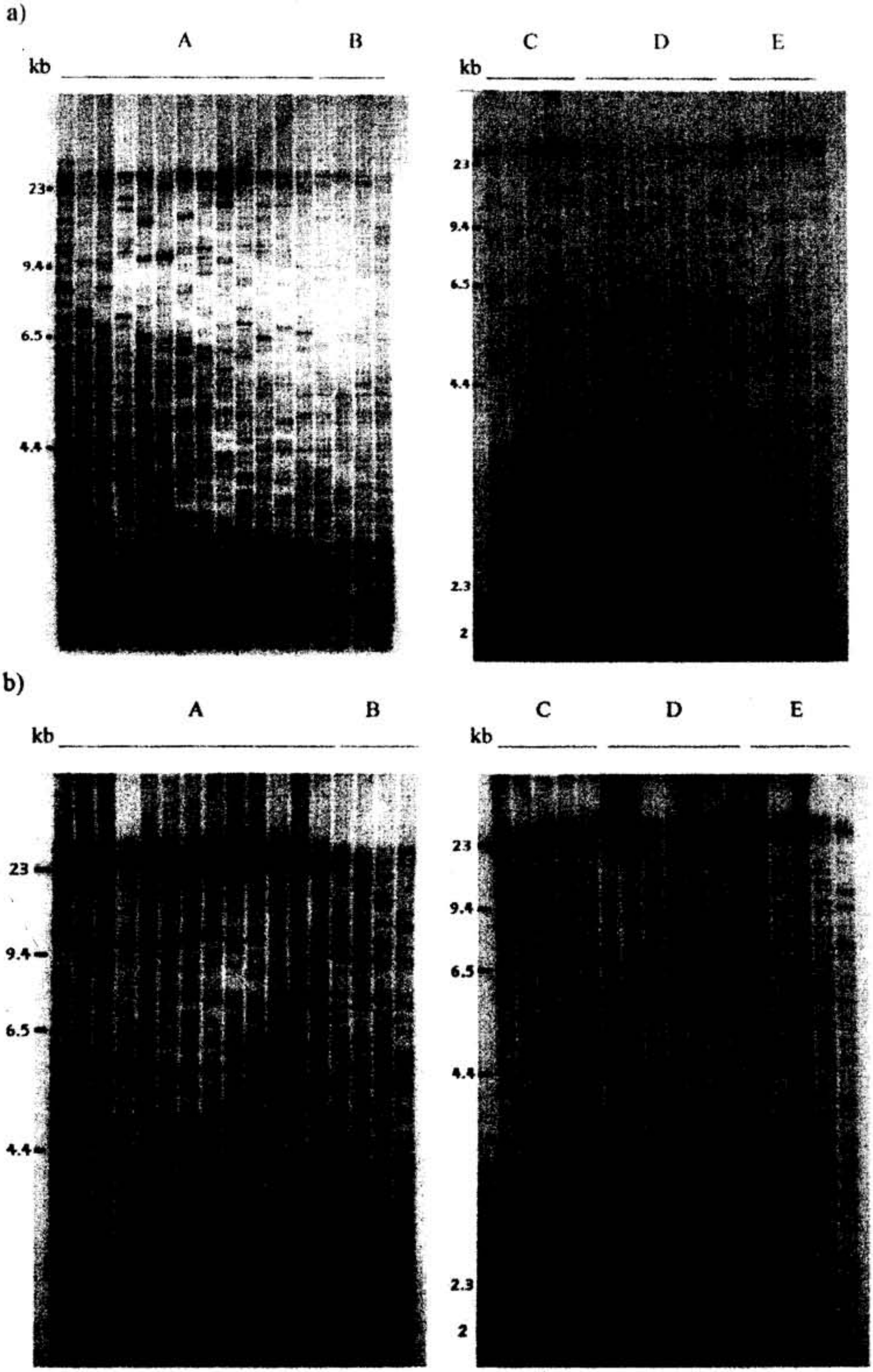

Figure 1. Multilocus DNA fingerprints of 34 individuals belonging to four *Amazona* species. a) Patterns obtained with human minisatellite multilocus probe 33.6. b) Patterns obtained with human minisatellite multilocus probe 33.15. A) *A. aestiva aestiva*, B) *A. aestiva xanthopteryx*, C) *A. amazonica*, D) *A. brasiliensis*, E) *A. ochrocephala xantholaema*.

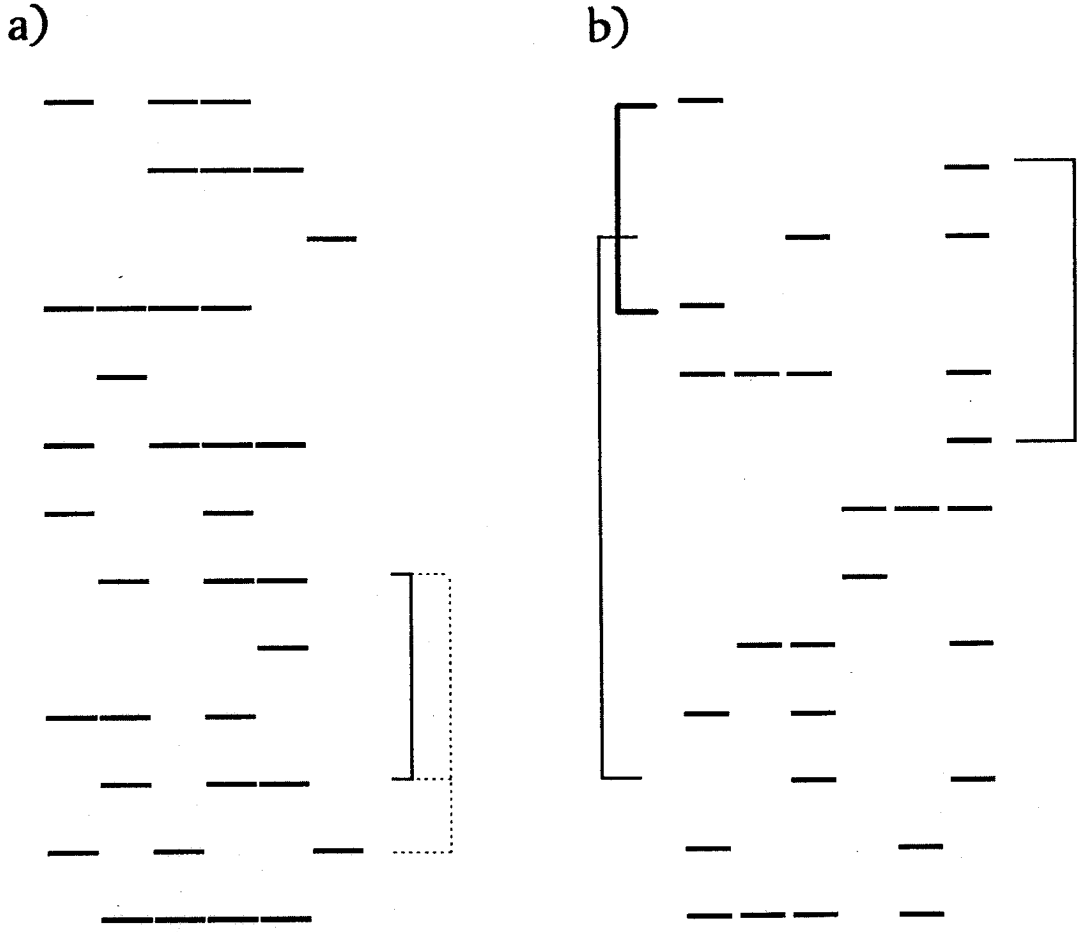

Figure 2. Segregation analysis of bands detected by minisatellite multilocus probe 33.6 in six full sibs of *Amazona aestiva*. Filled lines are co-segregating groups and dotted lines are allelic pairs. a) Paternal bands. b) Maternal bands.

ratio of chicks in a natural population of *Anodorhynchus hyacinthinus* (Miyaki *et al.* unpublished).

Interestingly, these W-chromosome linked bands could not be visualized in any of the *Amazona* species studied. This could be explained by the evolutionary history of this sex-linked minisatellite. The genera *Aratinga*, *Ara* and *Anodorhynchus* are phylogenetically closer to each other than to the genus *Amazona* and this may be related to the gain/loss of this minisatellite sequence.

The band sharing coefficients observed between unrelated individuals of the most endangered *Amazona* species (*A. brasiliensis*, *A. pretrei* and *A. vinacea*) are not higher than the ones found in other species of the same genus (table 1) and in various species of *Aratinga* parrots and other birds (Miyaki *et al.* 1995). This result indicates that the genetic variability among captive populations, measured by the DNA technique, is not depleted. These data indicate that the correct management of such populations should improve captive breeding efforts.

The similarity index (band sharing coefficient) between first degree relatives was higher, as expected, than those between unrelated birds (table 2). This coefficient can be used to advise breeders in their choice of less related pairs to mate.

In this work, we also report the successful captive breeding of *A. aestiva*, *A. brasiliensis* and *A. ochrocephala*, as demonstrated by DNA fingerprinting. All the bands present in the chicks were visualized in the parents, thus confirming the parentage of these families.

To our knowledge, successful captive breeding of *A. brasiliensis* has been claimed previously in only three occasions. The first one being of an Italian parrot breeder, G. A. della Riva, who owned an aviary in Miracatú, SP until his death in 1978 (Low 1986). N. Kawall (pers. obs.),

Table 1. Results of hybridization with human minisatellite multilocus probes 33.6 and 33.15 in unrelated individuals of *Amazona* species.

Probe	Species	N	n±sd	x±sd	x^n	q
33.6	*A. aestiva aestiva*	13	36.85±4.58	0.25±0.11	6.5x10^{-23}	0.134
	A. aestiva xanthopteryx	4	37.75±0.96	0.38±0.07	1.4x10^{-19}	0.212
	A. amazonica	5	27.8±7.3	0.22±0.09	5.2x10^{-19}	0.117
	A. brasiliensis	7	26.4±5.6	0.30±0.08	1.6x10^{-14}	0.163
	A. ochrocephala xantholaema	2	28.2±5.8	0.45	1.7x10^{-10}	0.258
	A. vinacea	8	20.9±4.6	0.14±0.07	1.4x10^{-18}	0.073
	A. xanthops	4	29.0±2.8	0.13±0.04	2x10^{-26}	0.067
33.15	*A. aestiva aestiva*	13	38.25±6.47	0.29±0.07	2.7x10^{-21}	0.157
	A. aestiva xanthopteryx	4	37.75±2.63	0.26±0.05	8.2x10^{-23}	0.140
	A. amazonica	5	45±7	0.28±0.09	1.3x10^{-25}	0.151
	A. brasiliensis	7	45.43±3.73	0.23±0.06	1x10^{-29}	0.122
	A. ochrocephala xantholaema	2	47.5±2.1	0.13	2.3x10^{-39}	0.067
	A. pretrei	10	26,00±3,46	0,12±0,07	4,7x10^{-25}	0,060
	A. vinacea	8	23.9±4.3	0.15±0.07	2x10^{-20}	0.078
	A. xanthops	4	27.5±3.5	0.15±0.06	2.2x10^{-23}	0.078

N - number of individuals; n - mean number of bands; sd - standard deviation; x - mean band sharing coefficient; x^n - probability for two unrelated individuals to show the same band pattern; q - mean band frequency (Jeffreys *et al.* 1985a).

Table 2. Mean number of bands of maternal and paternal origin, mean band sharing coefficient between parents and offspring and between full siblings of *Amazona* species.

Probe	Species	$x_{p\text{-}o}$±sd	n_f±sd	n_m±sd	x_s±sd	n_s±sd
33.6	*A. brasiliensis*	0.54±0.06	6 (54 %)	5 (46 %)	0.58	10
	A. ochrocephala	0.46±0.15	11.67±3.78 (70 %)	5±1 (30 %)	0.75±0.05	21±3
33.15	*A. brasiliensis*	0.49±0.02	20 (51 %)	19 (49 %)	-	-
	A. ochrocephala	0.46±0.10	17±3 (48 %)	18.67±6.35 (52 %)	0.53±0.06	42±5

$x_{p\text{-}o}$ - mean band sharing coefficient between parents and offspring; sd - standard deviation; n_f - mean number of bands of paternal origin; n_m - mean number of bands of maternal origin; x_s - mean band sharing coefficient between full siblings; n_s - mean number of bands in common between full siblings

a reputed Brazilian parrot breeder, visited this aviary on many occasions and stated that he saw several hybrids between an *A. brasiliensis* male and various *A. aestiva* females, but he never saw evidence of or heard about a successful intraspecific mating of *A. brasiliensis* in della Riva's aviary. Diefenbach and Goldhammer (1986) stated that della Riva obtained 15 hybrid birds by mating *A. aestiva* males with *A. brasiliensis* females. N. Kawall himself successfully bred *A. brasiliensis* in his aviary in only two occasions; one chick was produced in 1980 (Diefenbach and Goldhammer 1986) and another chick from a different pair, in 1988. Because of the low reproductive success and possible behavioural peculiarities of the mating behaviour of this species in captivity, we describe here the special circumstances of successful breeding. The original couple of *A. brasiliensis* we studied belonged to N. Kawall and was previously sexed by karyotype analysis. A peculiarity in the behaviour of the male was observed constantly: whenever it was in visual contact with *A. aestiva* females, it started to attack his own female and the couple had to be separated. Because of the arrangement of the cages in this aviary, it was difficult to place the birds in such a way as to prevent eventual visualization of *A. aestiva* females. Therefore the pair was removed to the aviary of another breeder, L. Maluf, where it was better isolated from other birds. During the next breeding season, following this transference, the couple mated and two chicks were born in December 1992; one of them died within the first days, but was not removed from the nest to avoid disturbance of the pair.

We studied this pair, their surviving chick and another chick born in 1994. DNA samples from other four unrelated *A. brasiliensis* individuals belonging to other aviaries, were also hybridized with minisatellite multilocus probes

33.6 and 33.15. Band segregation data detected in fingerprints are not available for *A. brasiliensis*, since this is the first birth documented by DNA fingerprinting and big families are not available. These segregation data are important for estimating the number of loci scored for paternity assignment and other forensic use. Brock and White (1991) have reported that in *Amazona ventralis* there are only 6 independent loci detected by probe 33.15. Miyaki *et al.* (1995) detected 14 unlinked loci in *Aratinga aurea* using the same probe. In this report, at least 9 independent loci were detected in *A. aestiva*. Assuming that in *A. brasiliensis* the number of segregating loci lies between 6 and 9 independent loci, the probability that this couple of birds will share all the bands with the chick by chance, lies between 7.3×10^{-4} and 2×10^{-5}. Thus, even without precise estimation of the number of unlinked loci, it can be possible to establish the paternity of the chicks studied. Hopefully, future matings of this or another couple will allow a better estimation of the number of loci detected .

The applications of multilocus fingerprint analysis in parrots are multiple: it can be used to determine the sex of some species, determine the paternity of chicks born in captivity, for individual identification and to provide data for the reproductive management of captive populations.

ACKNOWLEDGEMENTS

We thank T. Burke for the opportunity to visit his laboratory, O. Hanotte and C. F. M. Menck for their constant support and two annonymous referees for their suggestions. We thank FAPESP, CAPES and CNPq (Brazil) for financial support; L. Maluf, A. Marra, J. Moutran and A. Vertematti (aviculturists), J. M. B. Duarte and R. Caparroz (UNESP-Jaboticabal) and L. A. Labruna (Parque Ecológico do Tietê, SP) for parrot blood samples. C. Y. M. has a Fundo BUNKA/90 prize. The Jeffreys probes 33.6 and 33.15 are the subject of patent nº GBA2166445 and world wide patents (pending) for commercial diagnostic use.

REFERENCES

Birt, T. P., V.L. Friesen, J. M. Green, W. A. Monte Vecchi and W. S. Davidson (1992) Cytochrome-b sequence variation among parrots. *Hereditas* 117:67-72.

Brock, M. K. and B. N. White (1991) Multifragment alleles in DNA fingerprints of the parrot, *Amazona ventralis*. *J. Hered.* 82:209-212.

___ and __ (1992) Application of DNA fingerprinting to the recovery program of the endangered Puerto Rican parrot. *Proc. Natl. Acad. Sci. USA* 89:11121-11125.

Bruford, M. W., O. Hanotte, J. F. Y. Brookfield and T. Burke (1992) Single-locus and multilocus DNA fingerprinting, p. 225-269. *In*: A. R. Hoelzel (ed.) *Molecular genetic analysis of populations- a practical approach.* New York: Oxford Univ. Press.

Burke, T. and M. K. Bruford (1987) DNA fingerprinting in birds. *Nature* 327:149-152.

Collar, N. J., L. P. Gonzaga, N. Krabbe, L. G. Madroño-Nieto, L. G. Naranjo, T. A. Parker III and D. C. Wege (1992) *Threatened birds of the Americas - the ICBP/IUCN red data book*, 3rd edition. London: Smithsonian Inst. Press.

___ and A. J. Pittman (1996) *Amazona kawalli* is a valid name for a valid species. *Bull. Brit. Orn. Club* 116:256-265.

Derrickson, S. R. and N. F. R. Snyder (1992) Potentials and limits of captive breeding in parrot conservation p. 132-162. *In*: Beissinger, S. R. and N. F. R. Snyder (eds.) *New World parrots in crisis.* London: Smithsonian Inst. Press.

Diefenbach, K. H. and S. P. Goldhammer (1986) Biologie und Onkologie der Rotschwanzamazone (*Amazona brasiliensis*). *Trochilus*, Heft 3. (A translation of this article was published in Portuguese by *Boletim da Sociedade Ornitológica Bandeirante* 13:1-4, 1992).

Duarte, J. M. B. and R. Caparroz (1995) Cytotaxonomic analysis of Brazilian species of the genus *Amazona* (Psittacidae, Aves) and confirmation of the genus *Slavatoria* (Ribeiro, 1920). *Braz. J. Genet.* 18:623-628.

Forshaw, J. M. (1989) *Parrots of the world.* Neptune, N. J.: T. F. H. Publications, Inc.

Gilpin, M. E. and M. E. Soulé (1986) Minimum viable populations: process of species extinction p. 19-33. *In*: M. E. Soulé (ed.) *Conservation biology, the science of scarcity and diversity.* Sunderland: Sinauer Ass. Inc. Publ.

Grantsau, R. and H. F. A. Camargo (1989) Nova espécie brasileira de *Amazona* (Aves, Psittacidae). *Rev. Bras. Biol.* 49:1017-1020.

Jeffreys, A. J., V. Wilson and S. L. Thein (1985a) Hypervariable "minisatellite" regions in human DNA. *Nature* 314:67-73.

___, J. F. Y. Brookfield and R. Semeonoff (1985b) Positive identification of an immigration test-case using human DNA fingerprints. *Nature* 317:818-819.

Lacy, R. C. (1987) Loss of genetic diversity from managed populations: interacting effects of drift, mutation, immigration, selection, and population subdivision. *Conserv. Biol.* 1:143-158.

___, N. R. Flesness and U. S. Seal (1989) Puerto Rican parrot (*Amazona vittata*) population viability analysis p.129. *Report to the US Fish and Wildlife Service.* Captive Breeding Specialist Group, Species Survival Comission, IUCN. Minnesota: Apple Valley.

Low, R. (1986) *Parrots, their care and breeding.* London: Blandford Press Ltd.

Mathé, J., C. Eisenmann and A. Seitz (1993) Paternity testing of endangered species of birds by DNA fingerprinting with non-radioactive labelled oligonucleotide probes p.387-393. *In*: S. D. J. Pena, R.

Chakraborty, J. T. Epplen and A. J. Jeffreys (eds.) *DNA fingerprinting: the state of the science.* Basel: Birkhäuser Verlag.

Miyaki, C. Y. , J. M. B. Duarte, R. Caparroz, A. L. V. Nunes and A. Wajntal (1997) Sex identification of Brazilian parrots (Psittacidae, Aves) using the human minisatellite probe 33.15. *Auk* 114:516-520.

___, O. Hanotte, A. Wajntal and T. Burke (1992) Sex typing of *Aratinga* parrots using the human minisatellite probe 33.15. *Nucl. Acids Res.* 20:5235-5236.

___, ___ , ___ and ___ (1993) Characterization and applications of multilocus DNA fingerprinting in Brazilian endangered macaws p. 395-401. *In*: S. D. J. Pena, R. Chakraborty, J. T. Epplen and A. J. Jeffreys (eds.) *DNA fingerprinting: state of the science*, Basel: Birkhäuser Verlag.

___, ___ , ___ and ___ (1995) DNA fingerprinting in the endangered parrot *Aratinga guarouba* and other *Aratinga* species. *Braz. J. Genet.* 18:405-411.

Ruth, J. L. and S. R. Fain (1993) The 'individualization' of large North American mammals p. 429-436. *In*: S. D. J. Pena, R. Chakraborty, J. T. Epplen and A. J. Jeffreys (eds.) *DNA fingerprinting: the state of the science.* Basel: Birkhäuser Verlag.

Sambrock, J., E. F. Fritsch and T. Maniats (1989) *Molecular cloning- a laboratory manual.* New York: Cold Spring Harbor Laboratory Press.

Sick, H. (1993) *Birds in Brazil.* Princeton: Princeton Univ. Press.

Valentine, M. (1990) Chromosome analysis p. 127-131. *In*: J. Stoodley, P. Stoodley, P. G. H. Evans, P. W. Scott, M. Valentine, R. Teitler and G. J. Harrison. *Genus Amazona.* London: Bezels Publications.

Westneat, D. F. (1990) Genetic parentage in the indigo bunting: a study using DNA fingerprinting. *Behav. Ecol. Sociobiol.* 27:67-76.

Wetton, J. H., R. E. Carter, D. T. Parkin and D. Walters (1987) Demographic study of a wild house sparrow population by DNA fingerprinting. *Nature* 327:147-149.

___, D. T. Parkin and R. E. Carter (1992) The use of genetic markers for paternity analysis in *Passer domesticus* (house sparrow). *Hered.* 69:243-254.

Ararajuba 5(2):135-139
dezembro de 1997

Extra-pair paternity in the Golden Conure (*Guaruba guarouba*) (Psittacidae: Psittaciformes) detected in captivity

Felipe Becker Albertani, Cristina Yumi Miyaki and Anita Wanjtal

Departamento de Biologia, Universidade de São Paulo, Rua do Matão, 277, 05508-900, São Paulo, SP, Brazil. E-mail: aniwa@usp.br

Recebido em 20 de março de 1997; aceito em 16 de junho de 1997

RESUMO. **Paternidade extra-par em ararajuba *Guaruba guarouba* (Psittacidae: Psittaciformes) detectada em cativeiro.** Os estudos com psitacídeos sugerem que, pelo menos os de maior porte, formem casais fiéis por toda a vida, mas ainda existem espécies pouco estudadas, como *Guaruba guarouba*, que apresenta um comportamento gregário. Foram aplicadas técnicas de "DNA fingerprinting" para o estudo do comportamento reprodutivo de *G. guarouba* em cativeiro e para determinação do sexo dos indivíduos analisados. Foi encontrado que uma mesma fêmea foi fertilizada por dois machos distintos em cativeiro e teve quatro filhotes de um e um de outro em uma mesma ninhada. Porém, não existem dados sobre esse tipo de comportamento na natureza. Portanto, são necessários mais estudos de campo para confirmar a existência de paternidade extra-par nas ararajubas. Este trabalho vem confirmar a importância do uso da técnica de "DNA fingerprinting" no estudo do comportamento reprodutivo de aves.

PALAVRAS-CHAVE: ararajuba, comportamento reprodutivo, "DNA fingerprinting", Psittacidae.

ABSTRACT. Based on field observations, parrots are believed to live in pairs and stay together for life, at least the bigger ones, and behavioral studies of the gregarious Golden Conure *Guaruba guarouba* are very scarce. In this project, DNA fingerprinting was applied to study the breeding behavior of *G. guarouba* in captivity and sex-type the individuals analyzed. Our results show that one female was fertilized by two males in captivity, and had four chicks fathered by one and one chick fathered by the other, in the same brood. Unfortunately, there is no information about breeding behavior in the wild. Further field studies are necessary to confirm that this species is not essentially monogamous, but this work reinforces the potentials of DNA fingerprinting in studies of bird breeding behavior.

KEY WORDS: breeding behavior, DNA fingerprinting, Golden Conure, Psittacidae.

The Golden Conure (*Guaruba guarouba*) occurs in North eastern Brazil, and lives in humid lowland rainforests and hilly upland forests; the adults exhibit yellow plumage and dark green wing-coverts tips (Forshaw 1989). It was proposed as the national bird of Brazil (Sick 1987). According to Forshaw (1989) and Sick (1993) its distribution is restricted to the states of Maranhão and Pará. However, Yamashita and França (1991) reported the sighting of six individuals at Floresta Nacional do Parque Jamari, in Rondônia in a habitat similar to where this bird was seen before. Also, P. F. Develey (pers. comm., 1993) observed three individuals at Alta Floresta, in Mato Grosso.

Forshaw (1989) considered this bird to belong to the genus *Aratinga*, but Sick (1993) based on its distinct behavior and vocalization, suggested that this species should be in the genus adopted in this study.

The Golden Conure is uncommon or rare where it is still found (Ridgely 1980) and is considered endangered (Collar *et al.* 1992). Its great demand as a cagebird and especially the destruction of the forest habitat has caused a very considerable decline on the number of individuals, and these are still the main threats to the survival of the species. Besides this, the construction of highways, and the development and colonization caused a fragmentation in its distribution and increased the deforestation (Ridgely 1980).

Despite the fact that they live in the forest canopy, they can seek fruit at lower levels, always in small flocks. Its favorite food is "açaí", *Euterpe* sp. (Arecaceae) (Sick 1993) but they can also feed on fruit, seeds or nuts from *Lecythis* (Lecythidaceae), *Anacardium* spp. and *Mangifera indica* (Anacardiaceae), *Protium* spp. (Burseraceae), *Oenocarpus bacaba* (Arecaceae), *Cecropia* spp. (Moraceae), and other trees (Collar *et al.* 1992).

The breeding season in the wild occurs from December to April, months of higher humidity, and the nest is built in a hollow in the trunk of a tree, usually 15 to 20 m above the ground. The nest usually has multiple attendants, suggesting that the breeding occurs communally, with several females contributing to the clutch (Forshaw 1989). During the reproductive season, the large Psittacidae live strictly in pairs, and so far as known, stay together for life, but for most species of parrots appropriate studies were not performed and little is known. *Guaruba guarouba* is usually seen in flocks even during the breeding season (Sick 1993).

Miyaki *et al.* (1992, 1995) carried out several studies on parrot DNA. Those authors detected female linked bands in *G. guarouba* using DNA fingerprinting, allowing sex identification in this species; they also studied the genetic variability, band segregation pattern, and parentage assignment of captive birds.

In this work DNA fingerprinting was used to study the breeding behavior of a group of *G. guarouba* kept together in captivity and to sex the individuals studied.

METHODS

Samples of 100 µl of blood from 10 specimens of *G. guarouba*, kept in 500 µl of 100 % ethanol, from the "Flora Novaes" aviary, in Campinas, São Paulo, were used in this study. These individuals, whose sex was unknown, consisted of five presumably unrelated adults and five chicks born in captivity and from the same brood. All birds were kept together and the parents were unknown.

DNA was extracted from blood samples as described by Bruford *et al.* (1992). An aliquot from this DNA was digested with the restriction enzyme *Hae*III and purified with phenol-chloroform. The digested DNA was loaded onto a 30 x 20 cm 1 % agarose gel and run until the 2.0 kb marker had migrated to the bottom of the gel. The fractionated DNA fragments were transferred onto a nylon membrane (Hybond Nfp, Amersham) by capillary Southern blotting (Sambrook *et al.* 1989).

The membrane was pre-hybridized in 0.263mM Na_2HPO_4, 1mM EDTA, 7 % SDS and 1 % BSA at 65 °C; and after four hs, probe 33.15 (Jeffreys *et al.* 1985) oligolabelled with $[\alpha\text{-}^{32P}]$dCTP by random priming was added to the solution. After 15 hs, the membrane was washed three times for 10 min with three solutions: 0,25M Na_2HPO_4/1 % SDS; 2XSSC/0,1 % SDS and 1XSSC/0,1 %SDS. The membrane was exposed with two intensifying screens to an X-ray film, and then stripped and reprobed with minisatellite 33.6 (Jeffreys *et al.* 1985) as described above.

The autoradiograph was analyzed to determine the sex of each individual by presence or absence of the specific W-chromosome bands (Miyaki *et al.* 1992), and the parentage of the chicks was established by comparing each chick's patterns with the adult ones. The probability (I) for each pair sharing all the bands of the chick by chance was calculated using the formula:

$$I = [1 - (1 - X)^2]^n \qquad \text{(Jeffreys } et\ al. \text{ 1985)}$$

where n is the number of bands shared between a chick and its putative parents and X is the Index of Similarity (Wetton *et al.* 1987), calculated for an unrelated captive *G. guarouba* population (Miyaki 1993 and Miyaki *et al.* 1995). The index of similarity between the chicks, chicks and their parents, and between the adults, was also calculated, using the following formula by Wetton *et al.* (1987):

$$X = \frac{2N_{AB}}{(N_A + N_B)}$$

where N_{AB} is the number of bands shared among 2 individuals and N_A and N_B are the total number of bands of each individual.

RESULTS

The profiles obtained with probes 33.6 and 33.15 are shown in figure 1. Using the W-chromosome specific bands the sexes of the adults and chicks were determined. There were two female (A2 and A5) and three male (A1, A3 and A4) adults and four male (F1, F3, F4 and F5) and one female (F2) chick.

To determine the parentage of the chicks we verified which pair of adults had all the bands present in each chick. With this analysis it was possible to find that female A5 is the mother of all chicks, and male A3 is the father of chicks F1, F2, F4 and F5, while male A4 is the father of the chick F3. These data show that the same female was fertilized by two males, having a chick fathered by one and four fathered by another, in the same brood. The probability of all bands being shared between the chicks and their putative parents by chance is shown in table 1.

The index of similarity between chicks, chicks and their parents and among the adults (assumed as unrelated) are shown on table 2. The indexes were higher between related birds than between unrelated ones, as expected.

DISCUSSION

Our results show that in a group of *G. guarouba* kept together in captivity, one of the females was fertilized by two different males. The only behavioral information available about this group is that all the adults suddenly presented an aggressive behavior towards the aviculturist (A. Novaes) and her staff during the whole breeding season. No information is available on mating, egg incubation or feeding the nestlings, and at the time of blood sampling the chicks were fully feathered and feeding by themselves among the adult birds.

Besides the parentage and sex assignment of the 10 birds by DNA fingerprinting, we were able to show that similarity indexes were higher for related than for unrelated birds, as expected. Because of the presence of two female specific fragments detected by probe 33.15, and the occurrence of four males among the chicks, the mean index of similarity between chicks and mother was lower for probe 33.15 than for probe 33.6.

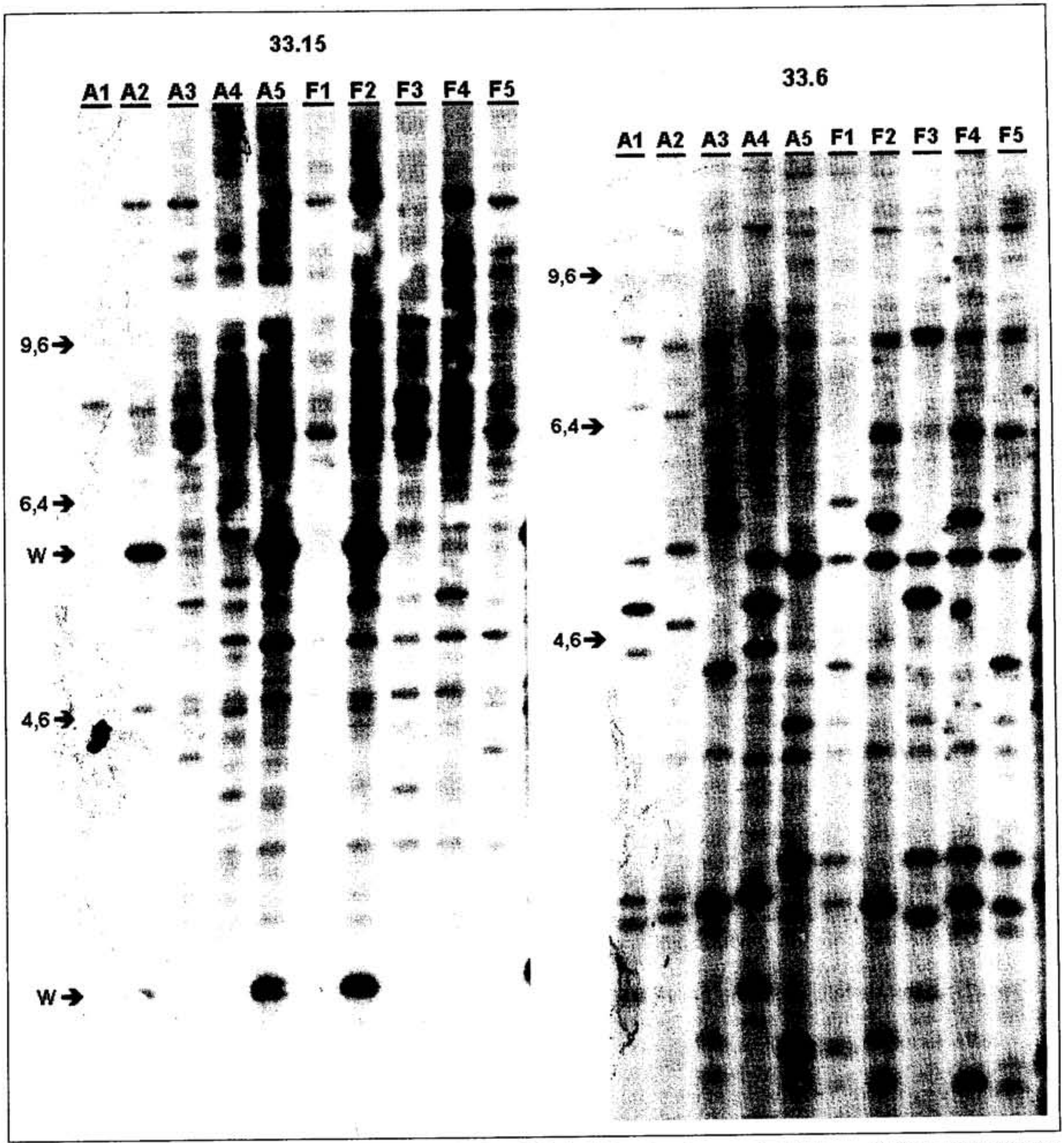

Figure 1. Autoradiographs obtained with probes 33.15 and 33.6. Molecular sizes are in kilobases (kb) and **W** indicates the sex linked bands. **A** represents the adults and **F** the chicks.

Observations in the wild during the mating season suggest that parrots live in pairs that stay together for life (Sick 1993). With the availability of molecular marker techniques and especially using the human multilocus minisatellite probes developed by Jeffreys *et al.* (1985), it is possible to study the breeding behavior of many birds, determine paternity of the chicks, and detect that some birds considered as monogamous can present extra-pair fertilizations (review in Birkhead and Möller 1992). Field observations are not always accurate enough to detect intra-brood parasitism or extra-pair paternity (Miyaki 1993). Burke and Bruford (1987) detected an unexpected extra-pair copulation in a House Sparrow (*Passer domesticus*) family, and Burke *et al.* (1989) found extra-pair parentage within two out of three different mating systems in dunnocks (*Prunella modularis*). Breeding behavior studies using DNA techniques have not been applied to wild parrot populations, but studies by Miyaki *et al.* (1995) with seven *G. guarouba* individuals that lived in the same cage showed that three chicks of two successive broods were

Table 1. Parentage relationships and probabilities (I) of the bands shared between the chicks and the pair occuring by chance, using minisatellite probes 33.15 and 33.6.

Chick	Mother	Father	Probabilities I 33.15	 33.6
F1	A5	A3	3,26 x 10^{-4}	1,66 x 10^{-5}
F2	A5	A3	1,31 x 10^{-5}	1,92 x 10^{-4}
F3	A5	A4	1,31 x 10^{-5}	1,66 x 10^{-5}
F4	A5	A3	2,64 x 10^{-6}	2,21 x 10^{-3}
F5	A5	A3	2,64 x 10^{-6}	4,89 x 10^{-6}

Table 2. Mean index of similarity and standard error between the adults, the chicks, the chicks and their fathers, and the chicks and their mother, calculated for both 33.15 and 33.6 probes.

	Probe 33.15	Probe 33.6
Adults	0.190 ± 0.127	0.330 ± 0.109
Chicks	0.543 ± 0.098	0.419 ± 0.079
Chicks and fathers	0.437 ± 0.091	0.475 ± 0.157
Chicks and mother	0.365 ± 0.094	0.570 ± 0.147

born from the same pair. In the present study, a female was fertilized by two of the three males present in the same cage.

The aviculturist L. Maluf (1988) observed the mating behavior of another group of five adult *G. guarouba* in captivity and reported their sudden aggressivity trying to protect the mated pair and its chicks during the breeding season. Despite the poor information about the *G. guarouba* breeding behavior in the wild, the available data suggests a communally protecting behavior towards the chicks. Carlos Yamashita (pers. obs.) reports that when the flocks feel threatened the whole group goes into the nest, which makes the capture of this bird relatively easy. Such gregarious behavior in other bird species increases tendencies toward cuckoldry, since colonially nesting species have been found to have a higher rate of extra-pair copulations than solitary ones (Birkhead and Möller 1992).

It was not possible to observe if the males helped to feed the chicks, as reported in *Campylorhynchus nuchalis* (Passeriformes) (Rabenold *et al.* 1990) since the *G. guarouba* chicks were already feeding by themselves by the time this work was being done.

This work reinforces the potentials of applying DNA fingerprinting on studies of breeding behavior of birds, since field and captivity observations are not always conclusive. The data presented here suggest that the gregarious behavior of *G. guarouba* might be related to a non monogamic mating system, as in other colonially and gregarious breeders (Birkhead and Möller 1992), which could not be tested due the lack of suitable data. Since the observations described here could be a consequence of an artificial captive situation, with the presence of more than one breeding male, further studies are necessary to establish the mating system and reproductive behavior of these birds in the wild.

ACKNOWLEDGMENTS

We would like to thank the "Flora Novaes" aviary for the blood samples, the two reviewers, M. A. S. Alves and J. K. Blakey, for their suggestions, M. Rodrigues for the editorial modifications, FAPESP, CAPES and CNPq (Brazil) for financial support, and all laboratory colleagues that helped in some way to this project. F. B. A. had a PIBIC/CNPq scholarship. The Jeffreys probes 33.6 and 33.15 are the subject of patent no. GBA2166445 and world wide patents (pending) for commercial diagnostic use.

REFERENCES

Birkhead, T. R. and A. P. Möller (1992) *Sperm competition in birds: Evolutionary causes and consequences.* London: Academic Press.

Bruford, M. W., O. Hanotte, J. F. K. Brookfield and T. Burke (1992) Single-locus and multilocus DNA fingerprinting, p. 225-269. *In:* A. L. Hoelzel (ed.) *Molecular genetic analysis of populations - a practical aproach.* New York: Oxford Press.

Burke, T. and M. W. Bruford (1987) DNA fingerprinting in birds. *Nature* 327:149-152.

_____, N. B. Davies, M. W. Bruford and B. J. Watchwell (1989) Parental care and mating behavior of polyandrous dunnocks *Prunella modularis* related to paternity by DNA fingerprinting. *Nature* 338:249-251.

Collar, N. J., L. P. Gonzaga, N. Krabbe, A. Madroño Nieto, L. G. Naranjo, T. A. Parker III and D. C. Wege (1992) *Threatened birds of the Americas. The ICBP/IUCN red data book.* Washington: Smithsonian Inst. Press.

Forshaw, J. M. (1989) *Parrots of the world.* Willoughby:

Lansdowne Ed.

Jeffreys, A. J., V. Wilson and S. L. Thein (1985) Hypervariable minisatellite regions in human DNA. *Nature* 314:67-73

Maluf, L. (1988) Uma reprodução de ararajuba em cativeiro. *SOBoletim* 12:2-3.

Miyaki C.Y. (1993) *Utilização de sondas de minisatélite na identificação individual e do parentesco de psitacídeos brasileiros.* Master Thesis. São Paulo: Instituto de Biociências, Univ. São Paulo.

___ , O. Hanotte, A. Wajntal and T. Burke (1992) Sex typing of *Aratinga* parrots using the human probe 33.15. *Nucleic Acids Res.* 20:5235-5236.

___ (1995) DNA fingerprinting in the endangered parrot *Aratinga guarouba* and other *Aratinga* species. *Brazilian J. Genet.* 18:405-411.

Rabenold, P., K. N. Rabenold, W. H. Piper, J. Haydock and S. W. Zack (1990) Shared paternity revealed by genetic analysis in cooperative breeding tropical wrens. *Nature* 348:538-540.

Ridgely, R.S. (1981) The current distribution and status of mainland neotropical parrots, p. 233-384. *In:* R. F. Pasquier (ed.) *Conservation of New World parrots - proceedings of the international commitee for bird protection, parrot working group meeting.* Washington: Smithsonian Inst. Press.

Sambrook, J., E. F. Fritsch and T. Maniatis (1989) *Molecular cloning - a laboratory manual.* New York: Cold Spring Harbor Lab. Press.

Sick, H. (1987) A guarouba: novo símbolo nacional? *Ci. Hoje* 5:76-77

___ (1993) *Birds in Brazil, a natural history.* Princeton: Princeton Univ. Press.

Yamashita, C. and J. T. França (1991) A range extension of the golden parakeet *Aratinga guarouba* to Rondonia state, western Amazonia (Aves: Psittaciformes). *Ararajuba* 2:91-92.

Wetton, J. H., R. E. Carter, D. T. Parkin and D. Walters (1987) Demographic study of a wild house population by DNA fingerprinting. *Nature* 327:147-149.

Ararajuba 5(2):141-150
dezembro de 1997

The Blue-throated Macaw *Ara glaucogularis*: characterization of its distinctive habitats in savannahs of the Beni, Bolivia

Carlos Yamashita[1,2] **and Yuri Machado de Barros**[3]
[1]IBAMA- Al. Tiete 637, 01417-020, São Paulo, SP, Brazil
[3]Rua Moraes de Barros 854/31, 04614-000, São Paulo, SP, Brazil

Recebido em 02 de abril de 1997; aceito em 20 de julho de 1997

RESUMO. **A arara *Ara glaucogularis*: caracterização de um hábitat distinto nas savanas do Beni, Bolívia.** *A. glaucogularis* é uma espécie exclusiva da região conhecida como Llanos de Mojos. É uma arara de savana com palmeiras, pouco predadora de sementes, com alimentação especializada em mesocarpo de palmeiras. A informação sobre a distribuição disponível na literatura anterior a 1993 foi baseada na informação de terceiros. Na literatura a distribuição da espécie esta confusa com a informação histórica e limítrofes no sul da arara canindé (*Ara ararauna*), atualmente parte do Paraguai e Argentina. A captura de Psittacideos ocorrida na década de 1980 foi a principal causa do declínio da espécie.

PALAVRAS-CHAVE: *Ara glaucogularis*, áreas inundáveis, Beni, Bolívia, campos, Llanos de Mojos, palmeiras, Psittacidae, savana.

ABSTRACT. The Blue-throated Macaw (*Ara glaucogularis*) is endemic to the Llanos de Mojos, in the Departamento de Beni, Bolivia. Previous reports (prior to 1993) on the range of the species were based on third-hand information. We document that this macaw is found in savannahs, where it is restricted to groves of motacú (*Attalea phalerata*) palms, but it is not a palm nut cracker specialist, rather a palm fruit specialist. Pre-1993 reports on the range of the species were based on third-hand information and are inaccurate. The accounts on the *Ara caninde* in Paraguay, Vice-Royalty of La Plata is a range of the historical distribution of the Blue-and-yellow Macaw (*Ara ararauna*) in the southern limits of its range (Paraguay and Argentina).The *A. glaucogularis* habitat is known locally as "sartejenal" has a long term human occupation before European colonization. The palm groves in the region are more than 500 years old and the palm population structure suggests long term decline. The parrot trapping activity during the 1980s was the main factor in the decline of many parrot species.

KEY WORDS: *Ara glaucogularis*, Beni, Blue-throated Macaw, Bolivia, grassland, habitat, Llanos de los Mojos, palm, parrot, Psittacidae, savanna, wetland.

The Blue-throated Macaw (*Ara glaucogularis*) Dabbenne 1921 is an endangered species, about which there has been very little information available (Forshaw 1989, Ingels *et al.* 1981, D. Lanning unpublished data 1982, Ridgely 1980). The validity of the species and the name were the subject of much controversy (Forshaw 1973). The taxonomic status of the Blue-throated Macaw was clarified by Ingels *et al.* (1981) who synonymized the *Ara caninde* and *Ara azarae* as junior synonymia of *Ara ararauna*, revalidating the name *A. glaucogularis*.

The distribution of *A. glaucogularis* was a mystery, without type-locality Ingels *et al.* (1981) designated as Santa Cruz de la Sierra. The few museum skins are labeled as general South America provenance; e.g., two skins in British Museum of Natural History (BMNH); River Amazon and Brazil (Ingels *et al.* 1981). Much of the scant available data is based on third-hand information; e.g., from bird dealers, aviculturists and trappers. The presumed distribution (Forshaw 1973, Ridgely 1980, Ingels *et al.* 1981, D. Lanning unpublished data 1982, Collar *et al.* 1992) of the species were Paraguay and Bolivia; Buenavista, Yacuiba, Santa Cruz de La Sierra and the Department of Beni. Only in 1992 was the bird found and observed in the wild (Jordan and Munn 1993). Motacuzales, or grove of motacú palms (*Attalea phalerata*) on seasonally flooded savannas, were identified as the most important habitat for the species (Jordan and Munn 1993). In this paper we use *A. phalerata* rather than *Scheelea princeps*, as a reference name of the motacú palm following Henderson *et al.* (1995). The systematic and taxonomy of this group of palm remains unclear (Balslev and Moraes 1989).

Our objective is to characterize critical elements of the habitat of this threatened macaw, based on landscape and vegetation structure. We also discuss historical data, food

---

[2]Correspondence address: R. Voluntários da Pátria 3714, apto. 52, 02402-400, São Paulo, SP, Brazil. E. mail: cyama@nethall.com.br

habits, sympatry with other parrots species, population and problems associated with conservation of the open habitats favored by *A. glaucogularis*.

METHODS

We conducted a survey of areas in the Llano de Mojos, Departamento de Beni, northern Bolivia (figure 1), previously visited by C. Munn in 1992. YB joined a Fundacion Armonia survey team from 17 July to 6 August in 1993, CY and YB from 3 August to 8 September in 1994 and from 9 to 19 October 1994 (YB) to characterize the microhabitat of Blue-throated Macaw. We do not reveal the precise localities at which we found Blue-throated Macaws, in order to protect these populations.

The transects were made at sites at which we observed foraging Blue-throated Macaws, utilizing a 50 m topcord. All the trees and palms 2.5 m from either side of the transect were counted, measured, and classified by size. Age classes of motacú palms were established according the pattern adopted by Anderson *et al.* 1991 (figure 2). We adopted five size class indices: (1) immature without trunk; (2) mature with old fronds on the trunk-healthy productive palm tree; (3) mature with exposed trunk in good conditions and good productivity; (4) mature with weathering trunk, productive but senile; (5) snag of dead

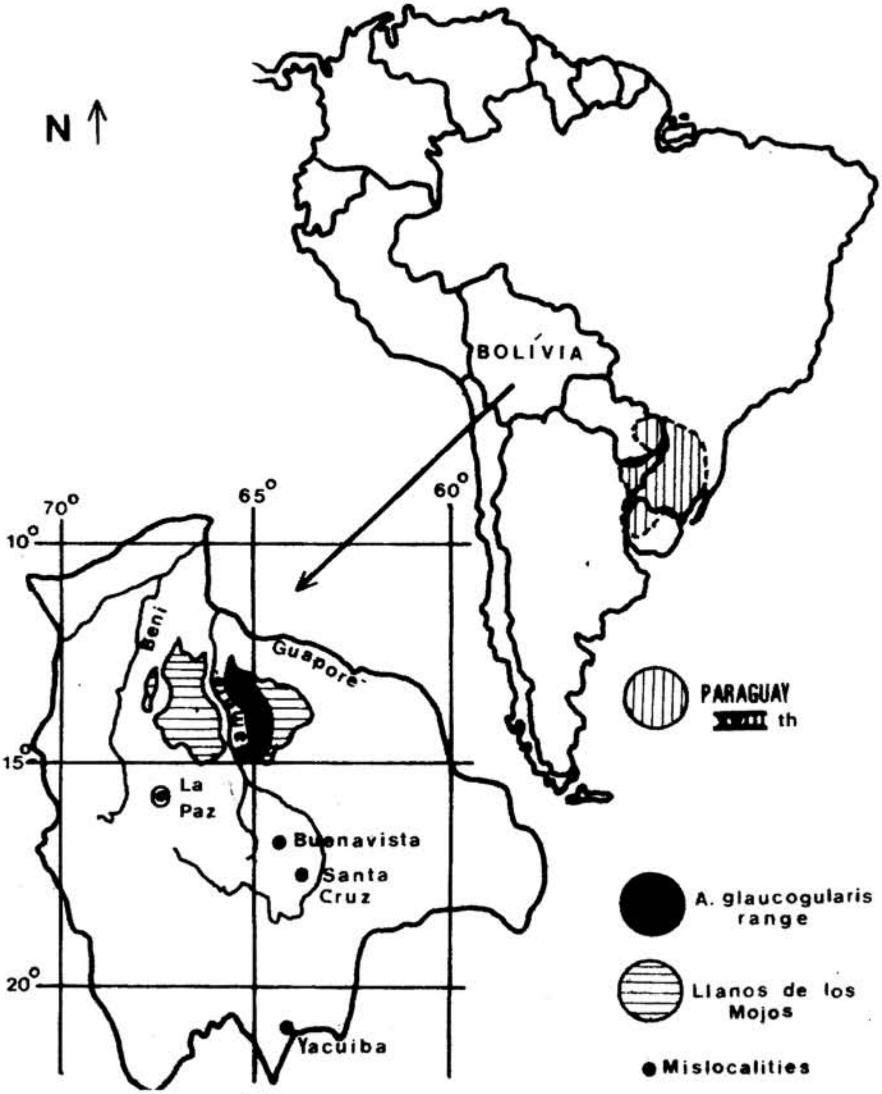

Figure 1. South America map, territory of Paraguay in shaded (adapted from MEC 1968). Distribution of the Blue-throated Macaw *Ara glaucogularis* in Bolivia (adapted from Unzueta 1975).

palm tree. The heights of palm trees were measured from the ground to the base of the crown. Tree heights were measured from the ground to the top of canopy, and the diameter at breast height (DBH) was measured over 10 cm in diameter.

We noted the presence of all the species of parrots. The relative abundance of parrot species was classified as follows: (1) abundant: more than 3 flocks with 12 individuals or more per day; (2) common: between 3-1 flocks of less than 12 individuals/each per day; (3) moderate: 1 flock per day; (4) rare: less than 1 flock per week.

We surveyed the Llanos de Mojos a total of 1,818 km with four-wheel drive vehicle, 380 km through rivers in a boat, 500 km on foot, and 1,040 km on small Cesnna plane. The phytogeographical terminology follows Hueck (1972).

Study site. The Llanos de Mojos or Pampas del Beni is a wide savannah plain of edaphic associations, laid in riverine sediments of sand and clay of Cenozoic origin. The region has a poor drainage, and in the wet season is suceptible to flooding. These llanos includes portions of the basins of the Itenez, Mamore, Beni and Madre de Dios rivers. These meandering rivers often change their course, creating oxbows lakes and swamps (Unzueta 1975, Palau y Saiz 1992).

The region, which lies between 200 and 300 m above sea level, is classified as humid subtropical to the Holdridge classification, based on 1000-1500 mm rainfall and average temperature of 23-24° C (Unzueta 1975).

On these large open ranges dominated by grassland, the physical and mechanical factors associated with differing microrelief create a mosaic of habitats including carandam palm (*Copernicia alba*) groves, semi-deciduous woodlands, gallery forests (containing Amazonian elements), and motacú palm (*A. phalerata*) groves on higher, unflooded terrain, islands that may be natural or the work of pre-Columbian humans (Denevan 1980).

The region is bounded by Amazonian rainforest to the north, the Chaco to the South, deciduous woodland and cusi palm (*Orbignya phalerata*) to the east, and by the humid Andean foothills to the west (Hueck 1972).

RESULTS AND DISCUSSION

Historical account and distribution. Records of *A. glaucogularis* from Argentina and Paraguay had mistakenly been based on a description of Caninde's Macaw of Felix de Azara (1802-1805) in Paraguay which, during the XVIII th Century, was a territory of the Vice-royalty of La Plata including parts of present day's: North-eastern Argentina, South-western Brazil and South-eastern Paraguay (figure 1). The historical account of the Caninde by Azara (1789, 1802-1805) detailed its description as " a yellow and blue macaw , white bare face, below the eye three feathered black lines and a green forecrown", which would be the *A. ararauna* rather than *A. glaucogularis*. The description of Caninde is corroborated by an earlier, richy detailed report of Sanchez Labrador (1767) "debajo del pico, en la garganta son las plumitas negras. Los lados del cuello, lo restante de la garganta, todo el pecho y vientre, visten plumas de color dorado, de un amarillo incendido. La extremidade de la cabeza, lo alto del cuello, toda la espalda, y lo exterior de las alas, tienen plumas de un azul muy bello.", unequivocally the Blue-and-yellow Macaw (*A. ararauna*). In Sanchez Labrador 1767's book reprint in 1968, the editor's note refers as *A. caninde*. For many decades A. caninde was used improperly as a synonymy of *A. glaucogularis*: e.g., Forshaw (1973), Ridgely (1980), D. Lanning (unpublished data 1982), and Nilson (1981, 1989). The confusion was caused by misinterpretation of Azara (1802-1805). The Azara (1789) manuscript when described it, says: "Guacamayo azul , y oro , o Canind or Caninde". "..Gola grande azul-turqui hay en las vertebras

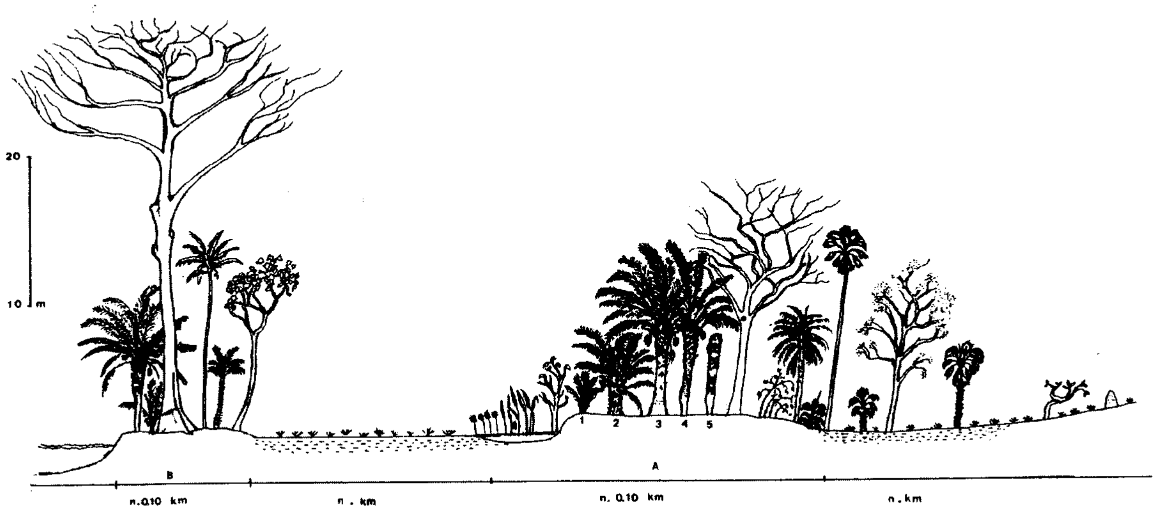

Figure 2. Schematic physiognomy profile of Blue-throated Macaw habitat on the Llanos de Mojos, upper Mamoré River, Bolivia. A. Palm island. B. Gallery woodland with motacz palms dominance. The number under the palms is related to age class. The (N) is whole number for distance. The scale is given in m and km.

mas altas del cuello. De alli lo inferior, y cortador del ave, y cobijas, bajo el al es amarillo-dorado". The color blue-turquise was assumed improperly as a throat by all previous papers (Dabbenne 1920, Forshaw 1989, Ingels *et al.* 1981, Ridgely 1980) or bluish-black throat color of *A. ararauna* (Ingels *et al.* 1981). In our point of view Azara's description refers to the blue turquoise upper parts (top neck, nape, upper parts) of *A. ararauna* that is blue-turquoise and the under parts yellow-gold.

All information on Caninde from "Paraguay" (The territory of the Vice-Royalty of La Plata, where Felix de Azara and Sanchez Labrador lived including parts of Argentina, Paraguay and southern Brazil) from the end of the 19th and early 20th centuries, should be considered a synonymy of *A. ararauna*. Nowadays an extinct bird of that region, during the end of XVIII the species was already a rare bird (Sanchez Labrador 1767). Caninde is a specific Tupi-Guarani name for *A. ararauna*. Collar *et al.* (1992) still consider the possible historical occurrence of *A. glaucogularis* in Paraguay, even well contrary to the arguments of Ingels *et al.*(1981).

There are museum specimens labeled "Bolivia" and also third-hand information that the species occured in this country (Forshaw 1973, Ridgely 1980, Ingels *et al.* 1981, D. Lanning unpublished data 1982, Collar *et al.* 1992).

There are two *A. glaucogularis* specimens in the Carnagie Museum US, with the locality of Buenavista (17°28'S, 63°37'W) (Forshaw 1989, Ingels *et al.* 1981, K. Parkes, *in litt.*) collected by Steinbach during the early 1920s. The Steinbach family had been bird-skin traders for three generation in Bolivia and sold thousands of bird skins, especially to US museums (O. Rocha, pers. com, K. Parkes *in litt.*, J. van Remsen, *in litt.*). There are no field notes for the collection dates, and the Steinbach used to collected birds all over Bolivia. The Steinbach's headquarter had been Buenavista. It is unlikely that if a high prized bird such as a *A. glaucogularis* had occured in Buenavista, so few skins had been sold, especially during early century when large series of macaw skins were arriving in U.S. museums. The rare scarce birds' skins that arrived in shipments of trade skins (e.g. Spix's Macaw *Cyanopsitta spixii*, and Indigo Macaw *Anodorhynchus leari* were all from species with unknown ranges. The Buenavista local habitat is unlikely a suitable one for *A. glaucogularis*, and it is one the most well-known richness site for birds in Bolivia (Gemuseus and Sagot 1996), casting further doubt on the validity of this collection location.

The other locality Yacuíba, Tarija Department, close to Argentine border told by C. Olrog (Ingels *et al.* 1981, pers. com.) came from the source of Mr. R. Romero, one of the most important live wildlife trader during the mid 1970s to mid 1980s. The local people report that he operated during the period throughout lowland Bolivia, especially in the Beni Department.

The type-locality designation as Santa Cruz de La Sierra in the specimen of MACN-Buenos Ayres (Ingels *et al.* 1981) can not be accepted. Santa Cruz de La Sierra (Paynter *et al.* 1975) had been the regional important city of all eastern (lowland) Bolivia. All Beni commerce was linked by regional center Santa Cruz. The eastern Bolivia foreign affairs was dependent, especially from Buenos Ayres, through Tucuman following the Camiño Real, during the 1860's when the mounted skin was donated to Museo Argentino.

In the XVIII Century Paraguay and Bolivia, the localities Buenavista, Santa Cruz de La Sierra and Yacuíba have a quite different habitat and it seems to be unreliable that *A. glaucogularis* had occurred at any time there.

Vegetation characteristics. The *A. glaucogularis* range harbors a complex mosaic of different landscape types. The habitat composition includes some specific microhabitat, although ecotones between them add further heterogeneity, described below (figure 2):

1. *Natural and artificial palm islands*. 0.2- 1 ha area. This is unflooded terrain, dominated by motacú palms with semi-deciduous emergent trees such as *Enterolobium cortisiliqun* Leguminosae, *Sterculia striata* Sterculiaceae, and *Tabebuia heptaphilla* Bignoniaceae. Typically these palm islands are surrounded by seasonally flooded grassland. The water ditch is covered by macrophytes as *Thalia paniculata* Maranthaceae, papyrus (*Cyperus giganteus*) Cyperaceae, and some *Erythrina* sp. Leguminosae trees.

At the water ditch side, the island is colonized by spiny bamboo *Actinocladum* sp. short trees, and carandaí palm *C. alba*, due the fact that this area is seasonally flooded, but becomes extremely dry during drought.

The emergent trees can reach more than 30 m and are concentrated at the center of the islands. All the older individuals of such trees can supply potential cavities, the principal source of nesting sites for large-bodied parrots such as macaws.

2. *Gallery woodland along rivers*. Characterized by Amazon forest influence, with some trees reaching more than 40 m height. e.g., mapajo or kapok tree (*Ceiba pentandra*) Bombacaceae, and *Hura crepitans Euphorbiaceae*. Densities of motacú palm (A. phalerata), sumuqui palm (*Syagrus botriophora*) and chontilla palm (*Astrocaryum vulgare*) vary greatly. On this formation it is possible to distinguish two degree of plant strata- one of emergent trees and below a evergreen leaf palm grove.

3. *Woodland bands and gradient to grassland*. The woodland band is characterized by Chaco (alkaline soil) and Cerrado (acid soil) influences. Much of the vegetation has structures to avoid water loss. The trees reach 15-20 m, and more than 50 percent are semi-deciduous. There are large extension of carandaí palm and totai palm (*Acrocomia aculeata*). The carandaí palms associated with soil that has high levels of salt, is seasonally flooded but experiences periods of severe drought. The totai palm occurs on higher terrain that never floods, on alkaline soil with very seasonal water availability.

4. *Cerrado*. This formation is characteristic of higher

and better drained terrain on acid soil. The formation is characterized by grasslands, thickly barked and twisted trunks shrub (e.g. **Curatella americana** Dilleniaceae, *Byrsonima* sp. Malpighiaceae, and *Qualea* sp. Vochysiaceae), and many nest ground termites.

5. *Grassland savanna*. Seasonal shallow flooding with vegetation dominated by grasses. During the rainy season the grasses reach more than 2 m height. The composition includes *Hyparrhea* sp., *Digitaria* sp., *Andropogon* sp., *Elyonorus* sp., *Arundinella* sp., Hypagynium sp. and Paspalum sp.

6. *Moriche palm (Mauritia flexuosa) groves*. This swampy formation is specific dominated by the palm *M. flexuosa*, characterizes by flooded depressions on acid and poorly drained soil, in the savanna, but also along rivers.

All *A. glaucogularis* sightings were in habitats 1 and 2. We found the *A. glaucogularis* only in natural and artificial palm islands and gallery woodland along rivers. The macaw favored tall trees and those areas with continuous motacú palm fruit production. Within the riverine gallery woodlands, the macaws were not observed where the motacú palm represented less than 60 % of the trees.

Population structure of motacú palm groves. Our population structure is based on 18 transects totaling 1,013 m, a total of 64 trees, 171 motacú palms, 10 carandaí palms, 1 chontilla palm. The individual density of dicotyledoneous trees and palm trees were 2.49 per 100 m^2. The density of trees were 0.66 per 100 m^2. The density of motacú palms as 1.72 per 100 m^2. Of those measured 26% were trees and 69 % are motacú palms. The Beni motacú can reach 11m trunk height, with a maximum DBH of 65 cm. The motacú palm produces continuous fruit throughout the year; the same palm tree may have 3-5 racemes each with a different stage of fruit development.

The dicotyledoneous trees (N = 64) measured in our transects, the mean height 12 ± 5 (range 3 - 26 m) and the mean DBH was 36 ± 21 (range 10 - 85 cm). In the transects we observed many remnant hardwood stumps indicating heavy logging of large DBH tree individuals.

Based on our data the age population structure of motacú palm are: class (1): 9.9 % are trunkless immature (N = 17); class (2):17 % are health without exposed trunk (stipe mean height = 3 ± 1 m, range = 5 - 1 m; mean DBH = 39 ± 7 cm, range 25 - 50cm; N = 29); class (3): 19% are in good conditions with exposed trunk (stipe mean height = 4 ± 2 m , range = 1 - 8 m; mean DBH = 25 ± 8 cm, range 25 - 65 cm; N = 33); class (4): more than 51.4 % are senile (stipe mean height = 6 ± 2 m, range = 1 - 11 m; mean DBH = 36 ± 7 cm , range 20-55 cm; N = 88); and class (5): 2.3 % found as snag (N = 4). A population structure of low immature palms outnumbered by old palm individuals, suggests a long-term palm grove decline (figure 3) caused by long term cattle grazing on unflooded terrain and annual burning practice by cattle ranchers during decades to centuries. Between 80- 90 % of motacú palms, including senile class produces raceme with nuts throughout the year. This intrinsic characteristic of this palm will insure, at least for a few decades, that there should be no lack of food for macaws.

Nest site availability. The emergent trees could produce cavities that would be potential sites for nesting, but to have a cavity with a minimum of 30 cm of internal diameter, the tree must have a DBH of 60 cm or greater. More than 45% of these trees have a DBH of greater than 40 cm, but very few individuals have a DBH of greater than 60 cm. On our sample (see above) we found only one huge tree (25 m tall, 85 cm DBH) with a cavity. This cavity at time was occupied by Africanized bees, but it also was used as a nest by *A. glaucogularis* in 1992 according locals.

From a total six nests of *A. glaucogularis* in palm

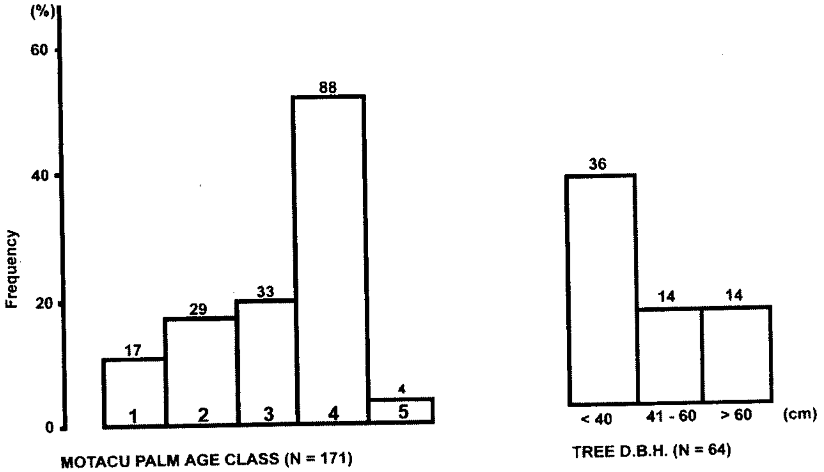

Figure 3. Left: Age classes of Motacu palms groves (N = 171) Class (1) Immature trunkless palm; class (2) mature and productive with old fronds on the trunk; class (3) mature and productive without old fronds on the trunk; class (4) senile and productive with weathering trunk; class (5) snag. The numbers above the bars are the number of individuals of each class and right: associated trees with DBH classes (N = 64).

snags that were utilized between 1993-1994, three nest sites, were in snags that had fallen down in the last visit. We estimate that the annual rate loss of natural palm snags is 50 % of potential cavities for nesting. The motacú palm snag class is of 2.3 % of population (see figure 3). We have no data on the mortality rate of motacú palm, the passage between age class four to five (snag).

Food habits. We observed Ara glaucogularis feeding on fruits, seeds, flowers and leaf steams of eigth plants species (N = 18 feeding bouts), but mainly motacú palm mesocarp (N = 11) (table1). With its specialized modification of the beak; (e.g., narrow chisel and longer lower jaws than A. ararauna), *A. glaucogularis* left characteristic marks in the ripe fruits of palm, making it possible to identify fruits used in the field. The palm fruits are scraped and then wheeled, cleaning the palm mesocarp (figure 4).

Jordan and Munn (1993) observed the birds plucking unripe palm nuts and drinking the juice in them, as do two other, large sympatric macaws (*A. chloroptera* and *A. ararauna*) (pers. obs.). *A. glaucogularis* is not a palm nut cracker as A. chloroptera in the region (pers. obs.) but specializes in palm fruit mesocarp (figure 4). Others food items, except unripe seeds of *Hura crepitans* Euphorbiaceae, represented a small amount of food intake, including flowers, flowers petals, and leaf stems after chewing and discarding the fibers. This motacú palm is the most important food item, its mesocarp is very orange with a high level of fat and carotenoids.

Parrots species sympatric with A. glaucogularis. We found 21 species of parrots (table 2) in the Llanos de Mojos. *A. glaucogularis* is endopatric and syntopic with its species pair *Ara ararauna* (figure 5), and *Ara chloroptera*. For these large macaws there is about 30 (difference in weight between one another, with weights of between 600-700 g for *A. glaucogularis* (J. Abramson, *in litt.*), (*A. ararauna* 1040-1286 g and *A. chloroptera* 1050-1320 g Forshaw 1989). In our experience the Scarlet Macaw *Ara macao* is not syntopic with *A. glaucogularis* (contra Ingels *et al.* 1981); *A. macao* is found only to the north in continuous rainforest.

The Llanos de Mojos is the distributional limit of such species pairs as Blue-fronted Amazon *Amazona aestiva* and Yellow-headed Amazon *Amazona ochrocephala*; Blue-headed Parrot *Pionus menstrus* and Scaly-headed Parrot *Pionus maximiliani*; and Canary-winged Parakeet *Brotogeris chiriri* and Cobalt-winged Parakeet *Brotogeris cyanoptera.*

The presence of some species reflects the influence of some of the vegetative formations that are adjacent to northern Bolivia, for example the Peach-fronted Parakeet *Aratinga aurea* and the Yellow-faced Amazon *Amazona xanthops* of the Cerrado, Blue-crowned Parakeet *Aratinga acuticaudata* of the Chaco, and the Dusky-headed Parakeet *Aratinga weddelli* of western Amazonian rainforest. Our observations of the Brown-throated Parakeet *Aratinga pertinax* in Llanos de los Mojos area a new distributional record of a species that has disjunct populations on periphery of the Amazon Basin.

Among the species that potentially are sympatric with the *A. glaucogularis*, only the Orange-winged Amazon *Amazona amazonica* was not observed by us, although

Table 1. Food items observed eaten by *Ara glaucogularis* at Llanos de los Mojos, August 1994.

			Observed habitat	
Latin name	Local name	Part consumed	Palm island	Gallery forest woodland
Palmae				
Attalea phalerata	motacú	mesocarp	X	X
Acrocomia aculeata	totai	mesocarp	X	X
Syagrus botryophora	sumuqué	inflorescence	X	
Astrocaryum vulgare	chontilla	inflorescence	X	
Euphorbiaceae				
Hura crepitans	ochohs	unripe seeds, leaf steam	X	
Cochlospermaceae				
Cochlospermum hybiscoides	tutumillo	flower petals	X	
Sapindaceae				
Sapindus saponaria	isotoubo	unripe seeds	X	
Rubiaceae				
Genipa americana	bi	leaf steam	X	

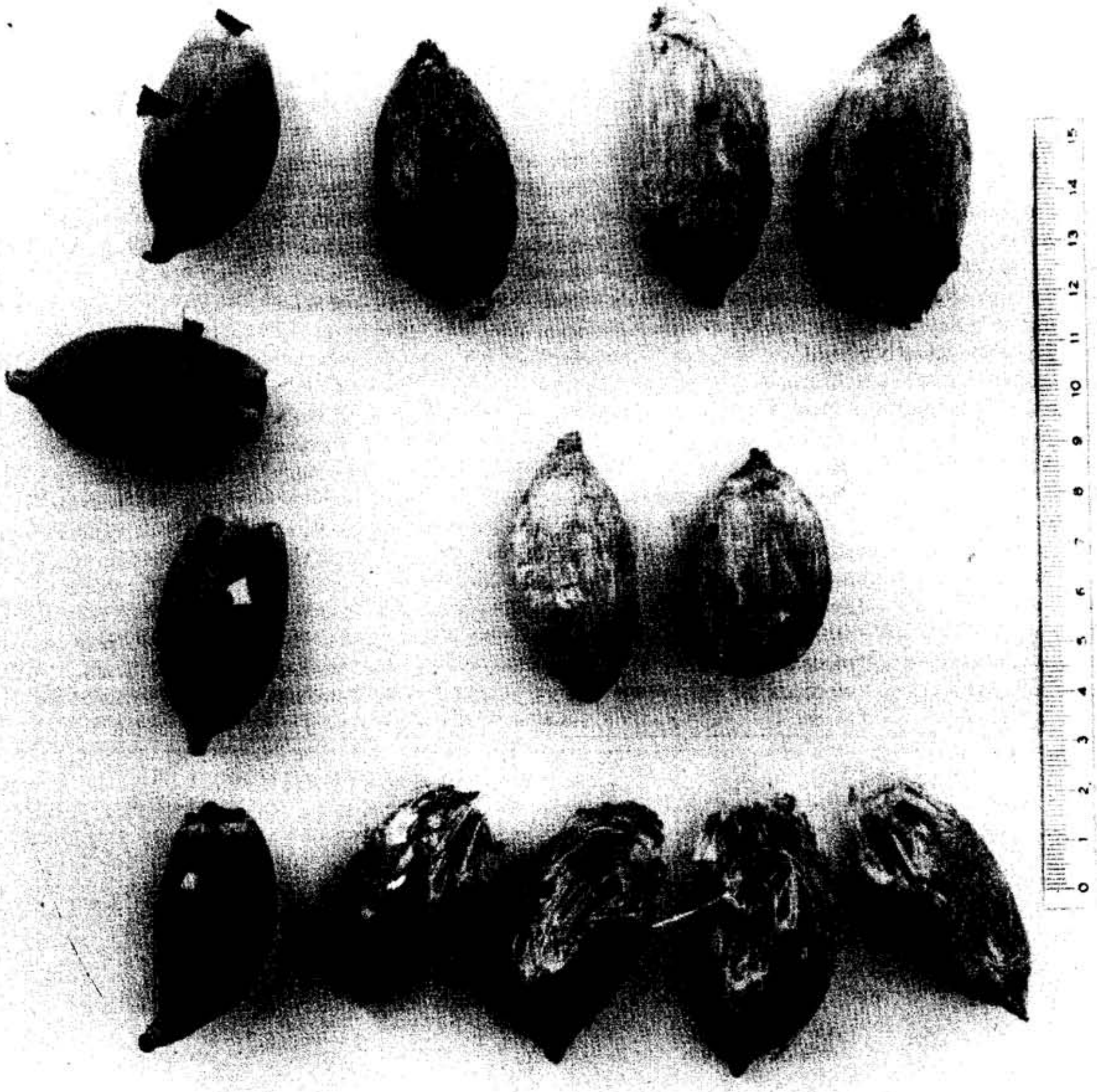

Figure 4. Palm nuts of motacú with macaws traces. Left column: unripe nuts which macaws drank the juice in them. The arrow indicated the puncture of the tip of upper jaws on the plucked fruits. In this tracks it is not possible the macaw species identification. Top right: Different pattern vestige by syntopic large macaws, *A. glaucogularis*; the fruit's mesocarp is consumed and there is a narrow chisel spin tracks, *A. ararauna*; the mesocarp is scraped longitudinaly, widder chisel mark, *A. chloroptera* predated the nut's kernel. Photo: C. Yamashita

there is a record from the northern portion of the area inhabited by the macaw in Mamoré river (Remsen *et al.* 1986).

Population. During the study we had 112 records of this species. Most observations were of birds in pairs (N = 43) or family groups (N = 68), althrough the largest number observed at one time was a single record of a flock of 15 *A. glaucogularis*. The total minimum number of individuals detected in the 2,000 km² region of the survey was 54 individuals.

This macaw is largely restricted to these palm islands and is only locally present within its range. The Llanos de Mojos is an isolated savanna grassland on the upper Rio Mamoré system, surrounded by forests: Andean lowlands, Amazonia, and deciduous to the east. Almost all macaw species of "medium" size (400 - 800 g) have a restricted distribution, e.g., Red-fronted Macaw *Ara rubrogenys* - Central Andean dry intermontane valleys (Lanning 1991, Collar *et al.* 1992), Military Macaw *Ara militaris*- montane and sub-montane foothills (Terborgh 1977, Forshaw 1989),

Table 2. The sympatric parrot species of Llanos de los Mojos and their relative abundance. All the species were sighted in August and October 1994.

Species	Motacú palm	Palm swamp	Gallery forest	Open woodland
Ara chloroptera	common	absent	moderate	moderate
Ara ararauna	common	common	moderate	rare
Ara glaucogularis	moderate	absent	moderate	absent
Ara manilata	absent	abundant	absent	absent
Ara auricollis	rare	absent	absent	rare
Ara severa	moderate	absent	abundant	rare
Ara nobilis	rare	moderate	rare	rare
Aratinga leucophthalmus	common	absent	abundant	moderate
Aratinga aurea	moderate	absent	rare	moderate
Aratinga acuticaudata	absent	absent	absent	moderate
Aratinga wedelli	moderate	rare	common	moderate
Aratinga pertinax	absent	absent	absent	rare
Amazona aestiva	common	absent	rare	common
Amazona ochrocephal	common	absent	moderate	common
Amazona farinosa	moderate	absent	moderate	rare
Pionus menstrus	absent	absent	rare	absent
Pionus maximiliani	rare	absent	absent	rare
Brotogeris chiriri	moderate	absent	rare	abundant
Brotogeris cyanoptera	moderate	absent	abundant	rare
Forpus xanthopterigyus	moderate	absent	abundant	abundant
Amazona xanthops	absent	absent	absent	rare

Figure 5. Silhouette of syntopic *Ara glaucogularis* and *Ara ararauna* in the same tree. The last in right corner is largest with wider flight feathers *A. ararauna*. Besides the smaller size the four (left) *A. glaucogularis* has a high pitched voice. This picture confirms the previous possibility pointed out by Forshaw (1973): a valid species sympatric with *A. ararauna*. The possibility to be juvenals or subspecies of *A. ararauna* is discard. The large macaws are extreme of altricial birds, the juvenal reach fully size when fledging. Photo: Y. Barros

Indigo Macaw *Anodorhynchus leari*- "Licuri" (*Syagrus coronata*) palm groves (Yamashita 1987), Glaucous Macaw *A. glaucus*- "Yataí" (Butia yatay) palm groves (Yamashita and Valle 1993) and Spix's Macaw *Cyanopsitta spixii* "Caraiba" (*Tabebuia caraiba*, Bignoniaceae) gallery woodland (Juniper and Yamashita 1991). *Ara glaucogularis* does not seem to be an exception to this pattern, based on its limited distribution and restriction to a particular habitat. Unzueta (1975) estimates the area of this habitat on the pampas or savanna of the Beni, which he calls "sartejenal", to be about 40 km by 200 km or 8,000 km^2. This corresponds to the area in which we observed *A. glaucogularis*, from 40 km south of Loreto to 50 km south of Magdalena. Therefore, our estimates for the total population is 200 individuals in the wild.

Conservation. In the pre-Columbian times the savannas were resting areas for nomadic bands of human hunters and agricultural societies. These agricultural societies had intensive technical capabilities, as shown by the hand made terraces of earth built up on flooded terrain, such as along the Mamoré river (Denevan 1980, Palau y Saiz 1992). After the Spanish conquest these agricultural platforms were abandoned (Unzueta 1975, Denevan 1980). It is on this unflooded terrain that motacú palm groves, currently the favored habitat of *A. glaucogularis*, became established, sometime in the past 500 years.

For centuries, open habitats in the Americas have been used as free range for cattle, and the Llanos de Mojos were no exception. This region is the main range for cattle ranching in Bolivia (Unzueta 1975). Local ranchers typically burn the pasture annually. Consequently, in all the rangeland that we visited there is almost no recruitment of palm groves due the long term effect of the overgrazing and annual dry season burning pratice.

During the 1980s intensive trapping of parrots for the commercial trade took place in Bolívia, primarily in the Beni. Before 1980 very few *A. glaucogularis* were available in the international market, and it was almost an unknown bird (Low 1992). Based on CITES permits importation to the U.S., Nilson (1981) records 38 birds in 1980 alone, and 112 birds from 1980-85 (Nilson 1981, 1989). Assuming the same level of discrepancies between CITES permits and quarantine data (US Department of Agriculture) as was demonstred with Hyacinthine Macaw (Munn *et al.* 1990), there are at least two times as many imported specimens, or a minimum of 300 Blue-throated macaws, exported to the U.S. alone. If we assume that Europe, Southeastern Asia, and South Africa also received comparable numbers, we can extrapolate that more than 1,200 wild-caught Blue-throated macaws entered the commercial trade in the 1980s. Even in the 1990s the occasional wild-caught bird was offered in the international market through Argentina (C. Bertonatti, per. com.), Spain, and Brazil. During our field work a ranch manager pointed out that at one local farm more than 5,000 macaws had been captured in an area of around 100,000 ha Munn (1995). The local people voiced their concern, noting that before the macaw trade years there were huge flocks of macaws, compared to "nothing" of today. Currently there is a lot of habitat available, with few remaining macaws.

ACKNOWLEDGMENTS

We thank C. Munn who gave us the opportunity to conduct this field work. A. Calatayud sent a copy of unpublished handwritten manuscript of Azara. Fundacion Armonia organized the first expedition in which YB participated to the Llanos de Mojos. O. Rocha, C. Quintela, and P. Ergueta provided copies of Bolivian literature. C. Olrog, K. Parkes, J. van Remsen, C. Bertonatti, J. Abramson answered my letters (CY) concerning *A. glaucogularis*. R. Guzman from Fundacion Amigos de la Naturaleza for the plants identification. G. Jafet from Fundação Zoológico de São Paulo for the the black and white picture. P. Martuscelli, J. Wiley, R. Bierregaard and T. Schulenberg made many suggestions, comments and improvement on the manuscript. We dedicated this paper in honor to Ted Parker who devoted his life to the study of the neotropical avifauna, and who had many discussions with CY about the possible range and habitat of *A. glaucogularis* before this species was rediscoreved in the wild. Two anonymous referees and M. Rodrigues improved the final version of the manuscript.

REFERENCES

Anderson, A. B., P.H. May and M. J. Balick. (1991) *The subsidy from nature: palm forest, peasantry, and development on Amazon frontier.* New York: Columbia Univ. Press.

Azara, F. (1789) *Apuntaciones para la historia natural de las aves de la Provincia del Paraguay.* 2 vol. Madrid: Mus. Nac. Cien. Nat. (unpublished).

___ (1802-1805) *Apuntamientos para la historia natural de los paxaros del Paraguay y rio de la Plata.* Madrid: Imprenta de la viuda de Ibarra.

Balslev, H. and M. Moraes. (1989) *Sinopsis de las Palmeras de Bolivia.* AAU Report 20, Aarhus: Inst. Aarhus Univ.

Collar, N. J., L. P. Gonzaga, N. Krabbbe, A. Madroño Nieto, L. G. Naranjo, T.A. Parker III and D. C. Wege. (1992) *Threatened birds of the Americas.* The ICBP/ IUCN Red Data Book. Cambridge: Intern. Council Bird Preserv.

Dabbene, R.(1920) El "Caninde"de Azara es el Ara ararauna (Lin.) *Hornero* 2: 56.

___ (1921) Algunas palabras mas sobre el cambio de nombre del Ara caninde auct. *Hornero* 2: 225.

Denevan, W. (1980) *La geografia cultural de los aborigenes de los Llanos de Mojos.* La Paz: Sibiria Ed. Juventud.

Forshaw, J. M. (1973) *Parrots of the world.* Melbourne: Landsdowne Ed.

___ (1989) *Parrots of the world.* 3rd ed. London: Blandford Press.

Gemuseus, R. C. and F. Sagot (1996) *A guide to the world's best bird watching place: Amboró protected area, Bolivia.* Santa Cruz de la Sierra: Fundacion Armonia.

Henderson, A., G. Galeano and R. Bernal (1995) *Field guide to the palms of the Americas.* Princeton: Princeton Univ. Press.

Hueck, K. (1972) *As florestas da America do Sul.* Brasília: Ed. Univ. Brasília.

Ingels, J., K. C. Parkes and J. Farrand (1981) The status of the macaw generally but incorrectly called *Ara caninde* Wagler. *Le Gerfaut* 71:283-294.

Jordan, O.C. and C. A. Munn.(1993) First observations of the Blue-throated Macaw in Bolívia. *Wilson Bull.* 105:694-695.

Juniper, A.T. and C. Yamashita (1991) The habitat and status of Spix's Macaw *Cyanopsitta spixii. Bird Conserv. Inter.* 1:1-9.

Lanning, D. V. (1991) Distribution and breeding biology of the Red-fronted Macaw. *Wilson Bull.* 103:357- 365.

Low, R. (1992) Parrots in aviculture: a photo reference guide. London: Bladford Press.

MEC (1968) Átlas histórico escolar. Rio de Janeiro: Ministério de Educação e Cultura

Munn, C.A., J. B. Thomsen and C. Yamashita (1990) The Hyacinth Macaw. p 404-419. In: W. J. Chandler (ed.) *Audubon Wildlife Report* 1989/1990. New York: Acad. Press.

___ (1995). The bigger they are harder they fall, or how body size affects the conservation status of the new world parrots. *Psittascene* 7:1-5.

Nilson, G. (1981). *The bird business.* Washington: The Animal Welfare Inst.

___ (1989). *Importation of birds into the United States in 1985.* Washington: The Animal Welfare Inst.

Palau, M. y B. Saiz. (1992). *Moxos, descripciones exactas e historia fiel de los indios, animales y plantas de la provmncia de Moxos en el Virreinato del Peru por Lazaro de la Ribera, 1786-1794.* Madrid: Ministério de Agricultura Pesca y Alimentacion, ICONA-INSPV.

Paynter, R. A., M.A. Traylor and B. Winter (1975) *Ornithological gazetteer of Bolivia* Cambridge, Mass.: Mus. Comp. Zool.

Remsen, J. V., A. T. Melvin and K. C. Parkes. (1986) Range extensions for some Bolivian birds, 2 (Columbidae to Rhynocryptidae). *Bull. Brit. Orn. Club* 106:22-32.

Ridgely, R. S. (1980). The current distribution and status of mainland Neotropical parrots. p. 233-384 *In* R.D. Pasquier, (ed.) *Conservation of New World Parrot.* Intern. Council of Bird Preserv. Tec. Publ.1. Washington: Smithsonian Inst. Press.

Sanchez Labrador, J. (1767). *Peces y aves del Paraguay natural ilustrado.* Ed. M. N. Castex (1968). Buenos Aires: Compaqia General Fabril Ed.

Terborgh, J. (1977). Birds species diversity on the Andean elevational gradient. *Ecology* 58:1007-1019.

Unzueta, O.(1975). *Mapa ecológico de Bolívia.* La Paz: Ministério de Asuntos Campesinos y Agropecuários.

Yamashita, C. (1987). Field observations and comments on the Indigo Macaw (*Anodorhynchus leari*), a highly endangered species from northeastern Brazil. *Wilson Bull.* 99:280-282.

___ and M. P. Valle.(1993). On the linkage between *Anodorhynchus* macaws and palm nuts, and the extinction of the Glaucous Macaw. *Bull. Brit. Orn. Club.* 113:53-60.

Ararajuba 5(2):151-158
dezembro de 1997

Nest characteristics of the Red-spectacled Amazon *Amazona pretrei* Temminck, 1830 (Psittacidae)

Nêmora Pauletti Prestes[1,2], Jaime Martinez[1], Paulo André Meyrer[3], Luis Henrique Hansen[4] and Marcelo de Negri Xavier[5]

[1] *Projeto Charão, Amigos do Meio Ambiente, Rua Presidente Vargas 190, 99500-000, Carazinho, RS, Brazil.*
E mail: martinez@pro.via-rs.com.br
[2] *Universidade de Passo Fundo, Instituto de Ciências Biológicas. C. P. 576. 99001-970, Passo Fundo, RS, Brazil*
[3] *Rua Rodrigues Alves 83, 99500-000, Carazinho, RS, Brazil*
[4] *Rua Pedro Vargas 1070, 99500-000, Carazinho, RS, Brazil*
[5] *Rua Silva Jardim 1440, 99500-000, Carazinho, RS, Brazil*

Recebido em 29 de abril de 1997; aceito em 02 de julho de 1997

RESUMO. **Características de nidificação do papagaio-charão *Amazona pretrei* Temminck, 1830 (Psittacidae).** Foram localizados 79 ninhos de *Amazona pretrei* no Rio Grande do Sul, identificando áreas de reprodução nas regiões dos Campos de Cima da Serra, Planalto Médio, Depressão Central, Serra do Sudeste e Alto Uruguai. Entre as 23 espécies vegetais arbóreas que o papagaio-charão utilizou em sua nidificação, três mostraram-se mais freqüentes, com 54,4 % das árvores-ninho: *Cupania vernalis* (Sapindaceae), *Sebastiania klotzschiana* (Euphorbiaceae) e *Nectandra lanceolata* (Lauraceae). Foram tomadas medidas da altura e diâmetro de cada árvore, enquanto dos ninhos obteve-se a orientação da abertura, o diâmetro do tronco, a altura em relação ao solo, os diâmetros da cavidade (internos e da abertura) e a profundidade. A variação dos resultados foi ampla na maioria desses ítens, sugerindo que os casais de *A. pretrei* nidificam em um amplo espectro de cavidades de árvores, desde que tenham dimensões mínimas capazes de permitir o acesso e abrigo dos papagaios. Aumentar o grau de proteção dos locais de nidificação do papagaio-charão e realizar campanhas de educação ambiental, são medidas que podem minimizar a pressão de captura de filhotes, uma das principais causas que ameaçam a sobrevivência da espécie.
PALAVRAS-CHAVE: *Amazona pretrei*, nidificação, ninhos, Psittacidae, Rio Grande do Sul.

ABSTRACT. Seventy-nine nests of *A. pretrei* were found in the state of Rio Grande do Sul (Brazil) in the physiographic regions known as Campos de Cima da Serra, Planalto Médio, Depressão Central, Serra do Sudeste and Alto Uruguai. Among the 23 species of trees used for nesting, the most frequent (54.4 % of the total) were *Cupania vernalis* (Sapindaceae), *Sebastiania klotzschiana* (Euphorbiaceae) and *Nectandra lanceolata* (Lauraceae). For each nest, the following data were recorded: height and diameter of the tree, orientation and height of the nest entrance, diameter of the trunk, entrance and cavity, and its depth. We found most of these measurements to show a broad variation, suggesting that *A. pretrei* can use a diverse array of nesting cavities provided they have a minimum size that allows access and shelter. To increase the protection of nesting sites and promote education programs are two strategies suggested to minimize the robbing of nestlings by poachers, one of the main threats to the species.
KEY WORDS: *Amazona pretrei*, breeding, nest sites, nesting, Psittacidae, Rio Grande do Sul.

Amazona pretrei Temminck, 1830 is a globally threatened parrot (Bernardes *et al.* 1990, Collar *et al.* 1992) occurring in southern Brazil (Schauensee 1966, Forshaw and Cooper 1978). Belton (1985) recorded it as occurring from 28°-31°S and between 50°30'-54°W, but that author believed it could be found beyond that limits. Collar *et al.* (1992) commented that the species seems to be currently restricted to Rio Grande do Sul state in Brazil, having occurred in small numbers in Argentina and, possibly, Paraguay, but with no proof of it ever ranging into Uruguay. The nomadic behavior of the species was confirmed by Martinez (1996), who proposed migratory routes between Rio Grande do Sul and Santa Catarina state, where the species is a non-breeding visitor and congregates from February to June, attracted by the abundant supply of seeds of the southern pine *Araucaria angustifolia* (Araucariaceae).

In Rio Grande do Sul, Sick (1996) recorded *A. pretrei* breeding in the regions known as Campos de Cima da Serra, Encosta Superior and Inferior do Nordeste, and Serra do Sudeste (nomenclature follows Fortes 1959). Silva (1981) added the Planalto Médio, Alto Uruguai and Serra do Sudeste regions (figure 1). Silva (1981) and Belton (1985) described two nests found in the Serra do Sudeste, one in a *Casearia* sp. (Flacourtiaceae) tree and

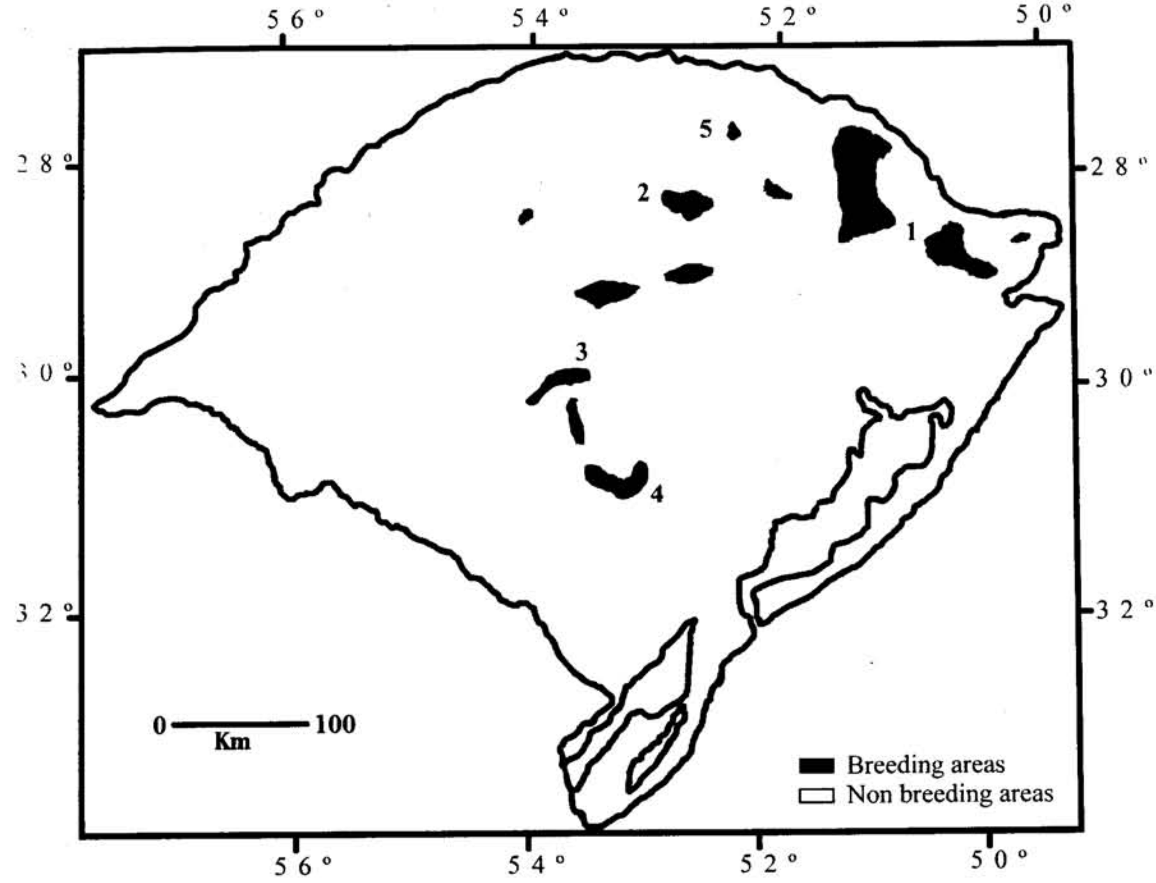

Figure 1. Breeding distribution of *A. pretrei* in Rio Grande do Sul state, southern Brazil. 1, Campos de Cima da Serra; 2, Planalto Médio; 3, Depressão Central; 4, Serra do Sudeste; 5, Alto Uruguai.

another in a *Quillaja brasiliensis* (Rosaceae), both nest cavities being 10 m high. In 1993, 18 nests were found in the Planalto Médio and Campos de Cima da Serra, where *Cupania vernalis* (Sapindaceae), *Sebastiana klotzchiana* (Euphorbiaceae) and *Nectandra lanceolata* (Lauraceae) are the commonest nesting trees (pers. obs.). Varty *et al.* (1994) discovered 51 nests in several localities in Rio Grande do Sul, and found a nest height ranging between 3 and 10 m from the ground. They also discovered that amazons used 27 tree species for nesting, with *Nectandra* sp. (Lauraceae), *Ocotea* sp. (Lauraceae), *Cupania vernalis* (Sapindaceae) and *Sebastiania* sp. (Euphorbiaceae) accounting for 50 % of the nest-cavity records.

The Projeto Charão, a research and environmental education program aimed to the conservation of *A. pretrei*, was created in 1991 and has been conducted by the non-governamental organization Amigos do Meio Ambiente (AMA) and the Grupo Ñhandú de Pesquisa em Vida Silvestre of the Universidade de Passo Fundo. From September 1992 to April 1995 the program located 79 nests of *A. pretrei*. Our objectives were to describe the breeding distribution of the species, nesting site characteristics and conservation actions needed on behalf of the species, including nest protection and provisions for nesting cavities.

METHODS

From September 1992 to April 1995 we made 38 field trips to the following regions of Rio Grande do Sul: Encosta Superior do Nordeste, Encosta Inferior do Nordeste, Planalto Médio, Alto Uruguai, Depressão Central, Campos de Cima da Serra, Serra do Sudeste, Missões and Campanha.

We used two methods in order to find *A. pretrei* nests. The first was to visit each physiographic region and to select sampling areas. In these areas, we described and showed pictures of *A. pretrei* to persons living both in the country and in urban areas, aiming to find people who knew of nests or had captive amazons. During investigating of the sources of captive amazons we tried to identify the poachers and use them to locate forest patches and nesting trees used by breeding amazons. Another less biased method was to install observation sites in the forest from August to December, when the amazons breed, to follow their movements to the nesting trees.

For each nesting tree we found we recorded plant species, diameter at breast height (DBH) and total height (HEIG). For each nest we measured the diameter of the trunk (TDIA) at the height of the nest entrance, the maximum and minimum diameters of the nest cavity entrance (OPDI max. and min.), the internal entrance diameter (INDI), the nest cavity depth (DEP), the height of the nest entrance from the ground (NEHE) and the direction (compass bearing) that the nest entrance faced.

The highest nests were reached with the aid of climbing equipment, and measurements and observations were made with metric tapes, compass and binoculars. Botanical samples of each nesting tree were taken for identification in the herbarium of the Museu Zoobotânico da Universidade de Passo Fundo.

RESULTS AND DISCUSSION

We found breeding *A. pretrei* (figure 1) mostly in the range recorded for the species by Belton (1985), and some breeding localities further north that confirm Belton's suppositions.

The main breeding area of the species is the Planalto of Rio Grande do Sul in the physiographic region of the Campos de Cima da Serra, in the northeastern part of the state, especially in the municipalities of Barracão (27°47'S, 51°23'W), Lagoa Vermelha (28°09'S, 51°33'W), Esmeralda (28°04'S, 51°09'W), Vacaria (28°30'S, 51°54'W) and Bom Jesus (28°10'S, 50°27'W). Breeding localities were also found in the Planalto Médio, in the municipalities of Salto do Jacuí (29°05'S, 53°13'W), Júlio de Castilhos (29°13'S, 53°41'W), Cruz Alta (28°38'S, 53°36'W), Soledade (28°52'S, 52°31'W), Carazinho (28°18'S, 52°47'W), Santo Antônio do Planalto (28°24'S, 52°40'W), Passo Fundo (28°15'S, 52°24'W), Coxilha (28°07'S, 52°18'W), Pontão (28°04'S, 52°41'W) and Augusto Pestana (28°32'S, 53°54'W). In the Alto Uruguai region only isolated small areas were used by breeding *A. pretrei* in the municipalities of Erechim (27°38'S, 52°17'W), Trindade do Sul (27°33'S, 52°42'W) and São José de Ouro (27°47'S, 51°35'W).

In the Depressão Central region breeding localities were found in the municipalities of Formigueiro (29°59'S, 53°28'W), Vila Nova do Sul (30°22'S, 53°51'W), São Sepé (30°08'S, 53°25'W) and Santa Maria (29°40'S, 53°48'W), especially in forests of the Vacacaí river basin. The Serra do Sudeste, where Belton and Silva (Silva 1981) found the first recorded nests in 1979, was also found to be an important breeding region for *A. pretrei*, especially the municipalities of Santana da Boa Vista (30°53'S, 53°07'W), Piratini (31°15'S, 53°06'W), Caçapava do Sul (30°31'S, 53°30'W) and Encruzilhada do Sul (30°37'S, 52°27'W). These results on the breeding distribution of the red-spectacled amazon in Rio Grande do Sul confirm and provide additional records to previous information by Sick (1969), Silva (1981), Belton (1985) and Varty *et al.* (1994).

Most of the forest patches where we found the 79 nests of *A. pretrei* are characterized by anthropogenic impacts like cattle grazing and logging (table 1), as recorded in the Planalto Médio, Alto Uruguai, Depressão Central and Campos de Cima da Serra. We found that 50.0 % of the nests were in the forest edge (up to 20 m from the border), 47.3% inside the forest (more than 20 m from the border) and only 2.7 % were found in open areas.

As shown in table 2, among the 23 tree species used by

Table 1. Number of *Amazona pretrei* nests found in each physiographic region (names follow Fortes 1959), their vegetation type and human disturbance levels.

Physiographic region	N° of nests (N=79)	Vegetation*
Encosta Superior do Nordeste	0	Mixed Evergreen Forest
Encosta Inferior do Nordeste	0	Seasonal Deciduous Forest
Planalto Médio	31	Mixed Evergreen Forest
Alto Uruguai	07	Seasonal Deciduous Forest
Depressão Central	06	Seasonal Deciduous Forest
Campos de Cima da Serra	20	Mixed Evergreen Forest
Serra do Sudeste	15	Savanna
Missões	0	Seasonal Deciduous Forest
Campanha	0	Steppe

* Follows RADAMBRASIL/IBGE - 1986

nesting amazons the most important were *Cupania vernalis* (Camboatá-vermelho, Sapindaceae) with 27 % of all occurrences (n = 21), *Sebastiania klotzchiana* (Branquilho, Euphorbiaceae) with 20 % (n = 16) and *Nectandra lanceolata* (Canela-branca, Lauraceae) with 7.6 % (n = 6). The family Sapindaceae accounted for 35 % of all nesting trees (n = 28), followed by the Euphorbiaceae (represented solely by *Sebastiania klotzchiana*) with 20 %, and the Lauraceae with 11.4 %. Our records of tree species used by nesting *A. pretrei* are similar to Varty *et al.* (1994). As with Silva (1981), Sick (1984), Belton (1985) and Varty *et al.* (1994), no nest was find in southern pines *Araucaria angustifolia* (Araucariaceae).

Most nests were found in live trees (92.4 %, n = 73) which, as recorded for the Blue-fronted Amazon *A. aestiva* (Sauad *et al.* 1991), belonged to species with few or no economic value for timber. Scherer-Neto (1989) and Martuscelli (1995) found that many (38 % and 67 %, respectively) nests of the Red-tailed Amazon *Amazona brasiliensis* were in dead trees. We found that 55.7 % (n = 44) of the cavities used by *A. pretrei* were in the main trunk, while 44.9 % (n = 35) were in limbs (figure 2).

Measurements of nesting tree and nest cavity characteristics typically showed wide variation (tables 2 and 3). Tree height ranged from 4.8 (a *Schinus* sp.) to 35 m (a *Parapiptadenia rigida*), with a mean of 13.2 m (s.d. = ± 4.5) with most trees (88 %) being 10-18 m. high. A significant correlation ($r = 0.8$, $p < 0.001$) was found between tree height and nest height from the ground, the latter ranging from 1.4 m (in a *Schinus* sp.) to 25.3 m (in a *Parapiptadenia rigida*), with most nests being between 4 and 10 m high. Nests were located an average of 6.9 ± 3.7 m from the ground. Martuscelli (1995) found that nest height ranged from 1 to 15 m for *A. brasiliensis*, while Sauad *et al.* (1991) recorded a range from 1.6 to 20 m for *A. aestiva*.

We found a significant correlation ($r = 0.56$, $p < 0.001$) between diameter at breast height (DBH) and tree height (HEIG), and also with nest height (NEHE) ($r = 0.52$, $p < 0.001$). Most nest trees had a DBH between 30 and 60 cm, ranging from 23.2 to 114.6 cm, with a mean of 46.4 ± 19.7 cm (n = 79). The results suggest that hollowed trees above 23.2 cm DBH offer conditions for nesting.

Trunk diameter at nest entrance height (TDIA) had a mean of 31.4 ± 8.2 cm, with a range from 8.6 to 54.4 cm, most nests (82.2 %) showing a 30 to 40 cm TDIA. The correlation between trunk diameter at nest entrance (TDIA) was significant ($r = 0.35$, $p < 0.001$) only with diameter at breast height (DBH).

With regard to nest entrance diameters we found a significant correlation between the minimum nest entrance diameter (OPDI min) and the minimum diameter of the nest cavity (INDI min) ($r = 0.36$, $p < 0.001$).

Many cavity-nesting birds show a preference for a certain orientation (i.e. compass bearing) with regard to nest entrance (Saunders 1979). Nevertheless the results for

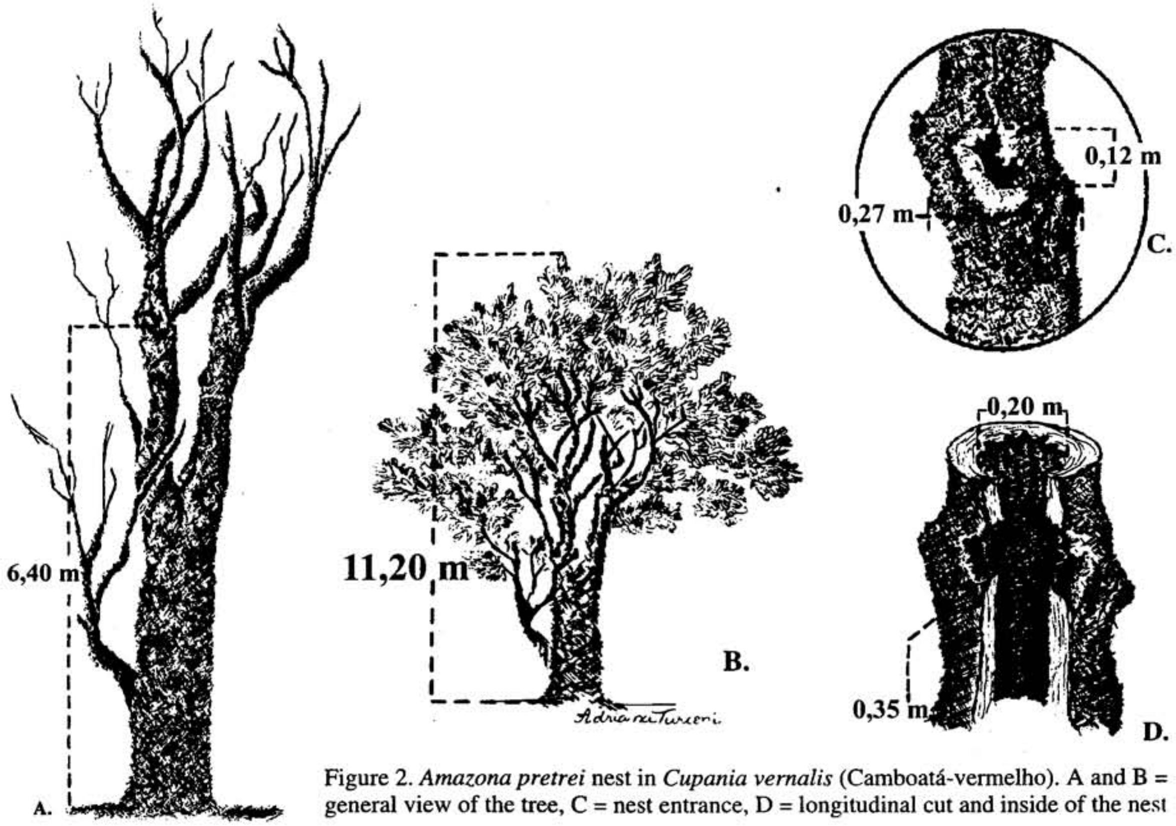

Figure 2. *Amazona pretrei* nest in *Cupania vernalis* (Camboatá-vermelho). A and B = general view of the tree, C = nest entrance, D = longitudinal cut and inside of the nest

Table 2. Average measurements of nest-trees and nesting cavities used by *Amazona pretrei* in Rio Grande do Sul, Brazil.

Species*	HEIG (m)	DBH (cm)	NEHE (m)	TDIA (cm)	DEP (cm)	OPDI (cm)	INDI * (cm)	Families (N = 17)	Nest trees (N = 79) N	%
Cupania vernalis	12.3	41.6	7.0	32.4	64.2	21.4 x 11.7	21.7 x15.6	Sapindaceae	21	26.6
range	7.5 - 16.7	23.23 - 54.11	2.4 - 12.2	20.69 - 46.79	10.0 - 175.0	10.0 x 6.0				
50.0 x 20.0	12.0 x 6.0									
43.0 x 32.0										
standard deviation	2.43	8.67	2.46	7.84	45.42	11.6 - 4.36	8.49 - 5.99			
Sebastiania klotzschiana	12.0	36.0	5.0	30.0	116.3	69.8 x 13.9	22.9 x 14.6	Euphorbiaceae	16	20.3
range	8.0 – 14.3	26.41 - 40.1	2.73 -7.8	22.0 - 38.19	6.0 - 340.0	13.0 x 5.0 278.0 x30.0	12.0 x 6.0 70.0 x 22.0			
standard deviation	2.01	5.53	1.63	5.06	86.09	78.81 - 7.90	13.46 - 4.33			
Nectandra lanceolata	13.5	77.4	7.4	42.3	55.7	19.3 x15.0	22.3 x 20.0	Lauraceae	06	7.6
range	11.0 - 15.0	31.83-114.58	5.22 - 10.0	28.01 - 54.43	23.0 - 120.0	15.0 x 7.0 28.0 x 23.0	20.0 x 24.0 17.0 x 23.0			
standard deviation	1.76	31.70	1.90	13.35	55.71	7.5 - 8.0	2.0 - 3.0			
Ruprechtia laxiflora	13.5	39.0	6.3	2.,5	114.8	27.9 x 19.1	21.1 x 20.3	Polygonaceae	04	5.1
range	11.0 - 16.5	31.51 - 42.01	3.22 - 8.22	15.91 - 30.23	33.0 - 260.0	8.5 x 7.5 50.0 x 35.0	12.5 x 10.0 40.0 x 40.0			
standard deviation	2.83	5.0	2.68	6.46	100.86	19.43 - 11.75	12.3 - 13.57			
Matayba elaegnoides	12.9	47.3	6.2	34.8	78.0	31.3 x 10.5	18.5 x 14.3	Sapindaceae	04	5.1
range	11.6 - 13.8	34.37 - 49.01	4.75-- 8.33	27.69 - 42.97	45.0 - 170.0	10.0 x 5.0 80.0 x 18.0	16.0 x 12.0 21.0 x 17.0			
standard deviation	0.92	10.07	1.68	6.3	61.36	32.75 - 5.56	2.38 - 2.06			
Allophylus edulis	10.7	28.4	4.5	22.6	198.0	90.7 x 13.7	16.7 x 12.0	Sapindaceae	03	3.8
range	8.80 - 12.50	25.78 - 31.83	2.30 - 6.98	8.59 - 30.23	56.0 - 358.0	17.0 x 13.0 142.0 x 14.0	14.0 x 10.0 21.0 x 14.0			
standard deviation	2.61	3.09	2.35	12.14	151.80	65.42 - 0.57	3.78 - 2.0			
Lithraea brasiliensis	14.4	55.6	8.5	31.3	32.3	54.3 x 11.3	17.7 x 14.7	Anacardiaceae	03	3.8
range	13.30 - 16.14	37.24 - 87.21	7.65 - 9.56	31.83 - 35.01	27.0 - 40.0	23.0 x 6.0 70.0 x 20.0	14.0 x 14.0 20.0 x 15.0			
standard deviation	1.5	27.49	0.98	4.0	6.80	27.13 - 7.57	3.21 - 0.57			
Parapiptadenia rigida	30.0	82.1	17.9	-	-	-	-	Leguminosae	02	2.5
range	25.0 - 35.0	82.12 - 82.12	10.5 - 25.3	-	-	-	-			
standard deviation	7.07	0	10.46	-	-	-	-			

Table 2. Continued.

Species*	HEIG (m)	DBH (cm)	NEHE (m)	TDIA (cm)	DEP (cm)	OPDI (cm)	INDI * (cm)	Families (N = 17)	Nest trees (N = 79) N	%
Eugenia pungens	7.1	34.7	5.7	25.5	157.5	31.5 x 9.0	-	Myrtaceae	02	2.5
range	7.0 - 7.2	34.37 - 35.01	5.0 - 6.35	25.46 - 25.46	95.0 - 220.0	8.0 x 8.0	15.0 x 15.0			
						55.0 x 10.0	15.0 x 15.0			
standard deviation	0.14	0.45	0.95	0	88.38	33.23 - 1.41	-			
Schinus sp.	6.4	36.6	2.3	37.4	21.5	37.5 x 12.0	14.3 x 11.0	Anacardiaceae	02	2.5
range	4.8 - 8.0	31.19 - 42.01	1.44 - 3.2	32.78 - 42.01	14.0 - 29.0	14.0 x 8.0	13.5 x 8.0			
						61.0 x 16.0	15.0 x 14.0			
standard deviation	2.26	7.65	1.24	6.52	10.6	33.23 - 5.65	1.06 - 4.24			
Ateleia glazioviana	20.5	52.5	15.1	26.0	90.0	13.8 x 10.3	17.0 x 13.5	Leguminosae	02	2.5
range	16.0 - 25.0	52.52 - 52.52	14.1 - 16.0	22.91 - 29.13	84.0 - 96.0	12.5 x 8.0	17.0 x 13.0			
						15.0 x 12.5	17.0 x 14.0			
standard deviation	6.36	0	1.34	4.39	8.48	1.76 - 3.18	0 - 0.70			
Ocotea cf pulchella	15.8	44.4	7.4	-	40.0	100.0 x10.0	14.0 x 10.0	Lauraceae	02	2.5
range	14.5 – 17.01	42.33 - 46.47	7.20 - 7.61	-	-		-			
standard deviation	1.77	2.92	0.28	-	-	-	-			
Capsicodendron dinisii	11.0	30.2	4.1	29.0	42.5	66.0 x 9.5	20.0 x 7.0	Canelaceae	02	2.5
range	10.0 - 12.04	27.21 - 33.10	2.81 - 5.46	28.64 - 29.28	30.0 - 55.0	52.0 x 7.0	19.0 x 6.0			
						80.0 x 12.0	21.0 x 8.0			
standard deviation	1.44	4.16	1.87	0.45	17.67	19.79 - 3.53	1.41 - 1.41			
Salix humboldtiana	24.0	98.7	15.0	30.2	35.0	11.0 x 8.0	18.0 x 17.0	Salicacea	01	1.3
Siloaneae sp.	20.0	95.5	7.4	52.5	0.8	50.0 x 12.0	18.0 x 10.0	Elaeocarpaceae	01	1.3
Prumus selowii	12.3	35.7	8.0	31.2	0.3	11.0 x 16.0	24.0 x 16.0	Rosaceae	01	1.3
Plantanus sp.	8.0	35.0	5.6	23.9	140.0	45.0 x 13.0	18.0 x 14.0	Plantanaceae	01	1.3
Nectandra megapotamica	13.0	76.4	8.8	25.5	0.6	40.0 x 15.0	20.0 x 15.0	Lauraceae	01	1.3
Cordia trichotoma	23.0	79.6	17.0	25.5	0.6	25.0 x 8.0	15.0 x 13.0	Boraginaceae	01	1.3
Ilex brevicuspis	8.3	29.0	4.9	36.3	0.8	104.0 x17.0	28.0 x 26.0	Aquifoliaceae	01	1.3
Xylosma sp.	13.0	54.1	4.8	42.7	0.9	81.0 x 17.5	32.0 x 20.0	Flacourtiaceae	01	1.3
Quillaja brasiliensis	13.3	34.4	6.3	29.9	0.5	179.0 x12.0	17.5 x 12.5	Rosaceae	01	1.3
Unidentified	15.5	59.2	7.6	29.9	0.6	61.0 x 15.0	17.5 x 16.0		01	1.3

(HEIG) total height; (DBH) diameter at breast height; (NEHE) height of the nest entrance from the ground; (TDIA) diameter of the trunk at the height of the nest entrance; (DEP) nest depth; (OPDI) maximum and minimum diameters of the nest cavity entrance; (INDI) internal diameter the nest cavity.

Table 3. Range, means and standard deviations of measurements taken from nesting trees and nest cavities used by *Amazona pretrei*. Abreviations are the same as in table 2.

Measurements	Min-Max	Mean	Standard Deviation
HEIG (m)	4.8 - 35.0	13.2	4.5
DBH (cm)	23.2 - 114.6	46.4	19.7
DTN (cm)	8.6 - 54.4	31.4	8.2
NEHE (m)	1.4 - 25.3	7.0	3.7
DEP (cm)	6.0 - 358.0	84.6	71.7
OPDI max (cm)	8.5 - 278.0	48.2	51.4
OPDI min (cm)	5.0 - 35.9	12.6	6.2
INDI max (cm)	12.0 - 70.0	20.7	8.7
INDI min (cm)	6.0 - 40.0	15.1	5.6

A. pretrei showed no preference for a given orientation, nest openings being almost equally distributed among the possible bearings (east 18.91 % (n = 14), northeast 16.21 % (n = 12), northwest 14.86 % (n = 11), west 12.16 % (n = 9), south 10.81 % (n = 8), north 9.45 % (n = 7), southwest 9,45% (n = 7) and southwest 8,10% (n = 6). Similarly, Sauad *et al.* (1991) studying *A. aestiva* nests, and Guedes (1993) with Hyacinthine Macaws *Anodorhynchus hyacinthinus*, found the nest opening orientations to be randomly distributed.

Another nest characteristic which showed wide variation was depth: we found nests ranging from 6 cm in a *Sebastiania klotzchiana* to 358 cm in an *Allophylus edulis* (Table 3). Mean depth was 84.6 ± 71.7 cm, with 64% of the nests being deeper than 50 cm. Nest depth (DEP) showed significant correlations with the minimum nest entrance diameter (OPDI minimum; $r = 0,38$, $p < 0.001$) and with tree diameter at breast height (DBH; $r = -0.32$, $p < 0.001$). Among other *Amazona* evidence of selection of nest sites by their depth is still wanting, as in the case of *Amazona brasiliensis*, which uses cavities ranging from 0.2 to 4.2 m (Scherer-Neto, 1989; Martuscelli, 1995).

The results of the measurement analysis of 79 nests suggest the wide range of the main nest characteristics are a result of the size, tree architecture and qualitative characteristics of the nest-trees trunks. They also suggest *A. pretrei* is not selecting nests with narrowly defined characteristics but rather using most cavities available in its habitat provided they are large enough to allow nesting (Table 3).

From 79 nests, 63.3% had their nestlings stolen in the previous nesting period. Poaching resulted in damage to 31.6% of the nests, as poachers commonly cut the nest tree at its base or at nest entrance level to get the nestlings.

We also found that 3.8% of the nests were occupied by owls, *Otus choliba* and *Otus sanctaecatarinae*, and by bees during the amazon's breeding season. Sick (1984) records that many tree cavities usable by parrots are occupied by bees, wasps and ants, and there is competition with small mammals like opossums and marmosets.

Natural predation of *Amazona pretrei* nestlings by the toucan *Ramphastos toco* was recorded once (1.3% of all studied nests) in the Serra do Sudeste, where this fact is well-known to the country people. *Ramphastos toco* is also considered a nest predator of the parrot *Myiopsitta monachus* in that region. A nest monitored in the Planalto Médio region, not included in this analyses, was depredated by a white-eared opossum *Didelphis albiventris* in October 1994. Only 19% of the nests located in this study were successful in producing fledglings.

In 1993, in a ranch at the Salto do Jacuí municipality, Planalto Médio, a *A. pretrei* nest was found in a very rotten trunk that the amazons had used for three consecutive years. Natural decomposition caused one entire face of the trunk to fall, this being repaired by us and the nest protected and followed by the landowner, who reported its successful use by a amazon couple during the same year. Lindsey (1992) found two out of ten repaired *A. vittata* nests to have been successful.

We found that over most of the specie's breeding range poachers take all the nestlings they find (usually 2 to 4 per nest, very rarely 5). Otherwise, in southern Rio Grande do Sul many poachers believe it is necessary to leave at least a nestling in the nest so the amazon pair will return for the next breeding season.

The Lagoa Vermelha municipality region and its environs is one of the main areas where *A. pretrei* nestlings are poached and sold. By contacting poachers and other people acquainted with the activity we were able to estimate that the minimum number of stolen nestlings is surprisingly high: 300 to 500 per year. So, only in this region many youngsters are not recruited into the population, which is under risk of lack of recruitment and an unbalanced aging.

The adequate management of the forests by the landowners to assure their continuing regeneration would increase the availability of nest sites for *A. pretrei*. This could be achieved by excluding sapling-destroying cattle from forest patches and by allowing a larger number of trees to reach a size usable by nesting amazons. We aim, in the long term, to calculate the replacement rates of the senile trees with nest cavities. In the short term the objective is to work in the properties currently known to be breeding areas for *A. pretrei* in order to conserve trees with cavities and to increase the degree of protection these habitats receive, especially in the period before the nestlings leave the nest (November to December) to protect them from poachers.

To reduce poaching, which is a serious threat to the population of *A. pretrei*, we recommend an urgent and widespread environmental education work aimed to the specie's conservation, and rigorous inspection of vehicles by the authorities along the roads crossing the region, especially in the December to February period when middlemen and traffickers go to the breeding areas to buy nestlings from the poachers.

The capture of *A. pretrei* nestlings is one of the main causes threatening the species with extinction, both by interrupting the biological cycle of the individuals taken to captivity, and by the damage the poachers cause to the nest cavities and trees when stealing the nestlings. To protect the nestlings and the nests is complex process which involves a greater degree of public awareness and the conscious to not buy wild animals.

ACKNOWLEDGMENTS

We wish to thank Dr. J. M. E. Vielliard for reviewing this paper, making suggestions and encouraging us to investigate the natural history of the red-spectacled amazon; Dra. T. L. Codenotti and Biol. P. Martuscelli for their valuable suggestions; Msc. F. M. B. Villanova da Silva for his interest in our work and for aiding us with his own observations on *A. pretrei*. The Fundação o Boticário de Proteção à Natureza for financial support. The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA, and the Secretaria Estadual da Agricultura through its Departamento dos Recursos Naturais Renováveis for allowing us to work in the conservation unities, and the logistical support. The Universidade de Passo Fundo, through the Instituto de Ciências Biológicas and Laboratório de Informática da Faculdade de Agronomia for technical support. C. Yamashita. J. M. Meyers and M. Rodrigues greatly improved the final version of this manuscript.

REFERENCES

Belton, W. (1985). Birds of Rio Grande do Sul, Brazil. Part. II. Formicariidae through Corvidae. *Bull. Am. Mus. Nat. Hist. New York* 180: 1-631.

Bernardes, A. T.; A. B. M. Machado; A. B. Rylands (1990) *Fauna Brasileira Ameaçada de Extinção.* Belo Horizonte: Fundação Biodiversitas para a Conservação da Diversidade Biológica.

Collar, N. J.; L. P. Gonzaga; N. Krabbe; A. Mandrono Nieto; L. G. Naranjo; T. A. Parker and D. C. Wege (1992) *Threatened Birds of the Americas, the ICBP/IUCN Red Data Book, 2.* Third Edition. Cambrige, International Council for Bird Preservation.

Forshaw, J. M. and W. T. Cooper, (1978) *Parrots of the World.* Melbourne, Landsdowe.

Fortes, A. B. (1959) *Geografia física do Rio Grande do Sul.* Porto Alegre, Livraria do Globo.

Guedes. N. M. R. (1993) *Biologia Reprodutiva da Arara Azul (Anodorhynchus hyacinthinus) Pantanal-MS. Brasil.* Dissertação de Mestrado, ESALQ, Univ. São Paulo, Piracicaba.

Lindsey, G. D. (1992). Nest Guarding fron Observation Blins: Strategy for Improving Puerto Rican Parrot Nest Success. *J. Field Orn.* 63:466-472.

Martinez, J. (1996) Projeto Charão: Biologia, Monitoramento e Conservação do Papagaio-Charão, *Amazona pretrei. Congresso Brasileiro de Ornitologia. 5., Campinas. Anais*: 94-96.

Martuscelli, P. (1995) Ecology and Conservation of the Red-tailed Amazon *Amazona brasiliensis* in southeastem Brazil. *Bird Conserv. Intern.* 5:225-240.

Radambrasil (1986) *Levantamento dos Recursos Naturais vol. 33 - Folha SH. 22 Porto Alegre e Parte das Folhas SH. 21 Uruguaiana e SI. 22 Lagoa Mirim.* Rio de Janeiro: IBGE.

Sauad, J.J.; V. Nunez; J. L. Garrido; S. Mosa; M. E. Calzon and Z. M. Chorolque (1991). Ambientes del Loro Hablador *Amazona aestiva.* Argentina. III. Características de los Arbores-Nido. *Manejo de Fauna*, P.T. 4. 1:12.

Saunders. D. A. (1979) The Availability of Tree Hollows for use as Nest Sites by White-tailed Black Cockatoos. *Aust. Wildl. Res.* 6:205-216.

Schauensee, R.M. de. (1966). *The species of birds on South America and their distribution.* Philadelphia: Acad. Nat. Sc:

Scherer-Neto, P. (1989) *Contribuição à biologia do papagaio-de-cara-roxa Amazona brasiliensis (Linnaeus, 1758) (Psittacidade, Aves).* Dissertação de Mestrado, Curitiba: Univ. Fed. Paraná.

Sick, H. (1984) *Ornitologia Brasileira, Uma Introdução.* Vol. 1. Brasília: Univ. Brasília.

Silva, F. (1981) Contribuição ao Conhecimento da Biologia do Papagaio-Charão, *Amazona pretrei* (Temminck, 1830) (Psittacidae, Aves). *Iheringia (Zool).* 58:79-85.

Varty, N.; G. A. Bencke; L. M. Bernardini; A. S. Cunha; E. V. Dias; C. S. Fontana; A. D. L., Guadagnin; A. Kindel; E. Kindel; M. M. Raymundo; M. Richter; A. O. Rosa, and C. S. Tostes (1994) *Conservação do papagaio-charão Amazona pretrei no sul do Brasil: um plano de ação preliminar.* Porto Alegre: EDIPUCRS (Div. Mus. Ciênc. e Tecnol. - UBEA/PUCRS. 1:1-70.

Ararajuba 5(2):159-167
dezembro de 1997

Muestreos del comercio de psitácidos neotropicales en la ciudad de Barcelona, España: 1991-1996

Juan Carlos Guix[1], **Lluís Jover**[2] **y Xavier Ruiz**[1]

[1]*Departament de Biologia Animal (Vertebrats), Facultat de Biologia, Universitat de Barcelona, Avda. Diagonal 645, 08028, Barcelona, España*
[2]*Unitat de Bioestadística, Departament de Salut Pública, Facultat de Medicina, Universitat de Barcelona, C/ Casanova 143, 08036, Barcelona, España*

Recebido em 07 de maio de 1997; aceito em 10 de julho de 1997

RESUMO. **Amostragens do comércio de psitacídeos neotropicais na cidade de Barcelona, Espanha: 1991-1996.** O comércio mundial de aves silvestres mobiliza um grande número de exemplares e representa uma importante atividade econômica para alguns países. A União Européia é um dos principais importadores de aves vivas, sendo a cidade de Barcelona, dada a sua elevada atividade comercial marítima e aérea, um importante centro receptor de aves silvestres procedentes de outros continentes. Nas últimas décadas, um dos grupos em que este comércio mundial incidiu de modo bastante acentuado foi na Família Psittacidae. Entre os anos 1991 e 1994, foram amostradas todas as espécies de Psitacídeos de distribuição neotropical em dez lojas de venda de animais da cidade de Barcelona, e entre 1994 e 1996 foram amostradas, exclusivamente, as espécies de *Amazona*. Um total de 3.989 exemplares pertencentes a 17 espécies foram amostrados nos primeiros 36 meses (1991-1994). Durante este período as espécies mais dominantes foram (por ordem de importância): *Myiopsitta monachus, Aratinga mitrata, A. acuticaudata, Cyanoliseus patagonus, Nandayus nenday* e *Amazona aestiva*. De 400 exemplares de *Amazona* spp. amostrados durante 60 meses (período: 1991-1996), 53,5 % correspondiam a espécie *Amazona aestiva*, 30 % a *A. amazonica*, 7,3 % a *A. autumnalis*, 5,3 % a *A. farinosa* e 4 % a *A. ochrocephala*. Durante o período total de amostragens, o número anual de exemplares de *A. aestiva* presentes nas lojas foi diminuindo, enquanto que o número de exemplares de *A. farinosa* e de *A. autumnalis* foi aumentando. Isso poderia sugerir que, devido a um maior controle do comércio de *A. aestiva*, esta espécie estaria sendo gradativamente substituída por outras espécies do mesmo gênero no comércio local. Atualmente considera-se que a elevada demanda de importação de Psitacídeos neotropicais pelos países mais industrializados e a crescente perda de hábitat nos países de origem, são as principais causas do acelerado decrécimo das populações selvagens deste grupo de aves.

PALAVRAS-CHAVE: *Amazona*, Barcelona, comércio, Espanha, Psittacidae.

ABSTRACT. **Sampling the trade of neotropical parrots in the city of Barcelona, Spain: 1991-1996.** The world trade of wild birds moves a large number of individuals and represents an important economic activity for some countries. The European Union is one of the main importers of live birds, and the city of Barcelona in particular, because of its high commercial activity by sea and by air, is an important receiver of wild birds from other continents. The Family Psittacidae is a group on which the world trade has had a strong impact in the last decades. Between 1991 and 1994, Neotropical species of Psittacidae were sampled monthly in ten pet-shops of Barcelona, and between 1994 and 1996 only the Neotropical *Amazona* species were sampled. A total of 3,989 individuals belonging to 17 species were sampled in the first 36 months (1991-1994). During this period, the most dominant species were (in order of importance): *Myiopsitta monachus, Aratinga mitrata, A. acuticaudata, Cyanoliseus patagonus, Nandayus nenday* and *Amazona aestiva*. Of 400 individuals of *Amazona* spp. that were sampled in 60 months (1991-1996), 53.5% belonged to *A. aestiva*, 30% to *A. amazonica*, 7.3% to *A. autumnalis*, 5.3% to *A. farinosa* and 4% to *A. ochrocephala*. During the whole sampling period, the annual number of individuals of *A. aestiva* in the shops decreased, while the number of individuals of *A. farinosa* and *A. autumnalis* increased. This may suggest that *A. aestiva* is being gradually replaced by other species of the same genus in the local trade, due to a more effective control of the international trade. Actually the high levels of parrots import by the most industrialized countries and habitat loss were considered the main causes of large declines in the wild populations of this group of birds.

KEY-WORDS: *Amazona*, Barcelona, Psittacidae, Spain, trade.

El comercio mundial de aves silvestres afecta a un gran número de especies y representa una actividad económica importante para algunos países. Más de 2.600 especies de aves han sido detectadas en el comercio internacional en los últimos 20 años, lo que representa aproximadamente el 27% de las especies descritas de este grupo de vertebrados

(Mulliken *et al.* 1992).

La mayor parte del tráfico internacional tiene como destinatários a países de la Unión Europea, los Estados Unidos de América y Singapur (Mulliken *et al.* 1992). Se calcula que en los años ochenta, el número de aves importadas anualmente tan sólo por los EUA ascendía a 700.000 ejemplares, de los cuales cerca de 230.000 corresponden a especies listadas en el apéndice II de la CITES (Mulliken y Thomsen 1990).

En las últimas décadas, uno de los grupos en que este comercio ha incidido de modo más acentuado ha sido la familia Psittacidae. En el período de octubre de 1979 a junio de 1980, de un total de 442.000 aves importadas por EUA más del 45% eran psitácidos. Cerca del 21% de los ejemplares procedían de Sudamérica, el 16% de la Región del Pacífico y el 8% de la Región Afro-asiática (Roet *et al.* in Sick 1985).

De entre los países sudamericanos, Argentina, Bolivia, Guayana, Perú, Surinam y Uruguay fueron los principales exportadores de aves silvestres durante la década de 1980 (Edwards 1992, Edwards y Villalba-Macías 1992, Groombridge 1992, Mulliken *et al.* 1992). Bolivia fue un importante exportador de estas aves hasta 1984 (ej: en 1982 y 1983 exportó 49.473 y 45.928 psitácidos, respectivamente; LIDEMA 1987), pero a partir de 1985 disminuyó significativamente sus exportaciones (Groombridge 1992). Por outra parte, Argentina se mantiene como unos de los principales exportadores sudamericanos de psitácidos (Thomsen *et al.* 1992, C. Yamashita *com. pers.* 1997).

Sólo en 1989, las exportaciones de psitácidos del conjunto de países sudamericanos ascendió a más de 232.000 ejemplares (Groombridge 1992). A pesar de que en los últimos años se ha notado una disminución en el número total de ejemplares capturados, el comercio de psitácidos silvestres continúa siendo una actividad económica importante (Germain 1992).

De entre los estados europeos importadores de psitácidos neotropicales, España recibe anualmente cantidades considerables de estas aves (Edwards y Biteye 1992, Valladares 1992), siendo una parte de ellas especies protegidas que entran ilegalmente por ejemplo, *Anodorhynchus hyacinthinus y Guaruba guarouba* incautados en los aeropuertos de Madrid y Barcelona (La Vanguardia 1991, 1993, Germain 1992, L. Colom *com. pers.* 1994).

Actualmente se reconoce que la elevada demanda de importación de psitácidos por parte de los países industrializados y la creciente pérdida de los hábitats de estas especies en sus países de orígen, son las principales causas de la tendencia a la extinción que presentan las especies de este grupo (Yamashita y Valle 1993). En el caso de las importaciones, se considera que prácticamente todos los ejemplares procedentes de Sudamérica son capturados en sus hábitats naturales (Yamashita 1992). Sin embargo, en muchas ocasiones los comercios aducen que buena parte de los animales en venta proceden de la cría en cautiverio, incluso en los propios países europeos. Con el fín de determinar si esto es plausible, se ha analizado la relación entre el porcentaje relativo de especies exportadas y el porcentaje relativo de especies comercializadas.

Muchas de las especies del género *Amazona* manifiestan ya los mismos síntomas que desencadenaron la tendencia a la extinción en las especies de guacamayos. Entre estos distintos tipos de presión la captura de animales vivos destinados a la comercialización, es uno de los factores más importantes en el declive de las poblaciones (Sick 1985, Yamashita 1992). Sirva de ejemplo que durante el año 1990 tan sólo Argentina exportó 22.744 ejemplares de *Amazona aestiva*, de un total de 62.559 psitácidos declarados (Edwards y Villalba-Macías 1992).

A fín de estimar la tasa de comercialización de especies de psitácidos neotropicales en general, y del género *Amazona* en particular, se registró periodicamente la disponibilidad comercial de estas aves en la ciudad de Barcelona, que por la intensa actividad comercial internacional que mantiene a través de su puerto y aeropuerto puede ser considerada un buen indicador del tráfico de dichas especies.

METODOS

Para estimar la disponibilidad comercial de dichas aves se realizó un censo de los individuos expuestos en 10 tiendas de venta de animales ubicadas en las Ramblas de Barcelona que, por su larga tradición de venta de todo tipo de aves, se pueden considerar indicadoras de la tasa de comercialización de psitácidos en toda la ciudad. Se estima que el número de ejemplares de psitácidos neotropicales comercializados en estas tiendas representa entre el 25% y el 40% del número total de ejemplares de este grupo comercializados en Barcelona y poblaciones vecinas (ej: Badalona, Hospitalet, Sant Joan Despí, Esplugues) (J.C. Guix, *obs. pers.* 1991-1996). Además, la exposición pública de las aves facilitaba enormemente su censo continuado por el mismo observador sin sesgos ni problemas de acceso a la información.

Para analizar la relación entre las proporciones de ejemplares de cada especie exportados y comercializados se empleó la correlación de rangos de Spearman (Zar 1984).

En una primera campaña de muestreo, realizada entre enero de 1991 y enero de 1994 (con excepción de octubre de 1991) se censaron mensualmente todas las especies de psitácidos neotropicales puestas a la venta en un sólo día. En orden a testar si existían diferencias importantes entre días de un mismo mes, algunos de estos censos se repitieron en intervalos de diez días (febrero y diciembre de 1991 y enero de 1994) y se examinó la asociación entre ambos censos mediante la correlación de rangos de Spearman. Los muestreos repetidos no se han utilizado para la descripción de los muestreos mensuales.

Debido a que el género *Amazona* se encuentra en una situación de conservación más crítica que las demás especies censadas (C. Yamashita *com. pers.* 1994), desde octubre de 1994 a septiembre de 1996 se controlaron exclusivamente las especies de éste género (segunda campaña de muestreo).

Los datos obtenidos en cada muestreo (1ª y 2ª campaña) pueden estar reflejando las siguientes situaciones: a- todos los ejemplares presentes en un mes son los mismos del mes anterior; b- cada mes hay una renovación total de los ejemplares (ya sea por venta o por muerte), aunque el número de ejemplares se mantenga constante de un mes a otro; c- de un mes a otro hay tantos ejemplares antiguos como recién llegados. Además de estas tres posibilidades, hay ejemplares que pueden llegar a las tiendas y ser vendidos, entre un muestreo y otro, sin haber sido contados. Teniendo en cuenta estas situaciones, la estima del número de ejemplares comercializados debe considerarse un número mínimo de ejemplares de las especies más frecuentes (con excepción de *Myiopsitta monachus*).

Para describir los muestreos se ha empleado el porcentaje numérico (%N) y el porcentaje de presencia (%P), considerando cada tienda una unidad de muestreo.

RESULTADOS

Primera campaña: todas las especies neotropicales detectadas. Los censos repetidos en intervalos de diez días mostraron una asociación significativa (r_s=0,72; N=12; P=0,008), por lo que se asumió que el censo mensual era representativo al menos para un intervalo de 20 días.

Se detectaron un total de 3.989 ejemplares pertenecientes a 17 especies de psitácidos neotropicales (figura 1 y Apéndice 1). Las especies más abundantes fueron: *Myiopsitta monachus, Aratinga mitrata, Aratinga acuticaudata, Cyanoliseus patagonus, Nandayus nenday* y *Amazona aestiva* (tabla 1).

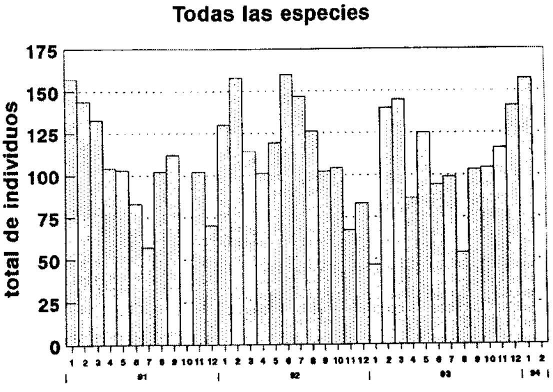

Figura 1. Número total (por mes) de ejemplares de psitácidos neotropicales registrados en las muestreos mensuales realizados en 10 comercios de Barcelona (período: enero de 1991 a enero de 1994).

Tabla 1. Número total de ejemplares de cada especie, registrados en los muestreos mensuales (N = 36) en el período de enero de 1991 a enero de 1994. %N = porcentaje numérico; %P = porcentaje de presencia. La nomenclatura de las espécies sigue el criterio de Sick (1993).

Especies	Total	%N	%P
Amazona aestiva	310	7,77	86,11
Amazona amazonica	63	1,58	58,33
Amazona autumnalis	8	0,20	13,89
Amazona farinosa	4	0,10	11,11
Ara ararauna	7	0,18	16,67
Ara chloroptera	1	0,03	2,78
Aratinga acuticaudata	628	15,74	97,22
Aratinga leucophthalmus	95	2,38	50,00
Aratinga mitrata	755	18,93	94,44
Brotogeris chiriri	2	0,05	2,78
Cyanoliseus patagonus	608	15,24	97,22
Forpus passerinus	5	0,13	2,78
Myiopsitta monachus	1061	26,60	97,22
Nandayus nenday	381	9,55	94,44
Pionus maximiliani	55	1,38	44,44
Pionus menstrus	5	0,13	8,33
Pyrrhura frontalis	1	0,03	2,78

Existe una correlación estrecha y muy significativa entre la proporción de cada especie exportada por Argentina en 1990 (Edwards y Villalba-Macías 1992) y la proporción de cada especie comercializada en Barcelona al año siguiente (r_s=0,942; N=10; P<0,001; figura 2). De esta relación se ha excluido *Aratinga mitrata*, que se comporta como un claro «outlier», al comercializarse en proporción muy superior a la exportada. Si dicha relación se examina para las exportaciones argentinas de 1990 con la comercialización en Barcelona para el período 1992-93, se observa una caida en la intensidad de la asociación, aunque ésta continua

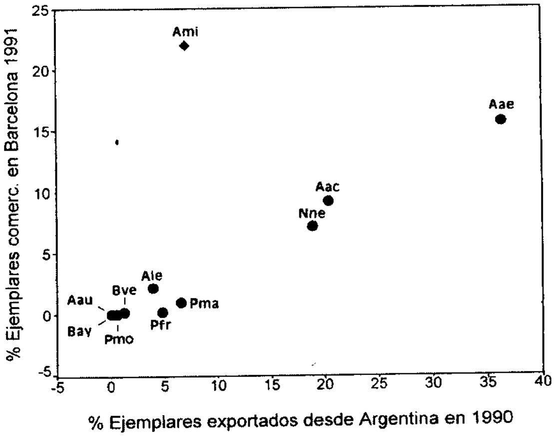

Figura 2. Correlación de rangos de Spearman entre las proporciones de cada especie exportadas desde Argentina en 1990 y comercializadas en Barcelona al año siguiente. La asociación es altamente significativa (r_s= 0.942, N=10 especies, P<0.001), excluyendo a *Aratinga mitrata* (Ami), que se comporta como un claro «outlier». Véase el texto para la interpretación de este dato. Las restantes especies son *Amazona aestiva* (Aae), *Aratinga acuticaudata* (Aac), *A. aurea* (Aau), *A. leucophthalmus* (Ale), *Bolborhynchus aymara* (Bay), *Brotogeris versicolurus* (Bve), *Nandayus nenday* (Nne), *Pionus maximiliani* (Pma), *Pyrrhura frontalis* (Pfr), *P. molinae* (Pmo).

siendo significativa (r_s= 0,834; N=10; P=0,003).

Segunda campaña: especies de Amazona. De un total de 219 ejemplares de *Amazona* spp., muestreados entre octubre de 1994 y septiembre de 1996, el 39,7% pertenecen a la especie *A. aestiva*, el 31,1% a *A. amazonica*, el 13,2% a *A. autumnalis*, el 8,7% a *A. farinosa* y el 7,3% a *A. ochrocephala* (tabla 3).

Cabe destacar que en noviembre de 1994 y mayo de 1996 se detectaron súbitos aumentos en el número de ejemplares de *Amazona* spp. en las tiendas (N = 21 y 18, respectivamente) respecto a los meses anteriores (N = 2 y 3) (Apéndice 2).

DISCUSION

Todas las especies de psitácidos neotropicales que han sido detectadas en las 10 tiendas de Barcelona estudiadas están incluidas en el Apéndice 2 de la CITES (Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres) (cf. CEE 1992). Esto significa que su exportación y posterior comercialización está condicionada a la existencia de licencias especiales, expedidas por organismos gubernamentales de los países exportadores e importadores. El número total de ejemplares de cada especie exportados anualmente (computado a partir de las licencias expedidas) no debe exceder el número máximo de ejemplares fijados en la cuotas de exportación establecidas para aquel año (Thomsen *et al.* 1992; C. Yamashita, *com. pers.* 1993). Sin embargo, durante 1990 no hubo restricciones por parte de la CITES para la captura y exportación de *Myiopsitta monachus* y *Cyanoliseus patagonus* (Edwards y Villalba-Macías 1992).

En general, las especies detectadas en las diez tiendas muestreadas presentan una distribución relativamente amplia en superficie absoluta (ej: *Amazona amazonica, Ara ararauna, Aratinga leucophthalmus*), aunque algunas están restringidas a una porción determinada del continente (ej: *Aratinga mitrata, Cyanoliseus patagonus, Nandayus nenday*). La superposición de las áreas de distribución de las especies estudiadas abarca casi todos los países de Sudamérica. Sin embargo, los países que comparten más especies son Brasil, Bolivia, Argentina y Paraguay (tabla 2). No se han detectado ejemplares de sub-especies (o poblaciones) cuyas distribuciones incluyan Chile.

Las especies más frecuentes en los muestreos del período 1991-1994 (frecuencia mayor o igual a 50%) fueron: *Aratinga acuticaudata, Cyanoliseus patagonus, Myiopsitta monachus,*

Tabla 2. Ocurrencia de las especies de psitácidos neotropicales detectadas en los países de Sudamérica.

ESPECIES	Ar	Bo	Br	Co	Ec	Gu	GuF	Pa	Pe	Su	Ur	Ve
Amazona aestiva	x	x	x					x				
Amazona amazonica		x	x	x	x	x	x		x	x		x
Amazona autumnalis			x	x	x							
Amazona farinosa		x	x	x	x	x	x		x	x		x
Amazona ochrocephala (*1)			x	x		x	x			x		x
Ara ararauna	x	x	x	x	x	x	x	x	x	x		x
Ara chloroptera	x	x	x	x		x	x	x	x	x		x
Aratinga acuticaudata	x	x	x	x				x			x	x
Aratinga leucophthalmus	x	x	x	x	x	x	x	x	x	x	x	x
Aratinga mitrata (*2)	x	x							x			
Brotogeris chiriri	x	x	x					x				
Cyanoliseus patagonus (*3)	x										x	
Forpus passerinus			x	x		x	x			x		x
Myiopsitta monachus	x	x	x					x			x	
Nandayus nenday	x	x	x					x				
Pionus maximiliani	x	x	x					x				
Pionus menstrus		x	x	x	x	x	x		x	x		x
Pyrrhura frontalis	x		x					x			x	
TOTALES	12	13	15	9	6	7	7	10	7	7	5	8

Ar = Argentina	Bo = Bolivia	Br = Brasil
Co = Colombia	Ec = Ecuador	Gu = Guayana
GuF = Guayana Francesa	Pa = Paraguay	Pe = Perú
Su = Surinam	Ur = Uruguay	Ve = Venezuela

(*1): también en Trinidad. (*2): En mayo de 1992, fueron detectados 4 ejemplares de *Aratinga mitrata alticola*, considerada por Olrog (1968) como una especie distinta (Forshaw 1989). (*3): No se han detectado ejemplares de *Cyanoliseus patagonus byroni*, subespecie presente únicamente en Chile.

Tabla 3. Número total de ejemplares muestreados de cada especie de *Amazona*, durante el período de febrero de 1992 a enero de 1994 (últimos 24 meses de la 1ª fase de campaña) y durante el período de octubre de 1994 a septiembre de 1996 (24 muestreos). Porcentajes numéricos (%N) en relación al número total de ejemplares de *Amazona* muestreados y porcentajes de presencia (%P) en relación a los 24 meses.

ESPECIES	1ª campaña			2ª campaña		
	N	%N	%P	N	%N	%P
Amazona aestiva	127	70,2	79,2	87	39,7	91,7
Amazona amazonica	52	28,7	54,2	68	31,1	66,7
Amazona autumnalis	0	0	0	29	13,2	54,2
Amazona farinosa	2	1,1	8,3	19	8,7	50,0
Amazona ochrocephala	0	0	0	16	7,3	16,7
TOTAL	181	100		219	100	

Aratinga mitrata, Nandayus nenday, Amazona aestiva y *Amazona amazonica* (tabla 1). Con excepción de *A. amazonica*, sus distribuciones se superponen en la región del polígono formado por Argentina, Paraguay, Brasil y Bolivia.

La estrecha asociación entre la composición de especies exportadas y presentes en las tiendas sugiere que el comercio de psitácidos neotropicales en Barcelona es mayoritariamente abastecido por el tráfico internacional y no por criaderos autóctonos. A éste respecto, es importante destacar el caso de *A. mitrata* que, al comercializarse en mayor proporción a la que se exporta, indica que, o bien se importa desde otros países, o bien se reproduce en criaderos españoles. Por un lado, la distribución de ésta especie es más andina (Forshaw 1989) y puede comercializarse desde otros países, por otro, existe un dato que sustenta la posibilidad de la cria en cautividad, ya que se han detectado ejemplares criando en libertad en Barcelona (J.C. Guix, *obs. pers.* 1997).

Aunque la comercialización de aves silvestres está regulada en Brasil y Bolivia (en el caso de Brasil, se prohibe la comercialización de ejemplares de especies autóctonas de anfibios, reptiles, aves y mamíferos que no hayan nacido en cautiverio), la recolección de pollos de psitácidos es una práctica muy extendida en ambos países (C. Yamashita, D.L. Fedullo, P. Martuscelli *com. pers.* 1990-1994) y una parte de estos ejemplares cruzan las fronteras con países vecinos (ej: Argentina y Paraguay: J. Villalba-Macías *com. pers.* 1988).

En los años 1991 y 1993, el número total de ejemplares de las 17 especies estudiadas fue mayor entre enero y marzo, coincidiendo con los meses en que hay una mayor disponibilidad de ejemplares jóvenes (recién emplumados) en la naturaleza. Sin embargo, en 1992 también hubo un incremento en el número de ejemplares entre junio y agosto, lo cual se podría explicar debido a una hipotética mayor importación de aves (o acumulación de ejemplares importados anteriormente) para venderlas durante el periodo de máxima afluencia de turistas, coincidiendo con la celebración de los juegos olímpicos de Barcelona.

De las cinco especies más frecuentes, en tres de ellas (*Aratinga mitrata, A. acuticaudata, Cyanoliseus patagonus*) no se ha observado ninguna tendencia clara de aumento o disminución del número de ejemplares comercializados a lo largo del período 1991-1994 (figuras 3, 4 y 5). Entre junio de 1992 y marzo de 1993, se observó un incremento en el número de ejemplares muestreados de *Nandayus nenday* (figura 6).

La única especie que experimentó una disminución progresiva del número de ejemplares, entre enero de 1991 y enero de 1994, fue *Amazona aestiva* (figura 7). Por otra parte, aumentó el número de ejemplares de *A. amazonica* detectados durante dicho periodo: 10 ejemplares en 1991, 12 en 1992 y 37 en 1993. En 1995 aumentó ligeramente el número de ejemplares de *A. aestiva* (47 ejemplares) mientras que el número de ejemplares de *A. amazonica* (26 ejemplares) descendió respecto a 1993 (41 *A. aestiva* y 37 *A. amazonica*).

Número estimado de ejemplares comercializados. En las figuras 3, 4, 5, 6 y 7 se pueden apreciar las estimaciones del número mínimo (acumulado) de ejemplares de las especies más frecuentes que pasaron por las diez tiendas estudiadas durante el primer período de seguimiento. Así, en 36 meses, estas cantidades mínimas habrían sido de alrededor de: 200 ejemplares de *Aratinga mitrata*, 190 de *A. acuticaudata*, 160 de *Cyanoliseus patagonus*, 105 de *Nandayus nenday* y 95 de *Amazona aestiva* (N = 750).

Tendencia observada en el comercio de especies de Amazona en la ciudad de Barcelona. Si comparamos los datos de las especies de *Amazona* obtenidos durante los últimos 24 meses de la 1ª campaña y los 24 meses de la 2ª podemos observar que el número total de ejemplares detectados ha aumentado (total 181 en la 1ª campaña y 219 en la 2ª). De entre las especies de *Amazona*, *A. aestiva* ha sido la más frecuente y la más abundante en ambas campañas, aunque su número ha disminuido de un periodo a otro (127 en el primero y 87 en el segundo). Por otra parte, el número de ejemplares de *A. farinosa* y de *A. autumnalis* aumentó y, durante los últimos meses de muestreo, apareció una nueva especie (*A. ochrocephala*) (tabla 3). Esto podría sugerir que, debido al mayor control en el comercio de *A.*

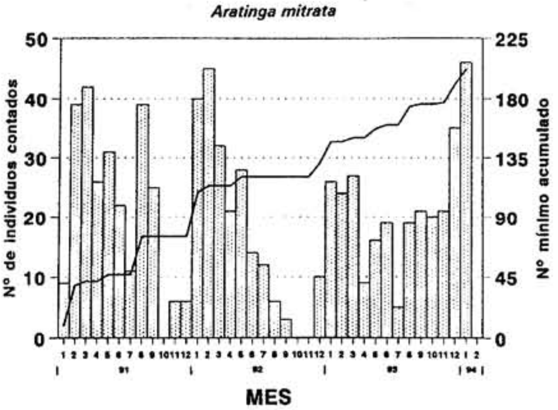

Figura 3. Número de ejemplares (por mes) de *Aratinga mitrata*, registrados en muestreos mensuales y estimación mínima del número acumulado de ejemplares a lo largo del período muestreado (1991-1994).

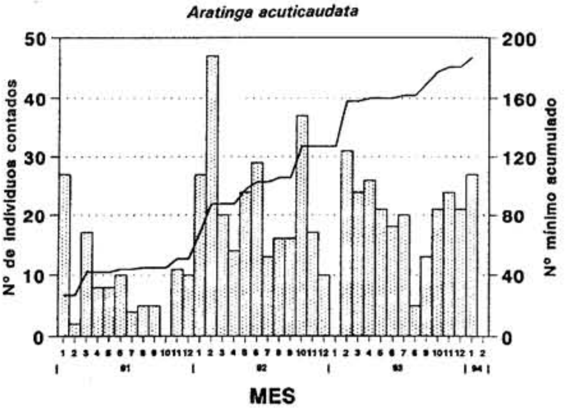

Figura 4. Número de ejemplares (por mes) de *Aratinga acuticaudata*, registrados en muestreos mensuales y estimación mínima del número acumulado de ejemplares a lo largo del período muestreado (1991-1994).

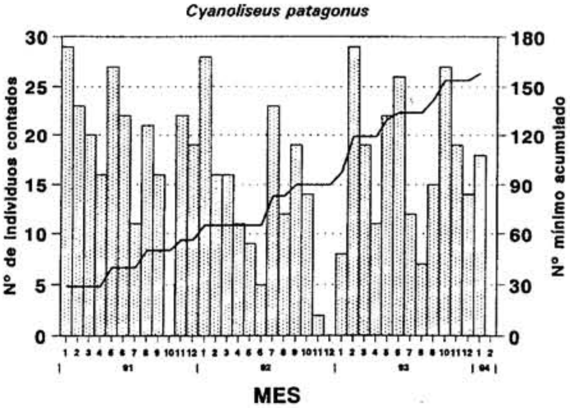

Figura 5. Número de ejemplares (por mes) de *Cyanoliseus patagonus*, registrados en muestreos mensuales y estimación mínima del número acumulado de ejemplares a lo largo del período muestreado (1991-1994).

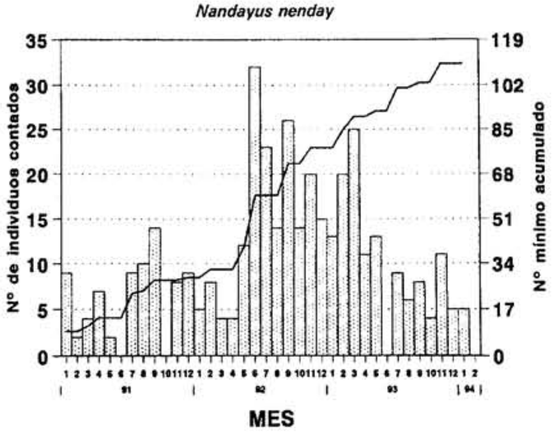

Figura 6. Número de ejemplares (por mes) de *Nandayus nenday*, registrados en muestreos mensuales, y estimación mínima del número acumulado de ejemplares a lo largo del período muestreado (1991-1994).

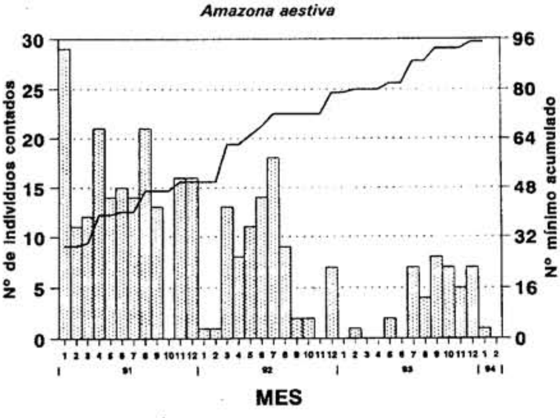

Figura 7. Número de ejemplares (por mes) de *Amazona aestiva*, registrados en muestreos mensuales, y estimación mínima del número acumulado de ejemplares a lo largo del período muestreado (1991-1994).

aestiva, esta especie estaría siendo gradualmente substituida por otras especies del mismo género.

Sin embargo, cabe destacar que en los últimos cinco meses (de mayo a septiembre) de la segunda campaña de muestreos, se detectaron ejemplares de *A. aestiva* con vértices flexores de las alas amarillas. Un seguimiento repetido confirmó (por medio de la detección de plumas rojas nuevas creciendo sobre fondo de plumas amarillas) que el color amarillo de los vértices flexores de las alas probablemente se obtuvo de forma artificial.

Estos ejemplares «maquillados» podrían haber pasado las aduanas con la documentación de exportación correspondiente a otras especies con aspecto similar (ej.: *A. amazonica, A. ochrocephala*).

Aparentemente el comercio de psitácidos neotropicales en Barcelona no ha disminuido en estos últimos años. No obstante, sí se ha observado una disminución en el comercio de *A. aestiva*, una de las especies más buscadas por los consumidores.

Hay otros aspectos del comercio de psitácidos de Barcelona que merecen atención, entre ellos los que se refieren a esta especie de loro. El área de distribución de *A. aestiva* abarca cuatro países (Argentina, Bolivia, Brasil y Paraguay). Formalmente, Bolivia, Brasil y Paraguay no exportan esta especie (Grombridge 1992) y las cuotas argentinas de exportación, establecidas por la CITES desde el año 1992, han sido «cero» (C. Yamashita *in litt.* 1996). Tampoco hubo importación de *A. aestiva* por parte de España, durante estos años (L. Colom *com. pers.* 1996). A pesar de ello, el muestreo acumulado registra la presencia de 214 ejemplares entre 1992 y 1996 (Apéndice 1). Teniendo en cuenta la fuerte asociación entre exportación y comercialización, y las dificultades que conlleva la crianza de estos animales, es dudoso que pueda atribuirse la presencia de dichos ejemplares a circuitos legales.

Como conclusión, es evidente la necesidad de que tanto España como el resto de países de la Unión Europea controlen con mayor efectividad la importación de psitácidos. Los mecanismos de control deberían actualizarse, usando tanto técnicas de marcado individual (huellas genéticas, microchips) y complementarse con acciones de control a posteriori. Entre ellas se sugiere realizar una estimación periódica del número de animales comercializados con el objeto de detectar posibles desviaciones respecto a los registros oficiales de entrada de ejemplares. Otra medida, consistiría en establecer cuotas máximas de importación anual más restrictivas para las subespecies y grupos de especies listadas en el Apéndice 2 de la CITES (como *Amazona* spp.).

AGRADECIMIENTOS

Agradecemos a C.Yamashita, J.del Hoyo, L.Colom, C.Sánchez, A.Pérez y F.Cumplido las informaciones prestadas, y a los dos revisores anónimos por sus comentarios y sugerencias que ayudaron a mejorar sustancialmente una primera versión del manuscrito.

REFERENCIAS

CEE (1992) Reglamento CEE nº 1970/92 de la comisión, 30 de junio de 1992, por el que se modifica el Reglamento CEE nº 3626/82 del Consejo, relativo a la aplicación en la Comunidad del Convenio sobre comercio internacional de especies amenazadas de fauna y flora silvestres. *Diario Oficial de las Comunidades Europeas*, Nº L 201 (Legislación): 20 de julio de 1992. Luxemburgo: Oficina de Publicaciones Oficiales de las Comunidades Europeas.

Edwards, S. R. (1992) Wild bird trade: perceptions and management in the Cooperative Republic of Guyana, p. 77 - 91. In *Perceptions, conservation, and management of wild birds in trade* (J.B. Thomsen; S. R. Edwards and T.A. Mulliken, eds.). Cambridge: TRAFFIC International.

___ y J. Villalba-Macías (1992) Wild bird trade: perceptions and management in Argentina, p. 61 - 75. In *Perceptions, conservation, and management of wild birds in trade* (J. B. Thomsen; S.R. Edwards y T. A. Mulliken, eds.). Cambridge: TRAFFIC International.

___ y M. Biteye (1992) Wild bird trade: perceptions and management in The Republic of Senegal, p. 117 - 130. In *Perceptions, conservation, and management of wild birds in trade* (J. B. Thomsen; S. R. Edwards and T.A. Mulliken, eds.). Cambridge: TRAFFIC International.

Forshaw, J. M. (1989) *Parrots of the world.* Third edition. Blandford: David and Charles.

Germain, J. (1992) Las aves exóticas son un gran negocio. *Integral* 5(146):382.

Groombridge, B. , ed. (1992) *Global biodiversity; status of the Earth's living resources.* World Conservation Monitoring Centre. London: Chapman and Hall.

LIDEMA (1987) Las exportaciones de aves tropicales a Estados Unidos en el periodo 1981-1985, segun Traffic (U.S.A.). *LIDEMA* (Liga de Defensa del Medio Ambiente), Nº 2.

Mulliken, T.A. y J. B. Thomsen (1990) US bird trade: The controversy continues although imports declines. *TRAFFIC USA* 10:1-11.

___; S. R. Broad y J.B. Thomsen (1992) The wild bird trade - an overview, p. 1 - 41. In *Perceptions, conservation and management of wild birds in trade* (J. B. Thomsen; S. R. Edwards and T. A. Mulliken, eds.). Cambridge: TRAFFIC International.

Olrog, G. C. (1968) *Las aves sudamericanas: una guía de campo.* Vol.I. Buenos Aires: Instituto Miguel Lillo.

Sick, H. (1985) *Ornitologia brasileira, uma introdução,* 1. Brasília: Ed. Univ. Brasília.

___ (1993) *Birds in Brazil.* Princeton: Princeton Univ. Press.

Thomsen, J. B., S. R. Edwards y T. A. Mulliken, eds. (1992) *Perceptions, conservation and management of wild birds in trade.* Cambridge: TRAFFIC Intern.

Valladares, M. A. (1992) Papel de España en el comercio de especies de la avifauna mundial. *In: Jornadas Ornitológicas Españolas*. Extremadura: ADENEX-SEO.

Vanguardia (1991) Animales protegidos. *La Vanguardia*, Suplemento «Ciencia y Tecnología» (11 mayo 1991).

___ (1993) Interceptadas en Francia 400 catorras destinadas a España. *La Vanguardia* (5 dic 1993).

Yamashita, C. (1992) Nada azul com a arara azul. *O Charão* 17:4-7.

___ y M. P. Valle (1993) On the linkage between *Anodorhynchus* macaws and palm nuts, and the extinction of the Glaucous Macaw. *Bull. Brit. Orn. Club* 113:53-60.

Zar, J. H. (1984). *Biostatistical Analysis.* New Jersey: Ed. Prentice Hall Intern.

APÉNDICE 1

Matriz con el número total (por mes) de ejemplares de 17 especies de psitácidos neotropicales, registrados a partir de muestreos mensuales en 10 comercios de Barcelona. Periodo: enero 1991 a enero 1994.

Especies:
E1: *Amazona aestiva*
E2: *Amazona amazonica*
E3: *Amazona autumnalis*
E4: *Amazona farinosa*
E5: *Ara ararauna*
E6: *Ara chloroptera*
E7: *Aratinga acuticaudata*
E8: *Aratinga leucophthalmus*
E9: *Aratinga mitrata*
E10: *Brotogeris chiriri*
E11: *Cyanoliseus patagonum*
E12: *Forpus passerinus*
E13: *Myiopsitta monachus*
E14: *Nandayus nenday*
E15: *Pionus maximiliani*
E16: *Pionus menstruus*
E17: *Pyrrhura frontalis*

OBS	MES	AÑO	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17
1	1	91	29	0	0	0	0	0	27	12	9	2	29	0	38	9	0	2	0
2	2	91	11	1	3	0	0	0	2	9	39	0	23	0	54	2	0	0	0
3	3	91	12	1	2	1	0	1	17	1	42	0	20	0	31	4	0	1	0
4	4	91	21	3	1	1	0	0	8	2	26	0	16	0	19	7	0	0	0
5	5	91	14	1	1	0	0	0	8	1	31	0	27	0	18	2	0	0	0
6	6	91	15	1	1	0	0	0	10	0	22	0	22	0	12	0	0	0	0
7	7	91	14	1	0	0	0	0	4	0	11	0	11	0	7	9	0	0	0
8	8	91	21	0	0	0	0	0	5	0	39	0	21	0	4	10	2	0	0
9	9	91	13	2	0	0	0	0	5	0	25	0	16	5	29	14	3	0	0
10	11	91	16	0	0	0	1	0	11	0	6	0	22	0	36	8	2	0	0
11	12	91	16	0	0	0	1	0	10	0	6	0	19	0	8	9	1	0	0
12	1	92	1	1	0	0	1	0	27	2	40	0	28	0	25	5	0	0	0
13	2	92	1	1	0	0	0	0	47	4	45	0	16	0	36	8	0	0	0
14	3	92	13	4	0	0	0	0	20	0	32	0	16	0	25	4	0	0	0
15	4	92	8	1	0	0	0	0	14	2	21	0	11	0	39	4	1	0	0
16	5	92	11	0	0	0	0	0	24	1	28	0	9	0	27	12	7	0	0
17	6	92	14	0	0	0	2	0	29	2	14	0	5	0	51	32	11	0	0
18	7	92	18	0	0	0	1	0	13	4	12	0	23	0	49	23	4	0	0
19	8	92	9	0	0	0	1	0	16	4	6	0	12	0	59	14	5	0	0
20	9	92	2	0	0	0	0	0	16	21	3	0	19	0	15	26	0	0	0
21	10	92	2	0	0	0	0	0	37	5	0	0	14	0	28	14	4	0	0
22	11	92	0	0	0	0	0	0	17	9	0	0	2	0	18	20	1	0	0
23	12	92	7	5	0	0	0	0	10	11	10	0	0	0	25	15	0	0	0
24	1	93	0	0	0	0	0	0	0	0	26	0	8	0	0	13	0	0	0
25	2	93	1	2	0	0	0	0	31	0	24	0	29	0	33	20	0	0	0
26	3	93	0	1	0	0	0	0	24	0	27	0	19	0	49	25	0	0	0
27	4	93	0	4	0	0	0	0	26	0	9	0	11	0	23	11	0	2	0
28	5	93	2	13	0	1	0	0	21	0	16	0	22	0	37	13	0	0	0
29	6	93	0	5	0	0	0	0	18	0	19	0	26	0	26	0	0	0	0
30	7	93	7	4	0	0	0	0	20	0	5	0	12	0	42	9	0	0	0
31	8	93	4	4	0	1	0	0	5	0	19	0	7	0	8	6	0	0	0
32	9	93	8	0	0	0	0	0	13	4	21	0	15	0	32	8	2	0	0
33	10	93	7	0	0	0	0	0	21	1	20	0	27	0	22	4	2	0	0
34	11	93	5	0	0	0	0	0	24	0	21	0	19	0	33	11	3	0	0
35	12	93	7	4	0	0	0	0	21	0	35	0	14	0	52	5	3	0	0
36	1	94	1	4	0	0	0	0	27	0	46	0	18	0	51	5	4	0	1

APÉNDICE 2

Matriz con el número de ejemplares de *Amazona* spp. contados a partir de los muestreos mensuales realizados en 10 comercios de Barcelona. Periodo: octubre de 1994 a septiembre de 1996.

Especies:
AESTI: *Amazona aestiva*
AMAZO: *A. amazonica*
FARIN: *A. farinosa*
AUTUM: *A. autumnalis*
OCHRO: *A. ochrocephala*

OBS	MES	AÑO	AESTI	AMAZO	FARIN	AUTUM	OCHRO
37	10	94	2	0	0	0	0
38	11	94	11	8	1	1	0
39	12	94	5	6	1	0	0
40	1	95	7	8	2	0	0
41	2	95	2	2	1	0	0
42	3	95	9	5	0	0	0
43	4	95	5	3	0	0	0
44	5	95	8	2	0	0	0
45	6	95	5	1	0	0	0
46	7	95	3	0	1	2	0
47	8	95	3	2	1	1	0
48	9	95	1	2	1	1	0
49	10	95	1	1	2	0	0
50	11	95	0	0	0	0	0
51	12	95	3	0	0	0	0
52	1	96	1	0	0	3	0
53	2	96	0	2	0	1	0
54	3	96	3	1	0	1	0
55	4	96	2	0	0	1	0
56	5	96	6	5	2	2	3
57	6	96	2	0	2	8	6
58	7	96	1	0	2	1	5
59	8	96	3	8	0	2	2
60	9	96	4	12	3	5	0

Ararajuba 5(2):169-174
dezembro de 1997

Vertical stratification and diet of psittacids in a Tropical lowland forest of Brazil

Isaac Simão[1], Flavio Antonio Maës dos Santos[2] and Marco Aurelio Pizo[1]

[1] *Departamento de Zoologia/ Pós-Graduação em Ecologia, Instituto de Biologia, UNICAMP, C. P 6109, Cidade Universitária, 13081-970, Campinas, SP, Brazil*

[2] *Departamento de Botânica, Instituto de Biologia, UNICAMP, C. P. 6109, Cidade Universitária, 13081-970, Campinas, SP, Brazil*

Recebido em 13 de maio de 1997; aceito em 30 de junho de 1997

RESUMO. **Estratificação vertical e dieta dos psitacídeos em uma floresta tropical de baixada no Brasil.** Levantamentos sobre a dieta de psitacídeos na natureza são importantes porque ajudam a compreender a seleção de alimento por parte destas aves, e também representam informações importantes para o sucesso de programas de reintrodução na natureza de espécies ameaçadas de extinção. O presente estudo apresenta dados sobre a dieta de oito das 13 espécies de psitacídeos que ocorrem na Reserva Florestal de Linhares (Espírito Santo, sudeste do Brasil), e investiga a ocupação vertical da floresta por estas aves. Com base na altura em que os psitacídeos foram vistos pousados, dois grupos distintos foram identificados: (1) *Pyrrhura leucotis* e *P. cruentata*, que ocupam os estratos inferiores da floresta, pousando preferencialmente em poleiros inferiores a 15 m de altura, e (2) *Amazona rhodocorytha* e *A. farinosa* que, pelo contrário, escolhem os estratos superiores para pousar (acima de 15 m de altura). Frutos (polpa e sementes) de 22 espécies de plantas (14 famílias) foram consumidos pelos psitacídeos. As famílias de plantas mais bem representadas na dieta das aves foram Cecropiaceae e Moraceae (4 espécies cada), tendo sido *Cecropia hololeuca* a espécie mais utilizada (23 registros). Os dados sobre dieta confirmaram alguns aspectos gerais sobre as preferencias alimentares de psitacídeos neotropicais na natureza: (1) flores e folhas não são comumente consumidas por estas aves, sendo que polpa de frutos e especialmente sementes, pelo contrário, constituem boa parte de sua alimentação; (2) as infrutescências de *Cecropia*, gênero composto por plantas pioneiras bastante comuns em vegetações secundárias, são muito consumidas por algumas espécies de psitacídeos.

PALAVRAS-CHAVE: dieta, Espírito Santo, estratificação vertical, Psittacidae.

ABSTRACT. Surveys of the diet of psittacids in nature are important because they provide a basis for studies of food selection by these birds, and also because they provide information important for the success of reintroduction programs often carried out with threatened species. This study presents information about the diet of 8 psittacid species occurring at Reserva Florestal de Linhares (Espírito Santo, southeastern Brazil), and about the vertical stratification of these birds within the forest. We identified two distinct groups of parrots that differed in their vertical stratification patterns: (1) inferior strata species (perching mainly below 15 m) - *Pyrrhura leucotis* and *P. cruentata*, and (2) superior strata species (frequently perching between 15 m and 30 m) - *Amazona rhodocorytha* and *A. farinosa*. *Brotogeris tirica* was observed in a broad range of height classes, but does not seem to prefer any particular stratum. We recorded the fruits (seeds and pulp) of 22 plant species (14 families) in the diet of psittacids. The most utilized plant families were Cecropiaceae and Moraceae (4 species each), *Cecropia hololeuca* being the plant species consumed most frequently (23 of 79 feeding bouts recorded). The diet survey corroborated some general aspects related to food preferences of neotropical psittacids in nature: (1) flower- and leaf-eating are rare events. Psittacids rely heavily upon fruit pulp and specially seeds for food. (2) The infructescences of *Cecropia* spp, pioneer species common in second-growth vegetation, are also heavily utilized by some psittacids as food.

KEY WORDS: diet, Psittacidae, Tropical forest, vertical stratification.

Neotropical psittacids, with the exception of large species such as macaws whose diets are composed mainly by palm fruits (Roth 1984, Brandt and Machado 1990, Yamashita and Valle 1993), eat fruits of a variety of species (in some cases also flowers, leaves and animal matter; Roth 1984, Sazima 1989, Scherer Neto 1989, Galetti 1993, Desenne 1995, Martuscelli 1995, Pizo *et al.* 1995) and, given current knowledge, can be regarded as food generalists. There is some evidence, however, that psittacids do select certain foods from the pool of plants available in their habitats: some sympatric species, for example, often explore different fruit species or alternatively the same fruit species but in different proportions (Roth 1984, Desenne 1995, Galetti 1997). The several criteria used by frugivorous birds such as psittacids to select their foods in nature interact in complex and poorly known ways (Martin 1985). For psittacids, the criteria probably include fruit availability (Pizo *et al.* 1995), fruit hardness (Galetti 1997), and presence of secondary compounds (Munn 1988) given that many unripe fruits are eaten (Desenne 1995).

Diet surveys provide the background for research on food selection by psittacids. Fortunately, the amount of information concerning the diet of neotropical psittacids in nature is growing rapidly (e.g. Desenne 1995, Martuscelli 1995, Pizo *et al.* 1995). That information is valuable not only for theoretical purposes but also for practical ones. Individuals interested in breeding threatened psittacid species in captivity often face problems of nourishing their birds adequately. In addition, reintroduction programs for the recovery of declining psittacid populations must tailor the diet in captivity to match the food items the newly-reintroduced birds will encounter in nature (papers in Pasquier 1982, Da-Ré 1996).

In this paper we present the results of surveys of the diets of 13 psittacid species occurring at an Atlantic forest site in southeastern Brazil. We also provide information on the vertical stratification of these species in the forest, which is likely, at least in part, to determine the fruit species selected for food.

STUDY SITE AND THE PSITTACID SPECIES

The study was carried out at the Reserva Florestal de Linhares (RFL, 19°18'S, 39°45'W), in the north of Espírito Santo state, southeastern Brazil. RFL is a private reserve of about 218 Km^2 covered by semideciduous ombrofilous forest. This reserve, together with the contiguous and similar-size Sooretama Biological Reserve represents one of the largest remaining blocks of tropical forest in lowland eastern Brazil. Although the forest at RFL is part of the Atlantic forest domain, it nevertheless differs in some aspects of physiognomy and plant species composition from the most typical form of this vegetation. The forest occurring at RFL may have been linked to the Amazonian forest in the past. For this reason, the present fauna and flora of RFL include both Atlantic forest and Amazonian forest elements (Peixoto and Gentry 1990).

Four types of vegetation can be distinguished at RFL: (1) 'terra firme' forest (68 % of the area) - dense forest with trees up to 40 m tall; (2) 'mussununga' forest (8 %) - dense forest with small shrubs and trees (up to 15 m tall) growing on a sandy soil; (3) 'várzea' forest (4 %) - seasonally forest with scattered trees and palms and a grassy ground cover; and (4) 'campos nativos' (6 %) - open fields with many shrubs, small trees, and Gramineae species (Peixoto 1982, Peixoto and Gentry 1990).

The ten most common plant families at RFL are: Leguminosae, Myrtaceae, Sapotaceae, Bignoniaceae, Lauraceae, Euphorbiaceae, Annonaceae, Hippocrateaceae, Apocynaceae and Rubiaceae (Peixoto and Gentry 1990). Jesus (1987) cited 478 trees and 103 herbaceous and shrub species that occur at RFL.

The reserve is almost perfectly flat with elevations varying from 28 to 65 m. The climate is warm and humid with a mean annual rainfall of 1403 mm, and a mean annual temperature of 23.6°C. Between April and August there is a marked dry season.

Psittacid species occurring at RFL are (names follow Forshaw 1978): Illiger's Macaw (*Ara maracana*), Red-shouldered Macaw (*A. nobilis*), Peach-fronted Conure (*Aratinga aurea*), Blue-throated Conure (*Pyrrhura cruentata*), White-eared Conure (*P. leucotis*), Blue-winged Parrotlet (*Forpus xanthopterygius*), Plain Parakeet (*Brotogeris tirica*), Golden-tailed Parrotlet (*Touit surda*), Blue-headed Parrot (*Pionus* menstruus), Scaly-headed Parrot (*P. maximiliani*), Red-crowned Amazon (*Amazona rhodocorytha*), Orange-winged Amazon (*A. amazonica*) and the Mealy Amazon (*A. farinosa*). *Aratinga aurea* occurs only in 'campos nativos' and 'várzea' forest. The remaining species occur both in 'terra firme' forest and 'mussununga' forest. These species can be grouped into three categories according to body weight: < 100 g (*Aratinga aurea*, *Pyrrhura cruentata*, *P. leucotis*, *Forpus xanthopterygius* and *Brotogeris tirica*), 200-300 g (*Ara nobilis*, *Pionus menstruus* and *P. maximiliani*), and > 400 g (*Ara maracana*, *Amazona rhodocorytha*, *A. amazonica* and *A. farinosa*). *Pyrrhura cruentata*, *T. surda* and *A. rhodocorytha* are considered threatened species (Collar *et al.* 1992).

METHODS

Between March 1992 and January 1993, we made 8 visits (8-15 days each month, from sunrise to approximately 18:00) to RFL. We looked for psittacids by walking around the area whenever weather permitted for a total of 374 hs of field observation. Walks were conducted along the extensive system of dirt roads that crossed the reserve. The used roads comprised approximately 14 Km, being 12 Km in the 'terra firme' forest, 1,5 Km in the 'mussununga' forest and 500 m in the 'várzea' forest; hence we obtained a sample which approximately represents the vegetational coverage of the whole area. Several of the roads have continuous canopy over them.

We recorded each observation of a flock or individual feeding on a resource as one feeding bout. If a psittacid (or a flock) moved to another food source and fed on it, a new bout was recorded (Galetti 1993, Pizo *et al.* 1995). Plants whose parts were eaten were identified at the RFL herbarium and with the staff of the Departamento de Botânica of the Universidade Estadual de Campinas (UNICAMP), Campinas, state of São Paulo, Brazil. All identified plant species have voucher specimens in the RFL herbarium.

To access the vertical stratification of psittacids, we visually estimated the perch height of the birds (even if they were not feeding) to the nearest 5 m class interval.

RESULTS

Vertical stratification. Perch heights of psittacids are summarized in table 1 for those species for which we gathered three or more records. *Ara maracana* was observed perched just once at three m height, and no data are available for *Ara nobilis*, *Forpus xanthopterygius* and *Touit surda*. Overall, our data indicate that the heaviest species occupy most commonly the highest strata (> 25 m) in the vegetation,

Table 1. Frequency (%) distribution of perch height for the psittacids from Reserva Florestal de Linhares. The most frequent perch height class for each species are highlighted.

Species	N	Height classes (m)						P[a,b]
		0-5	6-10	11-15	16-20	21-25	26-30	
Aratinga aurea[c]	6	33	**50**	17	-	-	-	NS
Pyrrhura cruentata	14	14	**50**	29	7	0	0	$P < 0.025$
Pyrrhura leucotis	57	7	**46**	26	9	3	9	$P < 0.001$
Brotogeris tirica	26	4	15	**27**	23	11	19	NS
Pionus menstruus	3	0	0	0	**67**	0	33	NS
Pionus maximiliani	8	0	12	12	0	25	**50**	NS
Amazona rhodocorytha	26	0	4	0	15	19	**61**	$P < 0.001$
Amazona amazonica	5	0	20	20	0	0	**60**	NS
Amazona farinosa	13	0	8	0	8	31	**54**	$P < 0.005$

[a]Log-likelihood goodness of fit test applied to raw data (Zar 1984). NS = not significant ($P > 0.05$). [b]Expected values were obtained through the division of the number of observations by the number of possible height classes. [c]*Aratinga aurea* occurs in open areas where trees higher than 15 m never occur.

whereas the lightest ones are more often found perched below 15 m. Considering as criterion 75 % of perches above or below 15 m, we distinguished two groups of psittacids according to perch height: those occupying inferior strata (*Pyrrhura cruentata* and *P. leucotis*), and those occupying superior strata (*Amazona rhodocorytha* and *A. farinosa*). *Brotogeris tirica* and *Pyrrhura leucotis* were observed in a broad range of height classes, but the former does not seem to prefer any particular stratum. The few data available for *Aratinga aurea*, *Pionus* spp and for *Amazona amazonica* preclude any conclusion.

Diet. We recorded 79 feeding bouts on 22 plant species representing 14 families (table 2); the seeds of all plant species recorded were eaten by the psittacids, but pulp was also ingested in some cases (nine plant species).

Forpus xanthopterygius, *Amazona amazonica*, *Ara nobilis*, *A. maracana* and *Touit surda* were not observed feeding during the study. Data about the diet of the *Amazona* and *Pionus* species are limited partly because they occupy the highest forest stratum which renders direct observations of feeding birds difficult. We have the most feeding observations for *Pyrrhura leucotis* (48 % of feeding bouts, 12 plant species) and *Brotogeris tirica* (27 % of feeding bouts, 8 plant species), two of the most abundant psittacids at RFL.

The most utilized plant families (figure 1) were Cecropiaceae (four species, 36 feeding bouts) and Moraceae (four species, 13 feeding bouts). With the exception of

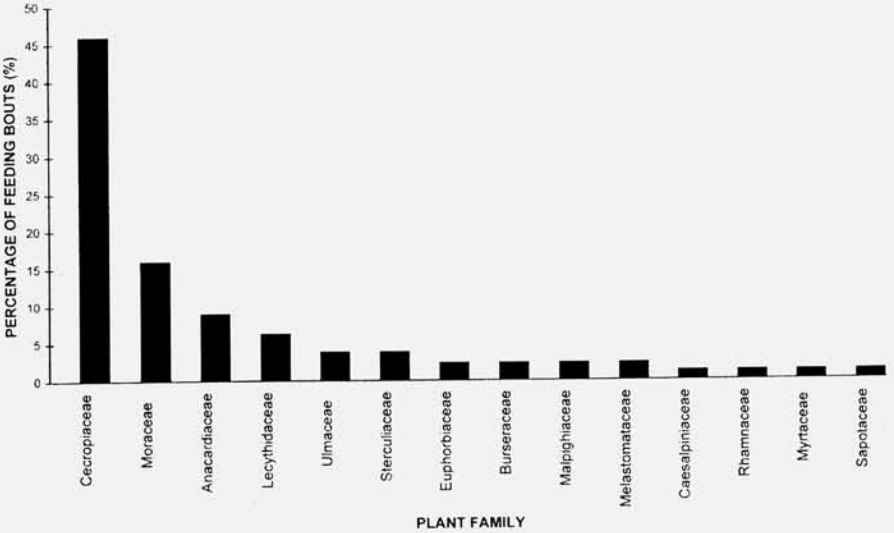

Figure 1. Percent distribution of feeding bouts (N = 79) among the 14 plant families recorded in the diet of psittacids at Reserva Florestal de Linhares.

Table 2. Plant species eaten by psittacids at Reserva Florestal de Linhares. Plant families and species are arranged in alphabetical order.

Families/plant species	Fruiting season	Part eaten[a]	Psittacid[b]	Feeding bouts (% of records for each bird species)
ANACARDIACEAE				
Tapirira guianensis	Mar-May	s	Pc	5 (62)
			Pl	2 (5)
BURSERACEAE				
Protium heptaphyllum	Dec-Jan	s	Ar	1 (50)
			Af	1 (20)
CAESALPINIACEAE				
Dialium guianense	Mar-May	s	Bt	1 (5)
CECROPIACEAE				
Cecropia glaziovi	Feb-Mar	p,s	Pl	1 (3)
			Bt	3 (14)
C. pachystachya	Apr-Nov	p,s	Pl	7 (18)
			Bt	1 (5)
C. hololeuca	Jun-Dec	p,s	Pl	18 (47)
			Bt	5 (24)
Pourouma velutina	Apr	s	Af	1 (20)
EUPHORBIACEAE				
Alchornea triplinervia	Nov-Jan	s	Pl	1 (3)
Pera glabrata	Apr-Jun	s	Pl	1 (3)
LECYTHIDACEAE				
Eschweilera ovata	Apr-May	p,s	Pt	2 (100)
			Pm	1 (50)
			Af	2 (40)
MALPIGHIACEAE				
Byrsonima sericea	Jun-Sep	s	Aa	1 (100)
Byrsonima sp.	May-Aug	s	Pc	1 (12)
MELASTOMATACEAE				
Mouriri glazioviana	May-Aug	s	Pc	1 (12)
			Pl	1 (12)
MORACEAE				
Artocarpus integrifolia[c]	Nov-Jan	p, s	Bt	4 (19)
Ficus nymphaeifolia	Feb-Mar	p, s	Pl	1 (3)
F. gomelleira	Jun-Dec	p, s	Pl	1 (3)
			Bt	3 (14)
F. guianensis	Feb-Oct	p, s	Pl	2 (5)
			Bt	2 (9)
MYRTACEAE				
Eugenia cumini[c]	Dec-Jan	s	Pl	1 (3)
RHAMNACEAE				
Ziziphus platyphilla	Mar-May	s	Pm	1 (50)
SAPOTACEAE				
Micropholis crassipedicelata	Jun-Jul	s	Ar	1 (50)
STERCULIACEAE				
Sterculia speciosa	May-Jul	p, s	Bt	2 (9)
			Af	1 (20)
ULMACEAE				
Trema micrantha	Feb-Mar	s	Pc	1 (12)
			Pl	2 (5)

[a] Part eaten: p = pulp, s = seeds. [b] Psittacids: Aa = *Aratinga aurea*, Pc = *Pyrrhura cruentata*, Pl = *P. leucotis*, Bt = *Brotogeris tirica*, Pt = *Pionus menstruus*, Pm = *Pionus maximiliani*, Ar = *Amazona rhodocorytha*, Af = *Amazona farinosa*. [c] Exotic species

Euphorbiaceae and Malpighiaceae (two species each), only one species was recorded for the remaining plant families.

DISCUSSION

Roth (1984) also reported that seven of the 15 psittacid species he studied at an Amazonian forest site could be assigned to vertical strata of the forest: amazons and macaws perched over than 25 m; *Deroptyus accipitrinus*, *Aratinga weddellii* and *Pionopsitta barrabandi* perched between 15-30 m; and two *Pyrrhura* species were most frequently observed perching below 25 m. In Roth's study there was also a group of species (*Pionus menstruus* among them) that occupied all strata almost equally. In our study, although *Aratinga aurea* occupies the same stratum as *Pyrrhura* spp (table 1), it occupies different habitats. At RFL *A. aurea* is found only in opened areas with scattered small trees ('campos nativos' and 'várzea' forests), whereas *Pyrrhura* spp lives in 'terra firme' and 'mussununga' forest.

The strata occupied potentially influence not only the fruit species but also the fruit type (if dry or fleshy) eaten by the psittacids. Fruit-bearing plants of different species obviously differ in height, and dry fruits tend to be better represented in the canopy than in the lower strata in semideciduous forest like the RFL forest (Morellato 1991, Morellato and Leitão-Filho 1992). Many of the data reported here were collected when the psittacids were feeding.

Concerning to the food items, Desenne (1995) and Pizo *et al.* (1995) have been recorded elsewhere the predominance of seeds in the diet of neotropical psittacids. Pulp, however, is also an important food item for some psittacids (e.g., *Ara severa*; Desenne 1995) or when the psittacids are feeding on particular plant species (e.g., *Euterpe* fruits, Palmae; Strahl *et al.* 1991, Pizo *et al.* 1995). We do not know if the pulp swallowed when the psittacids fed on *Ficus* and *Cecropia* species was ingested intentionally or accidentally as a result of ingesting the tiny seeds enveloped by the pulp.

Contrary to the findings of Roth (1984), Scherer Neto (1989), Martuscelli (1995) and Pizo *et al.* (1995), we did not observe psittacids eating flowers, nectar or leaves. Flower-eating is common among some species of neotropical psittacids (e.g., *Brotogeris chrysopterus*; Roth 1984, Desenne 1995) or in areas with a prolonged dry period (Galetti 1993, Olmos 1996). Additional field observations would probably result in flower-eating records, but this behavior is definitely not common among the psittacids at RFL, at least during the study period.

Curiously the most used plant families do not figure among the ten most common families occurring at RFL (Peixoto and Gentry 1990). This may indicate that the psittacids did not exploit the fruits according to their overall abundance in the area, but rather that some sort of food choice occurs. At this point, a survey about vegetational structure and fruit abundance, in each habitat of the site, would be very useful to get more conclusions about the ecology of the resource exploitation by the psittacids.

The high consume of *Cecropia pachystachya* (eight feeding bouts) and *C. hololeuca* (23 feeding bouts) may be a consequence of three factors: (1) *Cecropia* spp. are pioneer species especially common in the second-growth vegetation occurring along the road margins where the diet surveys were conducted, (2) *Cecropia* architecture facilitates visualisation of feeding birds, and (3) psittacids may be attracted to the *Cecropia* infructescences, because of their abundance in neotropical second-growth forests and/or because of the net energy reward they offer. Wherever the reason, our results corroborate earlier studies showing that *Cecropia* infructescences are highly used by psittacids as food (Pizo *et al.* 1995, Whitney 1996).

It is also worthwhile to note the occurrence of two exotic fruits in the diet of psittacids: *Artocarpus integrifolia* ('jaca' - Moraceae) and *Eugenia cumini* ('jamelão' - Myrtaceae), both introduced from India. These species are well adapted in Brazil and at RFL they are common in an orchard; moreover the genus *Eugenia* is represented at the site by at least 23 native species, that represents a potential food resource to psittacids. The utilization of these species are indicative of the opportunistic behavior of some psittacids which are able to exploit relatively new and uncommon resources to enrich their diet.

ACKNOWLEDGMENTS

We are grateful to R.M. de Jesus, the Director and to A. Garcia the Vice-director of RFL, for permission to work at the reserve and for the help during field work; to S. Rosas and the staff of RFL for friendly assistance in the field or in analyzing data; to J. Vasconcellos for the facilities used during the initial phase of the study; to J. Vielliard who helped in the identification of psittacids; to J. Semir and J. Tamashiro for plant identifications and fruit characterizations. I. S. was supported by a fellowship from Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP. M. Foster greatly improved the final version of the manuscript.

REFERENCES

Brandt, A. and R. B. Machado (1990) Área de alimentação e comportamento alimentar de *Anodorhyncus leari*. *Ararajuba* 1:57-63.

Collar, N. J., L. P. Gonzaga, N. Krabbe, A. Madroño-Nieto, L. G. Naranjo, T. A. Parker III and D. C. Wege (1992) *Threatened birds of the Americas.* The ICBP/UCN Red Data Book, 3rd ed. Cambridge: International Council for Bird Preservation.

Da-Ré, M. (1996) Reintrodução de um exemplar fêmea de Ararinha-azul *Cyanopsitta spixii* à natureza, p. 118-124. *In*: J. M. E. Vielliard, M. L. Silva and W. R. Silva (eds.) *Anais V Cong. Bras. Orn.* Campinas: Ed. UNICAMP.

Desenne, P. (1995) Preliminary study of the diet of 15 species of psittacids in an evergreen forest, Tawadu river basin, El Caura forest reserve, state of Bolivar, Venezuela, p. 26-43. *In*: G. Morales, I. Novo, D. Bigio, A. Luy and F. Rojas-Suarez (eds.) *Biología y Conservacion de los psitácidos de Venezuela.* Cambridge: Birdlife Intern.

Forshaw, J. M. (1978) *Parrots of the World*, 2nd ed. David and Charles Ltd, Brunel House, Newton Abbot, Devon; UK.

Galetti, M. (1993) Diet of the Scaly-headed Parrot (*Pionus maximiliani*) in a semideciduous forest in southeastern Brazil. *Biotropica* 25:419-425.

___ (1997) Seasonal abundance and feeding ecology of parrots and parakeets in a lowland Atlantic forest of Brazil. *Ararajuba* 5:95.

Jesus, R. M. (1987) Mata Atlântica de Linhares: aspectos florestais, p. 35-71. *In*: *Anais do seminário 'Desenvolvimento econômico e impacto ambiental em áreas do trópico brasileiro: a experiência da CVRD, Linhares'.* Rio de Janeiro: SEMA, IWRB, CVRD.

Martin, T. E. (1985) Resource selection by tropical frugivorous birds: integrating multiple interactions. *Oecologia* 66:563-573.

Martuscelli, P. (1995) Ecology and conservation of the Red-tailed Amazon *Amazona brasiliensis* in southeastern Brazil. *Bird Cons. Int.* 5:405-420.

Morellato, L. P. C. (1991) *Estudo da fenologia de árvores, arbustos e lianas de uma floresta semidecídua no sudeste do Brasil.* Ph. D. Thesis. Campinas: UNICAMP.

___ and H. F. Leitão-Filho (1992) Padrões de frutificação na Serra do Japi, p. 112-140. *In*: L. P. C. Morellato (ed.). *História natural da Serra do Japi.* Campinas: Ed. UNICAMP.

Munn, C. A. (1988) Macaw biology in Manu Nat. Park, Peru. *Parrot Letters* 1:18-21.

Olmos, F. (1996) Distribuição e ecologia de *Pyrrhura pfrimeri* (Psittacidae): primeiras observações, p. 93-94. *In*: J. M. E. Vielliard, M. L. Silva and W. R. Silva (eds.) *Anais V Cong. Bras. Orn.* Campinas: Ed. UNICAMP.

Pasquier, R. F. (1982) *Conservation of New World parrots*, 2nd ed. Smithsonian Inst. Press, Washington D.C.: Int. Council Bird Preserv. Tech. Publ.

Peixoto, A. L. (1982) Considerações preliminares sobre a flora e a vegetação da Reserva Florestal da CVRD (Linhares, ES). *Cadernos de Pesquisa 2 (Série Botânica 1)*:41-48.

___ and A. Gentry (1990) Diversidade e composição florística da mata de tabuleiro na Reserva Florestal de Linhares (ES, Brasil). *Rev. Bras. Bot.* 13:19-25.

Pizo, M. A., I. Simão and M. Galetti (1995) Diet and flock size of sympatric parrots in the Atlantic forest of Brazil. *Orn. Neot.* 6:87-95.

Roth, P. (1984) Repartição do habitat entre psitacídeos simpátricos no sul da Amazônia. *Acta Amazônica* 14:175-221.

Sazima, I. (1989) Peach-fronted Parakeet feeding on winged termites. *Wilson Bull.* 101:656-657.

Scherer Neto, P. (1989) *Contribução à biologia do papagaio-de-cara-roxa Amazona brasiliensis (Linnaeus, 1758) (Psittacidae, Aves).* M. Sc. Thesis. Curitiba: Univ. Fed. Paraná.

Strahl, S. D., P. A. Desenne, J. L. Jimenez and I. R. Goldstein (1991) Behavior and biology of the Hawk-headed Parrot *Deroptyus accipitrinus* in southern Venezuela. *Condor* 93:177-180.

Whitney, B. M. (1996) Flight behaviour and other field characteristics of the genera of Neotropical parrots. *Cotinga* 5:32-42.

Yamashita, C. and P. M. Valle (1993) On the linkage between *Anodorhynchus* macaws and palm nuts and the extinction of the glaucous macaw. *Bull. Brit. Orn. Club.* 113:53-61.

Zar, J. H. (1984) *Biostatistical analysis.* London: Prentice-Hall Intern. Ed.

Ararajuba 5(2):175-176
dezembro de 1997

Use of tree cavities for roosting by the Reddish-bellied Parakeet (*Pyrrhura frontalis*)

Giane Chaves Kristosch

Programa de Pós-graduação em Zoologia, C. P. 199, UNESP, 13506-900, Rio Claro, SP, Brazil. E-mail: gianeck@life.ibrc.unesp.br

Recebido em 26 de março de 1997; aceito em 22 de maio de 1997

RESUMO. **Uso de cavidades em árvores como dormitório pela Tiriba-de-testa-vermelha (*Pyrrhura frontalis*).** A utilização de cavidades naturais como dormitório, fora do período reprodutivo não é uma prática comum em psitacídeos. No período de janeiro a setembro de 1996, foram observados indivíduos de *Pyrrhura frontalis* utilizando cavidades em árvores como dormitório em uma floresta composta primariamente por *Araucaria angustifolia* (Araucariaceae) e *Podocarpus lambertii* (Podocarpaceae) em Campos do Jordão, noroeste do estado de São Paulo, Brasil. Durante este período, três indivíduos chegavam diariamente a uma cavidade de *P. lambertii* ao escurecer e saíam ao amanhecer. Outros dois indivíduos foram vistos utilizando uma cavidade em *A. angustifolia* nos meses de julho e agosto. O uso destas cavidades naturais não só fornece proteção aos indivíduos, mas também pode fazer com que os animais não tenham que procurar novos sítios reprodutivos para a próxima estação.

PALAVRAS-CHAVE: Campos do Jordão, dormitório, Psittacidae, *Pyrrhura*.

KEY WORDS: Campos do Jordão, Psittacidae, *Pyrrhura*, roosting.

Roosting in natural cavities is unusual among psittacids. A few exceptions are known. Small flocks (six individuals or more) of Buffy-faced Pygmy Parrot *Micropsitta pusio* and Yellow-capped Pygmy Parrot *M. keiensis* have been observed sleeping in abandoned termitaria at all times of the year (Bergman 1960, Shanahan 1969). Black-winged Lovebird *Agapornis taranta* roosts in natural cavities that are used through the year by small flocks (Forshaw 1981). Sick (1985) stated that the only parrot in Brazil known to roost in a place other than tree branches during non-breeding periods is the monk parakeet *Myiopsitta monachus* which builds colonial nests that are used as roosting site throughout the year.

Between January and September 1996, I observed the Reddish-bellied Parakeet *Pyrrhura frontalis* using tree cavities on 27 days for roosting within a forest composed mostly by *Araucaria angustifolia* (Araucariaceae) and *Podocarpus lambertii* (Podocarpaceae) trees in Campos do Jordão, northwestern State of São Paulo, Brazil (22°45'S, 45°30'W). During this period, three individuals would arrive silently at dusk between 17:15 to 17:40 close to a cavity in a *Podocarpus* tree (the cavity was 12 m high above the ground). Usually, the three birds entered the cavity one after the other, but sometimes, one of them remained outside perched on a tree branch until sunset, and then entering the cavity. By dawn 06:35, the three individuals would leave the cavity together calling loudly and flying to a nearby *Araucaria* tree circa 25 m away. There they would remain perched and remain there for a few minutes. Then they would fly off with two other passing individuals. This same dawn routine was repeated daily during all months that I observed. I also noted another two birds using a cavity (14 m above the ground) in an *Araucaria* tree in July and August 1996. This pair entered the tree cavity by 17:25h and left also at dawn by 06:35.

The breeding season of *P. frontalis* at Campos do Jordão begins in September through to January (pers. obs.). It is not known if the individuals, that were observed using these cavities during the non-breeding season January-September, had previously nested in these cavities prior to this study.

Many bird species that nest in cavities, use these structures as dormitories before and after nesting because they provide good shelter against inclement weather and predation (Skutch 1961). I note the use of *Araucaria* and *Podocarpus* tree cavities as dormitories for *P. frontalis* and also suggest that these cavities provide not only protection against inclement weather but also against predation. Furthermore, pairs may well use the same cavity during the next breeding season, as observed by Waltman and Beissinger (1992) for Green-rumped parrotlet *Forpus passerinus*. A shortage of natural nesting cavities for hole nesting bird species in general is a well know restricting influence for breeding success (Waltman and Beissinger 1992). I suspect this may well influence the *P. frontalis* behavior of roosting in cavity sites safeguarding them for their future breeding attempts.

ACKNOWLEDGMENTS

I thank L. M. Castanho for his help in observing the birds, L. R. Monteiro, D. O. V. Andrade and two anonymous referees for commenting the manuscript. Financial support was provided by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). The Instituto Florestal do Estado de São Paulo provided housing at the study site.

REFERENCES

Bergman, S. (1960) The smallest parrots of the world. *Avic. Mag.* 66:209-215.

Forshaw, J. M. (1981) *Parrots of the world,* 2nd ed. Melbourne: Landsdowne Ed.

Shanaham, P. J. (1969) The buffy-faced pygmy parrots. *Aust. Avicult.* 23:120-122.

Sick, H. (1985) *Ornitologia brasileira, uma introdução,* v.1. Brasília: Ed. Univ. Brasília.

Skutch, A. F. (1961) The nest as a dormitory. *Ibis* 103a:50-71.

Waltman, J. R. and S. R. Beissinger (1992) Breeding behavior of the Green-rumped Parrotlet. *Wilson Bull.* 104:65-84.

Ararajuba 5(2):176-182
dezembro de 1997

Anodorhynchus macaws as followers of extinct megafauna: an hypothesis

Carlos Yamashita[1]
IBAMA - Al. Tiete, 637, 01417-020, São Paulo, SP, Brazil

Recebido em 02 de abril de 1997; aceito em 20 de junho de 1997

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 freqüência, 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 gnatotheca "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 Pleistoscene, 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, maintaning 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 comensal 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. Seletive 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 rhythmics 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 xiric 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 acummulated 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 Jamari, 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 *Pyrrhura 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 autochtonous megafauna these razed gaps are simulated along the river banks during dry season.

Figure 3 . The behaviour of *Anodorhyncus* 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.

ACKNOWLEDGMENTS

I thank M. P. Valle, L. P. Gonzaga, C. Munn, J. Wiley, D. Homberger, R. Cavalcanti, H. Alvarenga, K. Redford and J. França for the incentive to publish this paper. I accompanied P. Crawshaw during his jaguar and caiman project in Miranda Estancia. Y. M. Barros provided the picture of palm nuts. G. Jafet of the Fundação Zoológico de São Paulo made the black and white illustrations. M. Galletti, F. Olmos and P. Martuscelli provided fruitful discussion and improvement of the the manuscript. Two anonymous referees and M. Rodrigues greatly improved the manuscript.

REFERENCES

Anderson, A. B., P. H. May and M. J. Balick (1991) *The subsidy from nature: palm forest, peasantry, and development on the Amazon frontier*. New York: Columbia University Press.

Brandt, A. and R.B. Machado (1990) Area de alimentagco e comportamento alimentar de *Anodorhynchus leari*. *Ararajuba* 1:57-63.

Boukessey, M., J. Saint-Pie and O. Morvan (1991) Observations on a population of Red-fronted Macaw Ara rubrogenys in the rio Caine valley, central Bolivia. *Bird Conserv. Inter.* 1:335-350.

Cartelle, C. (1994). *Tempo passado- mamíferos fósseis do pleistoceno de Minas Gerais*. Belo Horizonte: ACESITA

Collar, N. J., M. J. Crosby and A. J. Stattersfield. (1994). *Birds to watch 2. The world list of threatened birds.* Bird Conserv. Series number 4. Cambridge: Birdlife Intern.

Dean, W. (1995) *A ferro e fogo*. Rio de Janeiro: Ed. Cia das Letras

Eisenberg, J. F. (1981) *The mammalian radiations*. Chicago: Univ. of Chicago Press.

___ and K. H. Redford (1982) Comparative niche struture and evolution of mammals of the Neartic and southern South America, p. 77-84, In M. A. Mares and H. H. Genoways, (eds.) *Mammalian Biology in South America*. Pymatuning Laboratory of Ecology, spec. pub.6, Univ. Pittsburgh.

Eiten, G. (1972). The cerrado vegetation of Brazil. 38(2): 201-341.

Emmons, L. H. and F. Feer (1990) *Neotropical rainforest mammals*. Chicago: Univ. Chicago Press.

Forshaw, J.M. (1989) *The parrots of the world*. 3rd ed. London: Blanford Press.

Janzen, D. H. (1971). Seed predation by animals. *Annual Rev. Ecol. Syst.* 2:465- 492.

___ and P. S. Martin. (1982). Neotropical anachronisms: the fruits the Gomphotheres ate. *Science* 215: 19-27.

___ (1986). Mice, big mammals and seeds: it matters who defecates what where. p. 251-271. *In* A. Estrada, and T. H. Fleming (eds.) *Frugivores and seed dispersal*. Dordrecht: Dr. W. Junk Publishers.

Martin, P. S. (1967) Prehistoric overkill. p. 75-120 In P. S. Martin and H. E. Wright Jr., (eds.) *Pleistocene extinctions*. Tucson: Univ. Arizona Press.

___ (1984) Prehistoric overkill: the global model. Pp. 354-403 In P. S. Martin and R. G. Klein, (eds.), *Quaternary extinctions* Tucson: Univ. of Arizona Press.

May, D. L. (1996).The behaviour of Grey Parrot in the rainforest of the Central African Republic. *Psittascene* 8: 8-9.

Munn, C. A. (1988) The real macaws. *Animal Kingdom*. 91: 20-33.

___, J. A. Thomsen and C. Yamashita (1990) The Hyacinth Macaw, Pp 404- 419. In W.J. Chadler, (ed.) *Audubon Wildlife Report*. New York: Academic Press

Owen-Smith, N. (1987). Pleistocene extinctions: the pivotal role of megaherbivores. *Paleobiology* 13: 351-362.

Rizzini, C. T. (1979) Tratado de fitogeografia do Brasil. 2 vol. São Paulo: Ed. Univ. São Paulo.

Roth, P. (1984). Repartição do habitat entre psittacideos simpatricos no sul da Amazonia. *Acta Amazônica* 14:175-221.

Skape, C. (1991). Impact of grazing in savanna ecosystems. *Ambio* 20(8): 351-356.

Sick, H. (1986) *Ornitologia Brasileira*. 2 vol. Brasília: Ed. Univ. Brasília.

___, L. P. Gonzaga e D. M. Teixeira (1987) A arara azul de Lear, *Anodorhynchus leari* Bonaparte, 1856. *Rev.*

Bras. Zool. 3(7):441-463.

Simpson, G. G. (1980). *Splendid isolation: the curious history of South America mammals.* New Haven: Yale Univ. Press.

SUDECO (1979) *Estudo de desenvolvimento integrado da bacia do alto Paraguai-EDIBAP*. Brasília. Superintendência de Desenvolvimento da região Centro Oeste.

Veloso, H. P. e H. E. Strang (1970) Alguns aspectos fitofisionômicos da vegetação do Brasil. *Mem. Inst. Oswaldo Cruz* 68:9-76.

Yamashita, C. (1987) Field observations and comments on the Indigo Macaw (*Anodorhynchus* leari), a highly endangered species from northeastern Brazil. *The Wilson Bull*. 99: 280-282.

___ (1992) Comportamento de ararazna (*Anodorhynchus hyacinthinus*) Psittacidae, Aves. *Anais de Etologia*, 10:158-162.

___ and M. P. Valle. 1993. The linkage between *Anodorhynchus* Macaws and the palm nuts and the extinction of the Glaucous Macaw. *Bull. Brit. Orn. Club*. 113: 53-60.

Nest and egg description of an endemism of the Brazilian north-east: the Cactus Parakeet, *Aratinga cactorum*

Luciano Nicolás Naka

Cidade Universitária UFSC, C.P.5184, 88040-970, Florianópolis, SC, Brazil. E-mail:a94128119@ccb2.ccb.ufsc.br

Recebido em 29 de abril de 1997; aceito em 15 de agosto de 1997

RESUMO. **Descrição do ninho e ovo de um endemismo do nordeste brasileiro: o periquito-da-caatinga, *Aratinga cactorum*.** São descritos quatro ninhos do periquito-da-caatinga (*Aratinga cactorum*) achados em Curaçá, região norte do estado da Bahia, durante os meses de janeiro, fevereiro e março de 1997, assim como alguns comportamentos reprodutivos observados. Todos os ninhos encontrados foram feitos dentro de cupinzeiros arbóreos ativos. O conteúdo dos ninhos se encontrava depositado em uma câmara interna construída pelo casal de *A. cactorum* e conectado ao exterior através de um túnel. O número médio de ovos por ninho foi igual a 5,0 ± 0,82 (N = 4). Os ovos apresentavam um formato levemente ovóide sendo brancos com uma tonalidade opaca, com dimensões médias de 24,86 ± 0,38 mm de comprimento e 20,38 ± 0,72 mm de largura (N = 14).

PALAVRAS-CHAVE: *Aratinga cactorum*, caatinga, endemismo, ninhos, ovos, Psittacidae, reprodução.

KEY WORDS: *Aratinga cactorum*, caatinga, eggs, endemism, nests, Psittacidae, reproduction.

The voice of the Cactus Parakeet (*Aratinga cactorum*) is undoubtedly one of the most common and more characteristic sounds of the Brazilian Caatinga. This parakeet occurs in the Brazilian north-east, from Piauí, Ceará and Pernambuco to Minas Gerais (Meyer de Schauensee 1970), ocurring mainly in the caatinga (Sick 1997). As most of its eight Brazilian congeners (Altman and Swift 1993), this parakeet lives in open landscapes, being common and conspicuous, so the lack of information about this species is, to some extent, surprising. This paper describes the nest and eggs of this species, as well as some reproductive behaviour observed during nest construction and incubation.

The field study was undertaken near the town of Curaçá, 92 km east of Juazeiro, located on the northern part of the state of Bahia. All the data presented here were obtained near the Field Base of the Ararinha-azul Project (9°10'S, 39°47'W) at Fazenda Concórdia, and the nearby Fazenda Caraíbas, both with an elevation of 350 m.

The caatinga is characterized by usually flat, strongly eroded and stony soils, with a very irregular and intense dry season. The rainy season in the Curaçá area starts in December and goes until March (Rizzini 1979).

The caatinga, in a phytogeographic perspective, can be thought of as a seasonal, deciduous, sometimes thorny, dry forest, characteristic of semiarid north-eastern Brazil (A. Fernandes *in* Monteiro and Kaz 1995). Together with this dry habitat (for a full description see the characterisation of the shrubby or low caatinga of A. Fernandes *in* Monteiro and Kaz 1995), there are other distinctive and more humid regions in the Curaçá area, associated with streams, including varzeas and matas de galeria (Juniper and Yamashita 1991).

Once the nests were found and the presence of a breeding pair was confirmed, a small loophole was made on the opposite side of the tunnel entrance of the termitarium with a machete. The entire portion that was removed was placed in the same position after the manipulation of the eggs, which were left as they were originally found. As a result, the removed part would then serve as a cover, to eventually be repaired by the termites. After realizing that the termites were taking a long time to repair the damage, or not doing it at all, the sides of the covers were filled with wet mud, which dries very quickly, in order to fill the cracks.

Pairs of Cactus Parakeets were seen building their nests on three occasions, on 6 and 15 January and 14 March, 1997. In all three cases, the pairs displayed the same behaviour. While one of the birds was digging the nest's tunnel, its mate was keeping guard on a nearby branch in a vertical position, giving off alarms when somebody approached the building nest. The first pair was working on a small termitarium about the size of a soccer ball, which was 1.6 m up, and I was informed by local people that the pair had been working there for about a week. The second pair was also working on a small termitarium, located on a baraúna-do-sertão tree (*Schinopsis brasiliensis*: Anacardiaceae), 5 m up. The last pair observed had its nest under construction on an aroeira-do-sertão tree (*Myracrodruon urundeuva*: Anacardiaceae), on a middle-sized termitarium, with a diameter of about 30 cm, 1.7 m up. Its tunnel was already 15 cm long.

Four occupied nests of the Cactus Parakeet were found during the rainy season of 1996-1997. All the nests followed the same pattern, being found exclusively in arboreal active termitaria, with nestlings and eggs lodged in a chamber built by the parakeets inside the structure (figure 1). The chambers (table 1) were usually built in the middle part of the termitarium, and the entrance tunnel had its opening in the basal portion of the structure, sloping up to the nest chamber. No lining was found in the nests, the nestlings and eggs being in direct contact with the termitarium, although there were no termites around them. All of the 14 eggs examined were slightly ovoidal with a dull white tone (table 2). Nest 1, which had 6 eggs, was found on 4 January and was located on a big rounded termitarium located on a limb of a baraúna-do-sertão tree (figure 1). Nest 2 was found on 6 January on a spherical *Nasutitermes* termitarium located on an aroeira-do-sertão tree. The day the nest was found, there were 5 eggs in the chamber, but one week later one of them disappeared. Nest 3 was found on 7 January in an elongated termitarium located on a quixabeira tree (*Bumelia sartorum*: Sapotaceae). There were 5 eggs inside the chamber, one of them cracked, containing fresh yolk. Nest 4 was found by local people during the last week of February, and was shown to me on 4 March. It contained 3 nestlings with feathers on the tail and wings, and one addled egg inside the chamber. This nest was built on a dead baraúna-do-sertão tree in an antropic area, 50 m from a local house.

Everytime the nests were checked during the incubation period, at least one member of the pair was inside the termitarium, and two times both were inside.

During the study period, due to heavy and constant rains, some of the loopholes that were made in order to

Table 1. Nests' height above ground and chambers' measurements (cm). The height is from the base of the termitarium to the ground.

Nest	Height above ground	Length	Width	Height	Tunnel length/diameter
1	250	33	20	15	19/7
2	170	27	13	24	12.5/6
3	270	30	23	17	11/5
4	250	30	15	20	24/7

Table 2. Clutch-size and average measurements of the eggs per nest, with their respective standard deviation. Egg measurements are in mm.

Nest	Clutch-size	Average measurements of the eggs per nest
1	6	24.83 ± 0.54 x 20.69 ± 0.25 (N = 6)
2	5	24.50 ± 0.62 x 19.56 ± 0.32 (N = 4)
3	5	25.25 ± 0.45 x 20.90 ± 0.24 (N = 4)
4	4*	
Average	5.0 ± 0.82	24.86 ± 0.38 x 20.38 ± 0.72 (N = 14)

*Probable number of eggs, 3 nestlings and 1 addled egg found.

examine the nest contents, collapsed leading to the abandonment of the pairs in nests 2 and 3. In nest 1 two of the eggs hatched, but the nestlings were lost between 18 and 24 January due to unknown reasons.

Certain species of invertebrates and vertebrates often seek refuge in the termitaria during long dry periods. The former include ant colonies, spiders, scorpions and centipedes, and the latter, serpents, lizards and small rodents (Monteiro and Kaz 1995). This kind of reproductive behaviour has been recorded in a few other Brazilian birds' species, including some parrots, but none of them are known to be exclusively related to the termitaria, as seems to be the case of the Cactus Parakeet in the Caatinga. These other species are the Peach-fronted Parakeet *Aratinga aurea* (Antas and Cavalcanti 1988, Sick 1997), the Yellow-chevroned Parrotlet *Brotogeris chiriri* (Antas and Cavalcanti 1988, Paranhos 1995, Sick 1997), the White-eyed Parakeet *Aratinga leucophthalmus* (Y. de Melo Barros pers. comm.) and the Dusky-headed Parakeet *Aratinga pertinax* (Forshaw and Cooper 1978), which itself is closely related to the Cactus Parakeet (Sick 1997). The utilisation of termitaria by certain species to build their nests should be favoured, as pointed out by Sick (1997), by the constant humidity and temperature conditions inside the structure. Hardy (1963), also remarks that such relationship, termite-parakeet, makes it very difficult for most predators to reach the eggs or youngsters without being exposed to the irritated termites. The fact that all the nests were located on active termitaria shows the importance of the termites to the parakeets, providing protection to their nests and repairing any damage made on the external surface, which greatly stimulates the photodermatic sense of the termites, leading workers and soldiers to repair the wrapper (Von Hagen, 1930, cited by Hardy, 1963). This was also seen by Paranhos (1995) and Hardy (1963), who reported that parakeets never use deserted termitaria, which may become dry and are easily broken.

Little is known about the number of eggs that hatch, but nest 4 had three nestlings with feathers on the tail and wings. In January 1996, a nest with 5 nestlings was seen in the area (Y. de Melo Barros pers. comm., 1997). From the scarce data available on the reproduction of the neotropical parrots in the wild, an average of 5 eggs per nest seems quite high if compared with other species of the genus, however, it must be taken in consideration the favourable conditions in the area due to the abundant rains during the rainy season of 1996-1997. Forshaw and Cooper (1978) report an average of two eggs for the Blue-crowned

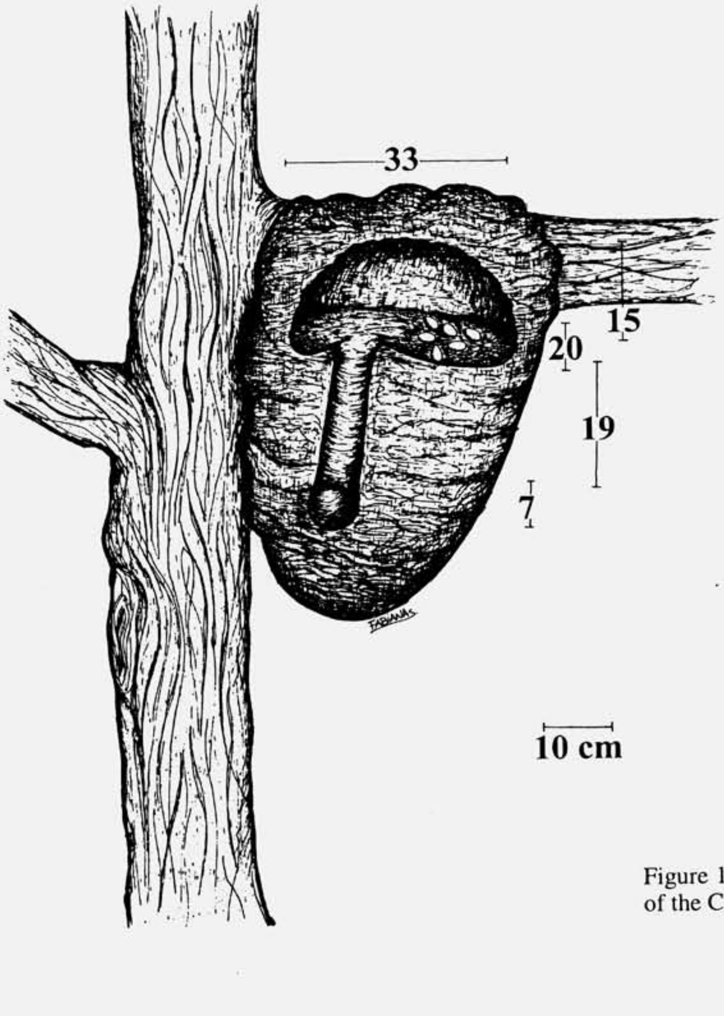

Figure 1. Cross section of the nest of the Cactus Parakeet (nest 1).

Parakeet *A. acuticaudata*, and De la Peña (1987) reports two nests with 3 eggs each. In the studied area, I have found two nests of this species, with 4 eggs each. The White-eyed Parakeet *A. leucophtalmus* clutches 3 or 4 eggs, and the Peach-fronted Parakeet *A. aurea* 2 or 3 (Forshaw and Cooper 1978). These authors give some information from captive individuals: the Jandaya Parakeet *A. jandaya,* lays 3 eggs, the Sun Parakeet *A. solstitialis,* 4 eggs and the Brown-throated Parakeet *A. pertinax,* 4 to 7 eggs, being the only example with such a high number. Apparently the only information about the Cactus Parakeet is from captive birds, reported in 1914 by Lovell-Keays, with 4 eggs (Forshaw and Cooper 1978). According to the same information, the female is the only one that incubates, and the male feeds the female during this period.

According to the observations made by the author and by M. A Da-Ré (pers. comm., 1997), the termitaria are abundant and widely available for the Cactus Parakeet, so they should not represent a limiting factor.

ACKNOWLEDGMENTS

This study was supported financially and logistically by the Ararinha-azul Project, with funds from Loro Parque Fundación and IBAMA. I would like to share this work with M. A. Da-Ré and all of the "Ararinha team" that was on the field with me, and shared most of the observations: A. L. Roos, J. Mazar, A. C. Rosa and J. S. Rosa, who found most of the nests. I also thanks E. Cancelo from the Museu de Zoologia de São Paulo for the termite identification, R. Newhouse for the English revision and to F. Suarez for her drawing of the nest. D.A. Machado from Dinâmica Projetos Ambientais, J. Mazar., M. Rodrigues, M. A. Da-Ré and two anonymous reviewers, for their critical revision of the manuscript and the many corrections suggested. Finally, I extend sincere thanks to Y. de M. Barros, who suggested this study and helped in many ways.

REFERENCES

Altman, A. and B. Swift (1993) *Checklist of the birds of South America*. Ohio: Bookmasters, Inc.

Antas, P. de T. Z. and R. B.Cavalcanti (1988) *Aves comuns do planalto central*. Brasília: Ed. Univ. Brasília.

De la Peña, M. R. (1987) *Nidos y huevos de aves argentinas*. Santa Fe: Lux S.R.L.

Forshaw, J. M. and W.T. Cooper (1978) *Parrots of the world.* Melbourne: Lansdowne Press.

Hardy, J. W. (1963) Epigamic and reproductive behavior of the Orange-fronted Parakeet. *Condor* 65:169-199.

Juniper, A.T. and C. Yamashita (1991) The habitat and status of Spix's Macaw *Cyanopsitta spixii*. *Bird Conserv. Intern.* 1:1-9.

Meyer de Schauensee, R. (1970) *A guide to the birds of South America*. Wynnewood: Livingston.

Monteiro, S. and L. Kaz (1995) *Caatinga-Sertão, Sertanejos*. Rio de Janeiro: Livroarte.

Paranhos, S. J. (1995) *Biologia comportamental de Brotogeris versicolorus chiriri (Vieillot, 1817) (Aves: Psittacidae): Alimentação e reprodução*. Dissertação de mestrado. Rio Claro: Univ. São Paulo.

Rizzini C.T. (1979) *Tratado de fitogeografia do Brasil, aspectos sociológicos e florísticos.* São Paulo: Ed. Univ. São Paulo.

Sick, H. (1997) *Ornitologia brasileira.* Rio de Janeiro: Ed. Nova Fronteira.

On the Hyacinth macaw's nesting tree: density of young manduvis around adult trees under three different management conditions in the Pantanal wetland, Brazil

Marc Aaron Johnson[1], **Walfrido Moraes Tomas**[2] **and Neiva Maria Robaldo Guedes**[3]

[1] *Departamento de Ecologia, Universidade de Brasília, C. P. 04631, 70919-970, Brasília, DF, Brazil. E-mail: johnsonm@guarany.cpd.unb.br*

[2] *CENARGEN/EMBRAPA, C. P. 02372, 70849-970, Brasília, DF, Brazil. E mail: tomasw@cenargen.embrapa.br*

[3] *UNIDERP - Projeto Arara Azul. Rua Geraldo J. M. Leite, 79, Conj. Maria A. Pedrossian, 79044-980, Campo Grande, MS, Brazil*

Recebido em 06 de maio de 1997; aceito em 07 de julho de 1997

RESUMO. **Sobre a árvore de nidificação da arara azul: densidade de manduvis jovens ao redor de árvores adultas sob três diferentes condições de manejo no Pantanal, Brasil**. A arara azul, *Anodorhynchus hyacinthinus*, é o maior representante dos psitacídeos e está ameaçada de extinção. A maior população da espécie é encontrada no Pantanal. A arara azul possui distribuição relativamente restrita e um nicho ecológico bastante especializado. Cerca de 95 % de seus ninhos, no Pantanal, localizam-se em troncos de manduvi (*Sterculia apetala*, Sterculiaceae), e a disponibilidade de sítios de nidificação pode ser o principal fator limitante para as populações da espécie. O objetivo deste trabalho foi avaliar a densidade de indivíduos jovens de manduvi sob três diferentes condições de manejo no Pantanal. Os resultados sugerem que há uma falha no estabelecimento de novos indivíduos em áreas submetidas à presença de gado e queimadas, o que pode comprometer a conservação da arara azul a longo prazo.

PALAVRAS-CHAVE: *Anodorhynchus hyacinthinus*, arara azul, manduvi, Pantanal, sítios de nidificação, *Sterculia apetala*.

KEY WORDS: *Anodorhynchus hyacinthinus*, Hyacinth Macaw, manduvi, nesting sites, Pantanal, *Sterculia apetala*.

Anodorhynchus hyacinthinus, the Hyacinth macaw, is the largest species of the family Psittacidae, and is threatened by extinction (Bernardes *et al.* 1990). This species is particularly vulnerable because of its low population size, limited distribution and highly specialized niche. The wild population has been estimated at 3,000 individuals (Munn *et al.* 1987). Collar *et al.* (1992) and Abramson and Thomsen (1995) describe the distribution of the Hyacinth macaw in three different areas, almost exclusively Brazilian: eastern Amazonas state, along the border with the state of Pará; north central Brazilian cerrado (part of the states of Piauí, Maranhão, Bahia, Tocantins, Goiás, Mato Grosso and Minas Gerais); and the Pantanal wetland, including part of Bolivia and Paraguay. Most of the Hyacinth macaw population occurs in the Pantanal, and the occurrence of this species in Bolivia and Paraguay is rare (Munn *et al.* 1987, López 1992, Abramsen and Thomsen 1995).

In the Pantanal, the Hyacinth macaw feeds only on the nuts of two palm trees: the bocaiúva *Acrocomia aculeata* (Jacq.) Lodd., and the acuri *Scheelea phalerata* (Mart.) Bur. In the pantanal this macaw nests primarily in only one species of tree, the manduvi *Sterculia apetala* (Jacq.) Karst (Guedes 1995, Guedes and Harper 1995). Between 95-100 % of Hyacinth macaw nests in the south central Pantanal occur in cavities of adult manduvis (Guedes and Harper 1995). Furthermore, only 5 % of adult manduvis in this area contain suitable cavities for the species (Guedes 1993). About 5 % of manduvis with Hyacinth macaw nests are annually lost to fire, deforestation, and/or windstorms, but senescence is also responsible for the loss of nesting sites (Guedes 1993, 1995). The shortage of suitable nesting sites likely constitutes an important limiting factor for this species (Munn *et al.* 1987, Guedes 1993, 1996).

Manduvis are large and fast-growing, canopy or emergent trees, which become established in primary succession or in secondary succession; secondary succession occurs in old fields or small natural clearings in the forest (Janzen 1972). In the Pantanal, the manduvi occurs within patches (capões) and corridors (cordilheiras) of non-inundable semi-deciduous forests (Ratter *et al.* 1988). Surrounding the capões and cordilheiras are seasonally flooded grasslands, much of which is used as rangeland for cattle. During the flooding season (January-June) these forest habitats experience increased pressure from cattle. Additionally, fire used for pasture management commonly enters capões and cordilheiras during the dry season.

The objective of this study was to conduct a preliminary evaluation of the density of young manduvis (seedlings and trees that have not yet begun to produce fruit) around adult manduvis, in three different management conditions. The surveys were conducted at Estação Ecológica Nhumirim (NHU), where cattle have been excluded for more than five years; at Campo Dora Ranch (CDR), where cattle are present throughout the year; and at Baú Ranch (BAU), where cattle are usually present for six months of the year (June to December). NHU is a 600 ha preserve located within the Nhumirim ranch (18°59'S, 56°39'W), a field station of the Centro de Pesquisa Agropecuária do Pantanal (CPAP-EMBRAPA). CDR is a neighboring ranch of 45,000 ha, and our survey was conducted in two pastures comprising about 15,000 ha. Both NHU and CDR are seasonally flooded by local rainfall and the Taquari River. BAU is located south of NHU and CDR (19°19'S, 57°02'W) and is seasonally flooded by the Miranda River.

The point-centered-quarter method (PCQ) (Bonham 1989) was used to determine the density of young individuals around adult manduvis. In each study area, 10 adult manduvis were located and used as centerpoints. The height, basal diameter (taken at a height of 10 cm), and distance to the centerpoint were recorded for the nearest young manduvi in each quadrant. Young manduvis were searched for within a maximum distance of 80 m from the centerpoint. In quadrants where no young manduvis were found, this distance (80 m) was used to fill the gap, as the PCQ requires at least one individual per quadrant. The signed rank test (Wilcoxon 1945) was applied to our data to compare the average densities of the three study areas.

Young manduvis at NHU tended to be of lesser height and closer to the centerpoint than at both CDR and BAU (figure 1). The average manduvi densities were 1.3139 ° 1.2489 (NHU), 0.0009 ° 0.0003 (CDR), and 0.0026 ° 0.0016 (BAU) individuals m^{-2}. The densities of young manduvis at BAU and CDR did not differ significantly ($P = 0.959$, $Z = -0.052$, d.f. = 39), but the young manduvi density at NHU differed significantly from the other two areas ($P < 0.001$, $Z = -3.730$ and -3.544, d.f. = 39). The majority (91.3 %) of the young individuals at NHU had a basal diameter less than 10 cm, whereas in both CDR and BAU, over 60 % of individuals exhibited basal diameters over 10 cm. Within NHU, approximately 78 % of young manduvis recorded were less than 3 m in height, whereas at CDR and BAU, 66 % and 75 % of the individuals, respectively, were taller than 3 m (figure 2).

The results suggest that outside NHU there is an establishment gap for manduvi recruits (figure 2). Within NHU the height distribution of those individuals recorded suggests a higher survivorship of seedlings than in CDR and BAU, where individuals from one to five m in height are relatively rare. It is likely that within NHU, after five years of protection, seedling establishment has improved due to a lack of cattle trampling, grazing, and burning. Improvement of microhabitat conditions could also be promoting higher seedling survivorship. These results contain two sources of bias: first, the PCQ method does not produce an accurate sample of population structure because it is limited to the measurements of one individual per quadrant (nearest to the center point); secondly, by limiting our search for young manduvis at 80 m from the centerpoint, the estimated densities are higher than actual. However, because the method used in this study was equally applied among the study areas, the results are comparable. A more detailed survey using random plots would be necessary to assess the actual density and population structure of manduvis under different management conditions.

The most common cause for the decline or extinction of American birds is habitat change (Caughley and Gunn 1996). Hyacinth Macaw populations have historically been affected by an illegal pet trade, but habitat loss has also greatly contributed to this species' decline (Thomsen and Brautigam 1991). Cattle have been present in the Pantanal for more than two centuries, and the cumulative long-term effects of grazing and burning could be disrupting the habitat dynamics of the floodplain. Prance and Schaller (1982) reported that little vegetation remains intact in the Pantanal because of the effects of cattle, fire, man or a combination of all three.

Young manduvis are foraged by cattle (Janzen 1972, Pott and Pott 1994) which may cause high seedling mortality (Janzen 1972). In the Pantanal, cattle have a considerable effect on the forest understory vegetation, particularly through selective grazing and trampling (Prance and Schaller 1982). High frequency fire may prevent trees in forested habitats from surviving to a size capable of providing usable cavities for birds (*e.g.*, Newton 1997). Pott and Pott (1994) suggest that fire may promote cavity formation in adult manduvis. However, the results of Guedes (1993) indicate that fire causes a high rate of nesting tree loss. Scarcity of nest cavities is known to limit the breeding density of parrot species in some areas (*e.g.*, Beissinger and Bucher 1992, Munn 1992). For example, competition for scarce nest sites has been reported as an important factor in the late stages of the decline of the Costa Rican Parrot (*Amazona vittata*).

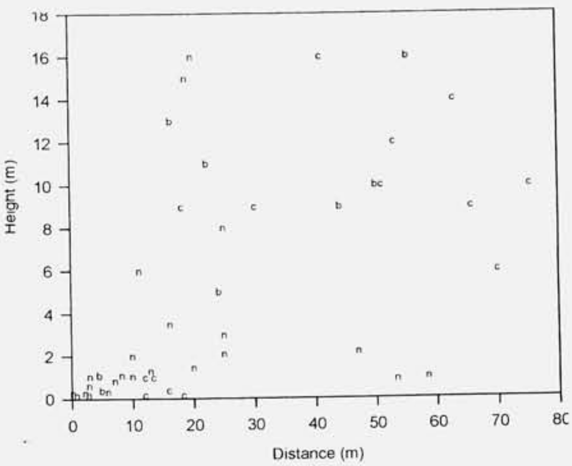

Figure 1. Relationship between height and distance from the centerpoint for young manduvis at NHU (n), CDR (c), and BAU (b).

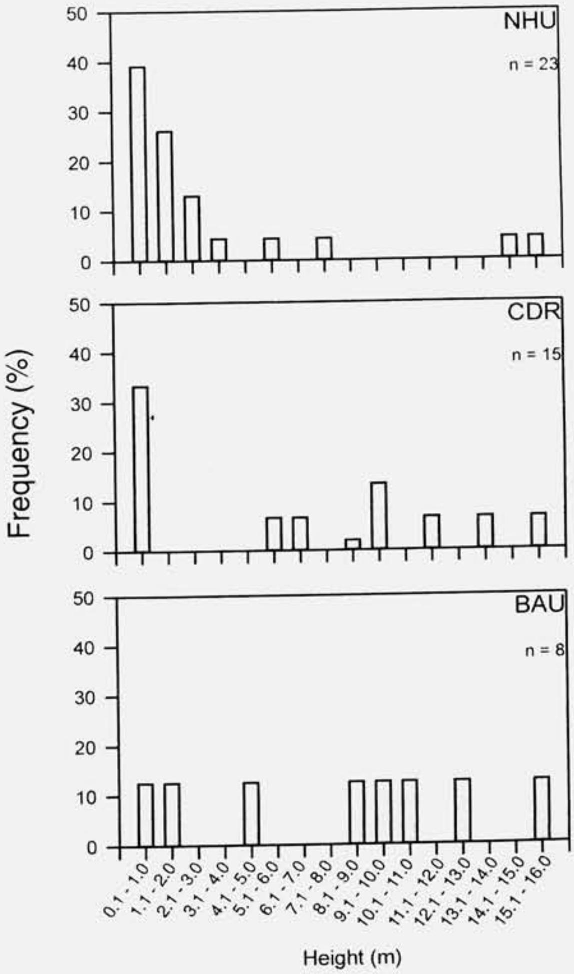

Figure 2. Relative frequencies of young manduvis sampled at NHU, CDR, and BAU by height class.

which in 1975 numbered only 13 individuals (Wiley 1985, Snyder *et al.* 1987).

Species that are not primary excavators are more often short of sites for nesting (Newton 1994). The Hyacinth macaw is included in this group of species, as breeding pairs only improve pre-existing suitable cavities (Munn *et al.* 1987, Guedes 1993, 1995, Guedes and Harper 1995). Because the Hyacinth Macaw's nesting sites are located mostly in old manduvis or those already in senescence, disruptions in the population dynamics of this tree, associated with increased loss of nesting trees, could result in a steady decline of this macaw's recruitment throughout the Pantanal. We strongly suggest that conservation efforts for Hyacinth macaw should also focus on manduvi population dynamics, including the effects of grazing, trampling, and burning, as well as seed dispersion.

ACKNOWLEDGMENTS

We thank the owners of the Campo Dora, Cáceres, and Baú ranches as well as CPAP-EMBRAPA for their logistic support to the project and research opportunity. The UNIDERF, WWF-Brazil Pousada Arara Azul, California Community Foundation, CECITEC, Toyota of Brazil, and Hyacinthine Macaw Survival Trust have all been important to Project Arara Azul. We thank M. N. Xavier for his help in the field. We also thank the two anonymous referees whom reviewed this manuscript for publication.

REFERENCES

Abramson, J. and J. B. Thomsen (1995) Identification and Profiles, p. 1-37 *In:* Abramson, J., B. L. Speen and J. B. Thomsen (eds.) *The Large Macaws: their care, breeding and conservation.* Fort Bragg: Raintree Publications.

Beissinger, S. R. and E. H. Bucher (1992) Sustainable harvesting of parrots for conservation, p. 73-115 *In:* Beissinger, S. R. and N. F. R. Snider (eds.) *New World Parrot Crisis.* Washington, D.C.: Smithsonian Inst. Press.

Bernardes, A. T., A. B. M. Machado and A. B. Rylands (1990*) Fauna Brasileria Ameaçada de Extinção.* Belo Horizonte: Fundação Biodiversitas para a Conservação da Diversidade Biológica.

Bonham, C. D. (1989) *Measurements of Terrestrial Vegetation.* New York: John Wiley and Sons.

Caughley, G. and A. Gunn (1996) *Conservation Biology in Theory and Practice.* Oxford: Blackwell Science, Inc.

Collar, N. J., L. P. Gonzaga, N. Krabbe, A. Madro°o Nieto, L. G. Naranjo, T. A. Parker III and D. C. Wege (1992) Anodorhynchus. p. 241-265 *In: Threatened Birds of the Americas.* Cambridge: The ICBP/IUCN Red Data Book. 3rd ed.

Guedes, N. M. R. (1993) *Biologia reprodutiva da arara azul (Anodorhynchus hyacinthinus) no Pantanal - MS, Brasil.* Master Thesis. São Paulo:Univ. São Paulo.

___ (1995) Alguns aspectos sobre o comportamento reprodutivo da arara- azul (*Anodorhynchus hyacinthinus*) e a necessidade de manejo para a conservação da espécie. p. 274-292. *In*: *Anais de Etologia* 13, Pirassununga:

___ (1996) Biologia e conservação da arara azul *Anodorhynchus hyacinthinus* no Pantanal. p. 97-99. *In*: J. M. E. Vielliard, M. L. da Silva e W. R. Silva (eds.) *Anais V Cong. Bras. Orn.*, Campinas: UNICAMP.

___ and L. H. Harper (1995) Hyacinth macaw in the Pantanal. p 394-421 *In:* J. Abramson, B. L. Speen and J. B. Thomsen (eds.). *The Large Macaws: Their care, breeding and conservation.* Fort Bragg: Raintree Publications.

Janzen, D. H. (1972) Escape in space by *Sterculia apetala* seeds from the bug *Dysdercus fasciatus* in a Costa Rican deciduous forest. *Ecology* 53:350-361.

López, N. E. (1992) Observaciones sobre la distribucion de psitacidos en El Departamento de Concepcion, Paraguay. *Bol. Mus. Nac. Hist. Nat. Paraguay* 11:2-25.

Munn, C. A. (1985) Macaw biology and ecotourism, or "when a bird in the bush is worth two in the hand", p. 47-72 *In:* S. R. Beissinger and N. F. R. Snider (eds.) *New World Parrot Crisis.* Washington, D.C: Smithsonian Inst. Press.

___, J. B. Thomsen and C. Yamashita (1987) *The distribution and status of the* Hyacinth macaw *(Anodorhynchus hyacinthinus) in Brazil, Bolivia and Paraguay.* Report to the CITES. Washington, D.C. and New York: World Wildl. Fund and Wildl. Conserv. Intern..

Newton, I. (1994) The role of nest sites in limiting the number of hole-nesting birds: a review. *Biol. Conserv.* 70:265-276.

Prance, G. T. and G. B. Schaller (1982) Preliminary study of some vegetation types of the Pantanal, Mato Grosso, Brazil. *Brittonia* 34:228-251.

Ratter, J. A., A. Pott, V.J. Pott, C. N. Cunha, and M. Haridasan (1988) Observations on woody vegetation types in the pantanal and at Corumbá, Brazil. *Notes Royal Bot. Garden Edinburgh* 45:503-525.

Snyder, W. F. R., J. W. Willey and C. B. Kepler (1987) *The Parrots of Luquillo: Natural History and Conservation of the Puerto Rican Parrot.* Los Angeles: Western Found. Vert. Zool.

Thomsen, J. B. and A. Brautigam (1991) Sustainable use of Neotropical parrots, p. 359-379 *In:* J. G. Robinson and K. H. Redford (eds.) *Neotropical Wildlife Use and Conservation.* Chicago: Univ.Chicago Press.

Wilcoxon, F. (1945) Individual comparisons by ranking methods. *Biometrics Bull.* 1:80-83.

Willey, J. W. (1985) The Puerto Rican parrot and competiton for its nest sites, p. 213-223 *In:* O. J. Moors (ed.) *Conservation of Island Birds.* ICBP Technical Publication 3. Cambridge: Intern. Council Bird Preserv.

Ararajuba 5(2):189-194
dezembro de 1997

Guilda de aves em *Bowdichia virgilioides* (Fabaceae: Faboideae) em área de cerrado de Furnas, Minas Gerais

Rosario Rojas e Rômulo Ribon

Pós-Graduação em Ecologia, Conservação e Manejo de Vida Silvestre, ICB, UFMG,Av. Antonio Carlos, 6627, 30161-970, Belo Horizonte, MG. E-mail: rosario@oraculo.lcc.ufmg.br

Recebido em 22 de julho de 1996; aceito em 14 de maio de 1997

ABSTRACT. **Bird guild in *Bowdichia virgilioides* (Fabaceae: Faboideae) in a cerrado area, in Furnas, Minas Gerais.** The bird species using the flowers of *Bowdichia virgilioides* as a food resource were determined. Nine species of birds were observed visiting 11 trees after 88 hours of observation. Birds looked for nectar and pieces of petals during their visits. The non-hummingbirds used the flowers occasionally and in a opportunistic way. Among the six hummingbird species, *Colibri serrirostris* was the most important both in frequency of visits and time spent on the flowers. Different activity peaks and also space-temporal hierarchy of dominance were observed among the hummingbird species among them. *Bowdichia virgilioides* appear to be an important tree for many bird species, especially for hummingbirds in cerrado.

KEY WORDS: *Bowdichia virgilioides*, cerrado, food resource, hummingbirds.

RESUMO. Este estudo visou determinar as espécies de aves que utilizaram as flores de *Bowdichia virgilioides* como recurso alimentar. Num total de 88 horas de observação, em 11 árvores, verificou-se que nove espécies utilizaram suas flores para obtenção de néctar ou para alimentar-se das pétalas. Os não-troquilídeos utilizaram suas flores de forma ocasional e oportunista. Entre as seis espécies de beija-flores, *Colibri serrirostris* foi a mais importante tanto em freqüência de visitas quanto em tempo gasto visitando as flores. Picos de atividade em horários diferentes foram observados entre as espécies de beija-flores bem como uma hierarquia espaço-temporal de dominância entre as mesmas. *Bowdichia virgilioides* mostrou-se importante para várias espécies de aves, especialmente para os beija-flores no cerrado.

PALAVRAS-CHAVE: beija-flores, *Bowdichia virgilioides*, cerrado, recurso alimentar.

Várias espécies de aves representam para as plantas uma forma eficiente de transferir pólen da antera para o estigma, sendo o néctar o meio pelo qual as plantas induzem as aves a executar esta tarefa (Stiles 1978). Embora a produção de néctar acarrete um alto custo energético para as plantas, o maior tamanho das aves e sua capacidade de termorregulação compensam este alto custo, por proporcionarem maior mobilidade (aumentando a distância e proporção de intercruzamentos) e menor dependência da temperatura ambiente que os polinizadores ectotérmicos. Isto aumentaria as possibilidades de sucesso na polinização (Brown *et al.* 1978).

O néctar serve de alimento para muitas espécies de aves. Entretanto, a maioria delas e as mais especializadas concentram-se ao redor do Mundo em quatro famílias (Trochilidae, Nectariniidae, Meliphagidae e Drepanididae), com os beija-flores (Trochilidae) ocorrendo somente no Continente Americano (Brown *et al.* 1978). O néctar representa a principal porção de sua dieta na fase adulta, podendo-se considerar os beija-flores de zonas tropicais abertas como o melhor exemplo de uma guilda animal limitada por alimento, onde a disponibilidade de néctar pode ser um fator severa e consistentemente limitante (Carpenter 1978). Apesar disto os artrópodes representam uma parte importante da dieta destas aves (Wolf 1970, Feinsinger e Colwell 1978, Stiles 1995), podendo elas alimentar-se também de cinzas (des Lauriers 1994, R. Ribon *obs. pess.* em *Eupetomena macroura* e *Phaethornis pretrei*).

Para obter energia suficiente as aves nectarívoras devem forragear durante todo o dia. De um modo geral os picos de forrageamento de néctar ocorrem no período da manhã e no final da tarde (Stiles 1978), havendo influência da quantidade de néctar disponível nas flores (Piratelli 1993, Stiles 1995). Quando este recurso é suficientemente abundante e rico para ser defendido, uma série de comportamentos agressivos por parte das aves podem estar a ele associados. Por outro lado, algumas plantas secretam néctar em quantidade insuficiente, forçando as espécies a migrarem em busca de alimento (Carpenter 1978).

Bowdichia virgilioides é uma leguminosa conhecida como sucupira-do-cerrado, com altura entre 8 e 16 m, 30 a 50 cm de diâmetro e folhas compostas pinadas. No Brasil ocorre na Bahia (Lewis 1987), Pará, Goiás, Mato Grosso, Minas Gerais, Mato Grosso do Sul e São Paulo, em áreas de cerrado e em sua transição para a floresta semidecídua

(Lorenzi 1992). Embora sua distribuição seja ampla e uniforme, a espécie ocorre em baixa densidade populacional. Floresce durante os meses de agosto-setembro com a planta quase totalmente despida de folhagem. Ilustrações e informações adicionais sobre a morfologia da flor e da espécie como um todo, podem ser encontradas em Lewis (1987) e Lorenzi (1992).

Este estudo teve como objetivo determinar quais espécies de aves utilizam as flores de *Bowdichia virgilioides* como recurso alimentar, com ênfase nos beija-flores. Procuramos verificar a existência de espécies dominantes com relação ao tempo de utilização das flores, número e freqüência de visitas, comportamento agressivo e ocorrência de diferentes picos de atividade entre as espécies. Além disso tentou-se verificar a relação entre algumas destas variáveis e o número de flores.

ÁREA DE ESTUDO E MÉTODOS

Este estudo foi realizado em Furnas (20°40'S, 46°19'W), município de Alpinópolis, Minas Gerais, em uma mancha de cerrado "sensu stricto" de aproximadamente 20 ha, alterado por fogo e ação humana. As observações foram feitas em 11 árvores de *Bowdichia virgilioides*, dez delas situadas na mancha de cerrado, e uma outra num gramado próximo a esta mancha, ao lado de uma estrada com pouco tráfego. Na área de estudo, *B. virgilioides* apresentou-se com até 8 m de altura, sendo que as copas das árvores estavam quase totalmente tomadas por inflorescências. De uma árvore para outra parecia haver uma pequena assincronia entre o número de flores abertas e botões. Embora Lorenzi (1992) cite agosto e setembro como os meses de floração, em nossa área de estudo as árvores estavam floridas já em julho.

Foram feitas observações contínuas das 6:00 às 11:00 e das 14:00 às 17:00, num total de 88 horas de observação de 17 a 22 de julho de 1995. Dois observadores trabalharam de modo a dispensar um dia de observação para cada árvore. As espécies de aves foram observadas com binóculos 7 x 35 e 8 x 40 mm de aumento, e identificadas através de suas vocalizações ou por meio de ilustrações em guias de campo (Frisch 1981, Sick 1985, Hilty and Brown 1986).

Cronometrou-se e registrou-se o tempo e o número de visitas de cada espécie, anotando-se também o comportamento das aves. Uma visita foi definida como o período no qual cada ave permanecia visitando as flores sem pousar para descansar, independente do número de flores visitadas. As freqüências de visitas foram obtidas dividindo-se o número de visitas de cada espécie pelo total de horas de observação. Quando as aves estavam com o bico inserido na flor, por sua abertura principal ou pelas laterais, assumimos que as mesmas estavam a procura de néctar. A captura de insetos foi vista por meio de binóculos (diretamente ou através da observação de comportamentos de forrageio como os descritos por Stiles (1995).

O número de encontros agonísticos associado ao número e tempo total de visitas foi tomado como indicativo de defesa territorial. A relação entre número de inflorescências e número de espécies e entrenúmero de inflorescências e número de visitas verificou-se através de regressão linear simples.

RESULTADOS

Bowdichia virgilioides foi visitada por seis espécies de beija-flores à procura de néctar e provavelmente também de insetos: beija-flor-de-canto, *Colibri serrirostris*, besourinho-do-bico-vermelho, *Chlorostilbon aureoventris*, beija-flor-rabo-de-tesoura, *Eupetomena macroura*, gravatinha-vermelha, *Calliphlox amethystina*, beija-flor-do-peito-roxo, *Amazilia lactea* e uma espécie de *Amazilia* não identificada, provavelmente beija-flor-de-garganta-verde *A. fimbriata*.

Duas espécies de Coerebidae, o saí-azul, *Dacnis cayana* e a cambacica, *Coereba flaveola* procuraram o néctar das flores. *Dacnis cayana* retirava o néctar tanto pela abertura natural da corola como por aberturas laterais. *Coereba flaveola* visitou poucas vezes e por tempo muito curto as flores de *B. virgilioides*. A jandaia-estrela, *Aratinga aurea* (Psittacidae), a saíra-amarela, *Tangara cayana* (Thraupidae) e *D. cayana* foram observadas comendo pétalas ou botões das flores. *Dacnis cayana* alimentou-se ocasionalmente também da "espuma" que cigarrinhas (Homoptera) excretavam em alguns galhos ou de insetos que poderiam se encontrar nela. A saíra-mascarada, *Nemosia pileata* (Thraupidae) e o bem-te-vi-do-bico-grosso, *Megarhynchus pitangua*, foram vistos alimentando-se de insetos. O sanhaço, *Thraupis sayaca* (Thraupidae) alimentou-se de néctar, insetos e pétalas, sendo observada só uma vez numa árvore onde permaneceu por 30 min contínuos.

A espécie predominante nas árvores estudadas foi *C. serrirostris*, sendo *C. aureoventris* a segunda espécie em importância. As espécies *T. cayana*, *D. cayana*, *A. aurea* e os demais passeriformes permaneceram por menos tempo nas flores, tendo o menor número de visitas (tabela 1).

Nas diferentes horas do dia houve presença de pelo menos três espécies de beija-flores em busca de alimento, em diferentes intensidades. *Colibri serrirostris* e *A. lactea* tiveram picos de atividade pela manhã, mas a atividade de *C. serrirostris* foi muito maior que a de *A. lactea* (tabela 1, figura 2). As demais espécies mostraram picos de atividade durante a tarde.

As freqüências de visitas mostraram grande variação de uma espécie para outra (tabela 1). Não se encontrou relação significativa entre número de inflorescências e o número de espécies ($a = 2{,}463$, $b = 4{,}06 \times 10^{-5}$, $r = 0{,}037$) nem entre o número de inflorescências e o número de visitas ($a = 81{,}85$, $b = -3{,}11 \times 10^{-3}$; $r = 0{,}39$).

Embora a maioria das espécies não apresente dimorfismo sexual acentuado, pode-se observar numa espécie em que isto ocorre (*C. aureoventris*) que uma fêmea não permitia a aproximação de outros indivíduos da espécie, perseguindo mesmo *C. serrirostris*, de tamanho

Tabela 1. Visitas de espécies de beija-flores e de outras espécies de aves em árvores de *Bowdichia virgilioides*. AV = número de árvores visitadas; NV = número de visitas, TV = tempo de visita; % TV = porcentagem do tempo total de visitas; TM = tempo médio de visitas; FV = frequência de visitas.

Espécies de beija-flores	A V	N V	T V (seg)	% T V	T M	F V
Colibri serrirostris (Cs)	11	544	21469	63	39,5	8,11
Chlorostilbon aureoventris (Ca)	7	132	4990	14,7	37,8	1,97
Amazilia lactea (Al)	2	70	2415	7,1	34,5	1,04
Calliphlox amethystina (Cm)	4	52	1460	4,3	28,1	0,77
Eupetomena macroura (Em)	4	52	1410	4,1	27,1	0,77
Amazilia sp. (As)	4	4	76	0,22	19,0	0,06
Outras espécies						
Dacnis cayana (Dc)	2	5	890	2,6	178,0	0,07
Tangara cayana (Tc)	1	8	1259	3,7	157,4	0,12
Aratinga aurea (Aa)	1	2	76	0,22	38,0	0,03

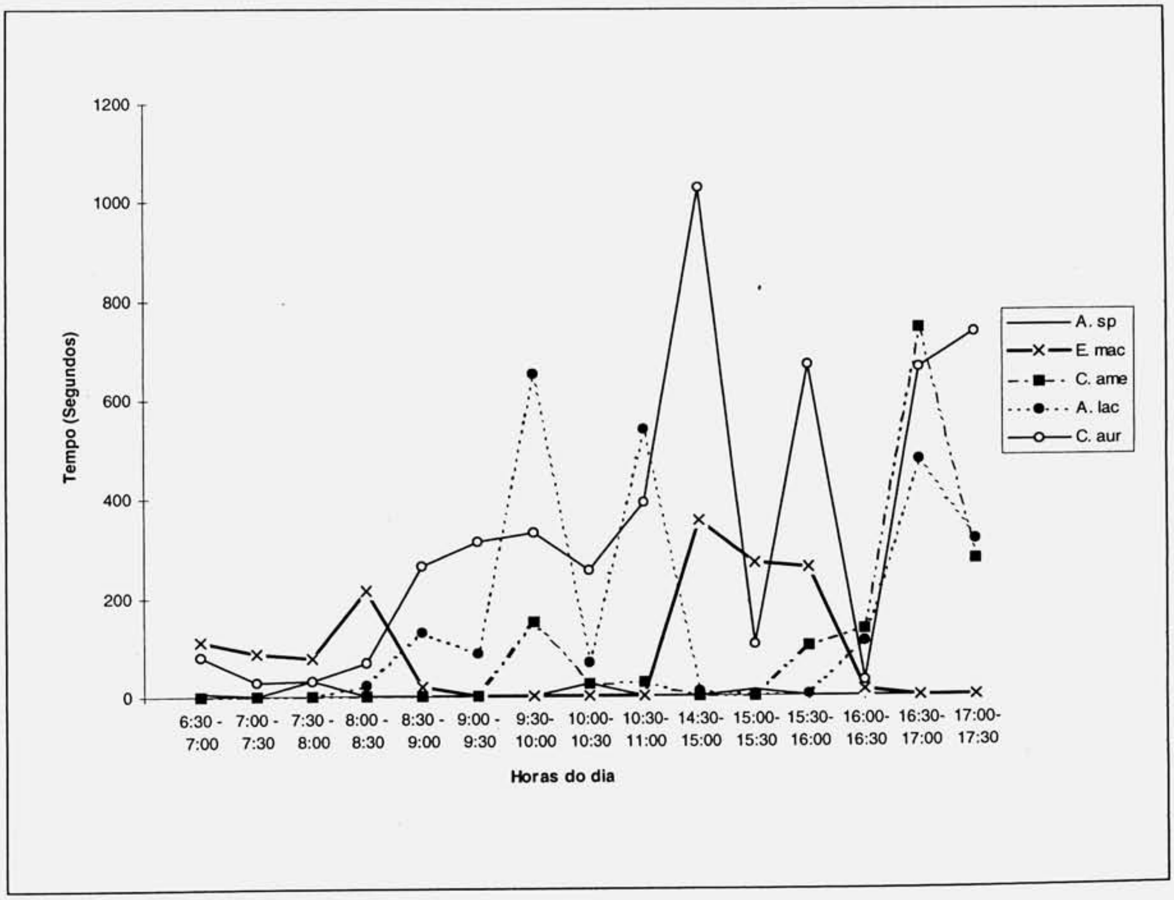

Figura 1. Variação da atividade das espécies de beija-flores em relação às horas do dia.

Tabela 2. Dado dos 11 indivíduos de *Bowdichia virgilioides*. NI = número de inflorescências; NE = número de espécies visitantes; NV = número de visitas; TV = tempo de visitas.

Árvore	N I	N E	N V	T V (seg)
1	4033	2	17	1552
2	1430	5	163	6525
3	1232	3	38	940
4	65	2	9	194
5	72	2	40	966
6	58	3	23	511
7	760	6	18	1626
8	980	4	159	7431
9	980	3	100	5208
10	24	1	8	202
11	459	5	294	9289

Tabela 3. Encontros agressivos entre beija-flores em *B. virgilioides*. *C.*s. = *Colibri serrirostris*; *A.l.* = *Amazilia lactea*; *A.*s. = *Amazilia sp.*; *C.a.* = *Chlorostilbon aureoventris*; *E.m.* = *Eupetomena macroura*; *C.m.* = *Calliphlox amethystina*.

Agressor	Agredido					
	*C.*s.	*A.l.*	*A.*s.	*C.a.*	*E.m.*	*C.m.*
*C.*s.	26	20	-	7	12	4
A.l.	-	2	-	2	-	4
*A.*s.	-	-	-	-	-	-
C.au.	2	-	-	-	-	-
E.m.	11	6	-	-	1	2
C.m.	-	-	-	-	-	-

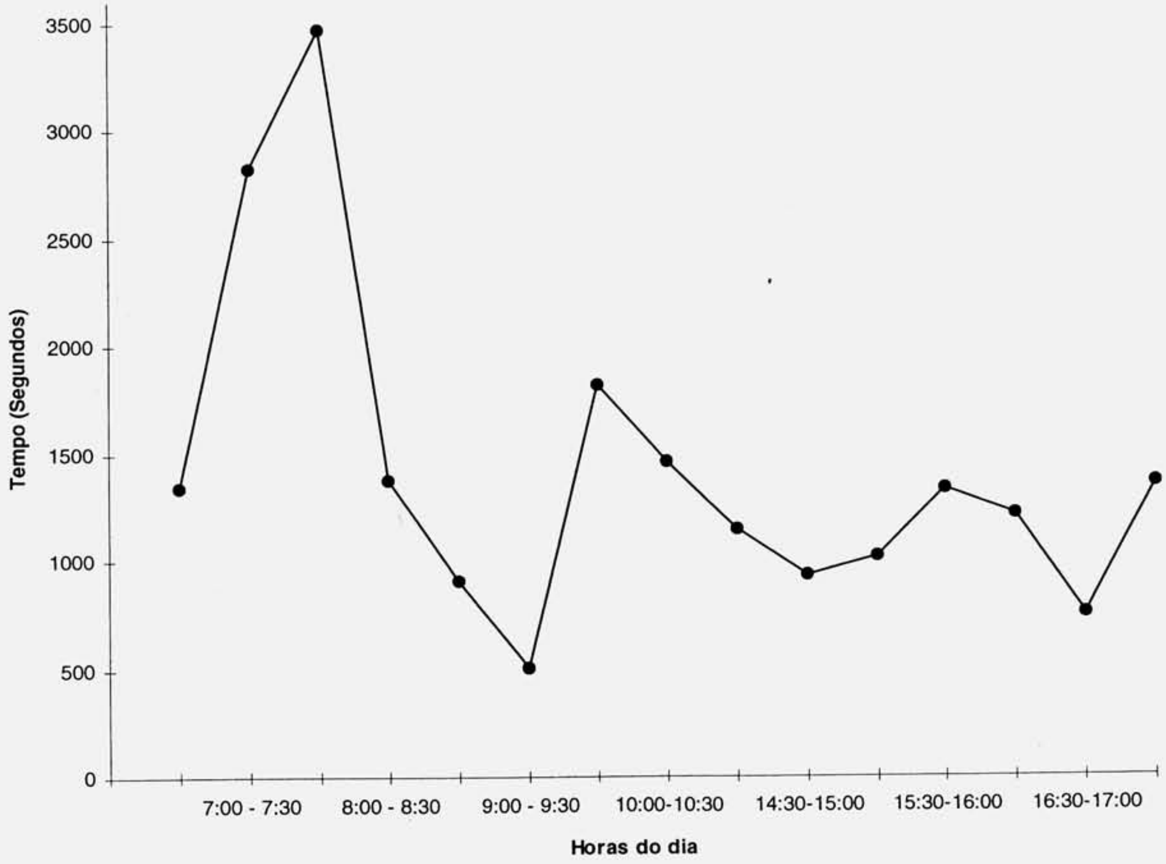

Figura 2. Variação do tempo de visita de *Colibri serrirostris* ao longo do dia.

maior.

Um indivíduo de *E. macroura* em uma das árvores apresentou-se extremamente agressivo contra todos os beija-flores e mesmo abelhas mangangavas (*Bombus* sp.) (Hymenoptera) eram atacadas quando se aproximavam. A área defendida por este indivíduo compreendeu cerca de 1/5 do total da porção florida da copa. Entretanto este mesmo indivíduo tolerou a presença de *C. serrirostris* e *C. aureoventris* na mesma árvore.

C. amethystina, alimentava-se sempre de forma furtiva, aproximando-se pelo alto da copa ou por um lado não freqüentado por outra espécie, e também não agredindo nenhuma outra espécie. *Amazilia lactea* foi fortemente perseguido por *C. serrirostris*, apresentando porém somente dois encontros agressivos intra-específicos.

Colibri serrirostris foi a espécie que apresentou o maior número de encontros agressivos (tabela 3). Vinte e seis foram intra-específicos, 23 com *E. macroura*, 20 com *A. lactea*, nove com *C. aureoventris* e quatro com *C. amethystina*. Na maioria dos encontros *C. serrirostris* foi o agressor, sendo porém agredida por *E. macroura* 11 vezes e duas vezes por *C. aureoventris*. Entretanto, se em certas instâncias *C. serrirostris* atacava coespecíficos ou indivíduos de outras espécies, em outras ocasiões isto não ocorreu. A espécie *Amazilia* sp. não foi observada em nenhum encontro agressivo.

DISCUSSÃO

As guildas de beija-flores tropicais estão organizadas de acordo com os recursos disponíveis e os atributos morfo-fisiológicos e de comportamento de cada espécie (Feinsinger e Colwell 1978). Além das seis espécies de beija-flores citadas anteriormente, na região de Furnas foram identificadas outras cinco espécies de beija-flores, as quais não foram observadas em *Bowdichia virgillioides*: Beija-flor-limpa-casa, *Phaethornis pretrei*, beija-flor-preto-e-branco, *Melanotrochilus fuscus*, beija-flor-de-veste-preta, *Anthrachothorax nigricollis*, beija-flor-de-barriga-violeta, *Thalurania furcata* e beija-flor-de-banda-branca, *Amazilia versicolor*. Essas espécies foram observadas principalmente na mata de galeria, ao invés do cerrado, o que em parte explica sua ausência na árvore durante a realização deste trabalho.

O habitat, estrato da vegetação, a dispersão, a morfologia da corola e a quantidade de néctar produzido pelas flores são os principais atributos das plantas que as tornam atrativas para as aves nectarívoras. Para as aves, são importantes a morfologia do bico, o tamanho do corpo, a relação entre o comprimento da asa e o peso do corpo e o tamanho dos pés. Diferentes inter-relações entre estes atributos levam a diferentes posições das espécies na comunidade. Assim, Feinsinger e Colwell (1978) discernem cinco "funções" que as espécies podem exercer na comunidade, as quais podem mudar conforme a disponibilidade de néctar e a competição com outros beija-flores.

"*Trapliners*" altamente recompensados: espécies que têm a morfologia do bico adaptada para explorar flores dispersas e com morfologia bem característica, como aquelas da família *Musaceae*, percorrendo um circuito (*trapline*) entre flores ou aglomerados de flores (e.g. *Phaethornis* spp.).

Territorialistas: espécies que apresentam defesa territorial intra- ou inter-específica, geralmente em flores muito ricas em néctar e moderada ou fortemente aglomeradas.

"*Trapliners*" pouco recompensados: espécies que utilizam flores dispersas ou moderadamente agrupadas e entomófilas, e que são expulsas de aglomerações de flores ricas em néctar por espécies territorialistas (*Chlorostilbon canivetii*, Feinsinger 1976).

Parasitas territoriais (*marauders*): espécies que utilizam flores moderadamente agrupadas, ignorando as agressões das espécies territorialistas (*Phaeochroa cuvierii*, *Anthracothorax prevostii*) (Stiles e Wolf 1970, Wolf 1970, respectivamente). Aqui também entram os "ladrões" (*filchers*), que lembram grandes insetos e alimentam-se geralmente em zonas das plantas pouco utilizadas ou invisíveis para as espécies territorialistas (*Calliphlox amethystina*, obs. pess.).

Generalistas: espécies que têm uma posição oportunista e fracamente definida na comunidade, ora visitando flores moderadamente dispersas, ora atuando como ladrões em aglomerações maiores.

Segundo essas diferentes "funções" dos beija-flores, a guilda de aves desta família em *B. virgilioides,* em Furnas, parece estar organizada da seguinte forma: *Colibri serrirostris* mostrou comportamento claramente territorialista, sendo dominante em termos de tempo e número de visitas. Embora *C. aureoventris* tenha sido observado agredindo *C. serrirostris*, os dados obtidos são insuficientes para classificá-lo como territorialista.

Embora *E. macroura* tenha defendido um pequeno território na árvore 9, foi a penúltima espécie em termos de tempo e número de visitas. Mesmo que *B. virgilioides* possa não oferecer recursos suficientes para justificar a presença constante desta espécie, o comportamento agressivo que ela mostrou pode indicar que a mesma seja co-dominante com *C. serrirostris* em termos de território defendido.

Amazilia lactea e *Amazilia* sp. também encaixam-se no grupo dos generalistas, uma vez que não defenderam territórios e foram vistas utilizando plantas com flores de características mais entomófilas, bem mais abaixo das copas de *B. virgilioides*. *Calliphlox amethystina* encaixa-se na categoria dos "ladrões" entre os parasitas territoriais.

Houve uma clara dominância hierárquica entre as espécies de beija-flores presentes em *B. virgilioides*, mas não com uma área defendida durante todo o dia. Possivelmente, como suposto por Wolf (1970), o suprimento alimentar não é suficientemente estável para que a defesa contínua de territórios ao longo de todo o dia seja vantajosa, como foi observado em *C. serrirostris*. Esta espécie defendeu território, ainda que não o fizesse durante o dia todo na mesma árvore. Embora tenha defendido territórios em algumas situações, *C. aureoventris* aproveitou-se desta situação, utilizando as flores enquando *C. serrirostris* saía em perseguição a outros beija-flores.

O fato da floração estar restrita a determinadas épocas do ano gera padrões temporais e espaciais de distribuição das flores, permitindo o estabelecimento de diferentes formas de utilização pelos beija-flores. Entre as aves observadas, talvez somente *C. serrirostris* e *C. aureoventris*, este tem inclusive bico menor que o primeiro, participem mais ativamente na polinização de *B. virgilioides*. Pela forma fechada, tamanho pequeno da corola e intensa presença de abelhas e mangangavas (obs. pes.), supõe-se que estes insetos participem de forma mais ativa na polinização desta espécie.

Segundo Piratelli (1993), os picos de atividade em horários diferentes possivelmente são uma estratégia que permite a utilização do recurso por um maior número de espécies e diminui o número de encontros agonísticos entre as mesmas. A fim de se fazer uma análise mais refinada sobre os motivos destes picos seria necessário medir a variação na quantidade de néctar e/ou o teor de açúcar no néctar ao longo do dia, pois tais fatores podem estar diretamente relacionados com os mesmos.

Os nectarívoros mais freqüentes foram os beija-flores, apesar de outras aves nectarívoras também estarem presentes. Embora estas aves utilizem muitas das plantas polinizadas por beija-flores em busca de néctar, elas tendem a visitar grupos de flores espacialmente diferentes daqueles mais explorados por Troquilídeos (Feinsinger e Colwell 1978). Talvez isto possa ocorrer com *D. cayana* e *T. sayaca*, podendo a baixa freqüência destas espécies estar relacionada a uma pequena dependência das flores de *B. virgilioides*.

Tangara cayana, *D. cayana*, *T. sayaca* e *A. aurea*, todos não-troquilídeos, alimentaram-se de flores ou botões de *B. virgilioides*. Estas espécies apresentaram um pequeno número de visitas e pouco tempo de forrageio, visitando a árvore de forma ocasional e oportunista, mantendo uma relação de predação das flores.

De um modo geral *B. virgilioides* parece ser uma espécie importante para a guilda de nectarívoros durante o mês de julho em áreas de cerrado da região de Furnas. Assim consideramos que a mesma deve ser levada em consideração em programas de manejo de vegetação de cerrado, mostrando-se também útil para plantios visando a atração de aves.

AGRADECIMENTOS

Agradecemos ao Curso de Pós-Graduação em Ecologia Conservação e Manejo de Vida Silvestre, da UFMG, Fundação Biodiversitas, CNPq, CAPES e Furnas Centrais Elétricas S. A, aos professores Fernando da Silveira e Júlio Lombardi (UFMG) pela revisão do manuscrito e aos dois revisores anônimos que fizeram valiosas sugestões.

REFERÊNCIAS

Brown, J. H., W. A. Calder III e A Kodric-Brown (1978) Correlates and consequences of body size in nectar-feeding birds. *Amer. Zool.* 18:687-700.

Carpenter, F. L. (1978) A spectrum of nectar-eater communities. *Amer. Zool.* 18:809-819.

Des Lauriers, J. R. (1994) Hummingbirds eating ashes. *Auk* 111:755-756.

Feinsinger, P. (1976) Organization of a tropical guild of nectarivorus birds. *Ecol. Monogr.* 46:257-291.

___ e Colwell, R. K. (1978) Community organization among neotropical nectar-feeding birds. *Amer. Zool.* 18:779-795.

Frisch, J. D. (1981) *Aves Brasileiras*. Verona: Mondadori.

Hilty, S. L. e W. L. Brown (1986) *A guide to the birds of Colombia*. Princeton: Princeton Univ. Press.

Lewis, G. P. (1987) *Legumes of Bahia*. Kent: Royal Botanic Gardens Whistable.

Lorenzi, H. (1992) *Árvores Brasileiras*. São Paulo: Editora Plantarum.

Piratelli, A. J. (1993) Comportamento alimentar de beija-flores em flores de *Inga* sp. (Leguminosae, Mimosoidade) e *Jacaratia virgilioidesinosa* (Caricaceae) em um fragmento florestal do sudeste brasileiro. *IPEF, Piracicaba* 46:43-51.

Sick, H. (1985) *Ornitologia brasileira; uma introdução*. v. I e II. Brasilia: Ed. Univ. Brasilia.

Stiles, F. G. (1978) Ecological implications of bird pollination. *Am. Zool.* 18: 715-727.

___ (1995) Behavioral, ecological and morphological correlates of foraging for arthropods by the hummingbirds of a tropical wet forest. *Condor* 97:853-878.

___ e L. L. Wolf (1970) Hummingbird territoriality at a tropical flowering tree. *Auk* 87:467-491.

Wolf, L. L. (1970). The impact of seasonal flowering on the biology of some tropical hummingbirds. *Condor* 72:1-14.

Ararajuba 5(2):195-202
dezembro de 1997

Exclusão geográfica e ecológica de *Penelope obscura*, *Penelope superciliaris* e *Pipile jacutinga* (Galliformes, Cracidae) no estado de São Paulo

Juan Carlos Guix

Departament de Biologia Animal (Vertebrats), Facultat de Biologia, Universitat de Barcelona, Av. Diagonal 645, 08028 Barcelona, Espanha

Recebido em 27 de novembro de 1996; aceito em 28 de agosto de 1997

ABSTRACT. **Geographical and ecological exclusion of *Penelope obscura*, *Penelope superciliaris* and *Pipile jacutinga* (Galliformes: Cracidae) in the state of São Paulo.** Between February 1987 and September 1994, periodic and sporadic surveys were conducted in 18 areas covered by native forests in the state of São Paulo and one area of the state of Rio de Janeiro, in order to detect Cracid species. Data on habitat use by *Penelope obscura*, *Penelope superciliaris* and *Pipile jacutinga* were collected in eleven of these areas. The data on present occurrence of the species in the study areas were compared with museum capture data, with occurrence citations published in old naturalistic reports, and with occurrence citations published during the last two decades (1977 to 1994). Of the 19 areas studied, *P. obscura* was present in six, *P. superciliaris* in six, and *P. jacutinga* in three. It is concluded that *P. obscura* and *P. jacutinga* are syntopic in the Serra do Mar and Serra da Mantiqueira regions, and today they only occcur in areas covered by the moist forests of the coastal plain and coastal mountain hillsides (Atlantic rainforest). *Penelope superciliaris* occurs in the driest forests inland (deciduous and semi-deciduous Subtropical forests), transitional forests (in contact zones of Subtropical forests and Atlantic rainforest), savannas, and in coastal arboreal or scrubland «restingas». Although *Penelope obscura bronzina* also occurs in areas covered by *Araucaria* forests, it seems that the species habitat preference is the Atlantic rainforest. The association (or syntopy) *P. obscura* + *P. jacutinga* (**A**) and *P. superciliaris* (**B**) are ecologically exclusive in the east of the state of São Paulo.

KEY WORDS: Cracidae, distribution, *Penelope obscura*, *Penelope superciliaris*, *Pipile jacutinga*, sympatry, syntopy, southeastern Brazil.

RESUMO. Entre fevereiro de 1987 e setembro de 1994, foram feitas incursões periódicas e esporádicas em 18 áreas de florestas nativas do estado de São Paulo e em uma área do estado do Rio de Janeiro, com a finalidade de detectar a presença de espécies de cracídeos. Dados sobre utilização de hábitats por *Penelope obscura*, *Penelope superciliaris* e *Pipile jacutinga* foram coligidos em onze destas áreas. Os dados sobre ocorrência de espécies nas áreas de estudo foram comparados com os dados de coleta em coleções oficiais, com os registros de ocorrência em relatos antigos de naturalistas e viajantes e com os registros de ocorrência publicados nas últimas décadas (1977 a 1994). Das 19 áreas visitadas, detectou-se a presença de *P. obscura* em seis delas, de *P. superciliaris* em seis e de *P. jacutinga* em três. Conclui-se que *P. obscura* e *P. jacutinga* são sintópicas nas regiões da Serra do Mar e da Serra da Mantiqueira e que atualmente só ocorrem nas florestas mais úmidas das encostas montanhosas e da planície costeira (Floresta Pluvial Atlântica). *Penelope superciliaris* utiliza as florestas mais secas (Subtropical semi-decídua e decídua) do interior do estado, as florestas de transição (Florestas Subtropicais-Floresta Pluvial Atlântica), os Cerrados e as Restingas arbóreas e arbustivas do litoral. Apesar de também utilizar zonas cobertas por florestas de araucária, aparentemente *Penelope obscura bronzina* tem como hábitat preferencial a Floresta Pluvial Atlântica. A associação (ou sintopia) *P. obscura* + *P. jacutinga* (**A**) e *P. superciliaris* (**B**) excluem-se ecologicamente no leste do estado de São Paulo.

PALAVRAS-CHAVE: Cracidae, distribuição, *Penelope obscura*, *Penelope superciliaris*, *Pipile jacutinga*, simpatria, sintopia, sudeste do Brasil.

A distribuição geográfica de *Penelope obscura*, *Penelope superciliaris* e *Pipile jacutinga* no sudeste do Brasil tem sido um tema muito discutido, e ainda persistem importantes dúvidas sobre a exclusão ecológica e geográfica entre essas espécies (Sick 1970, 1985, 1993, Straube 1988).

Das três espécies aqui tratadas, *P. superciliaris* é a que apresenta distribuição mais ampla, ocorrendo desde o sul dos Rios Amazonas e Madeira, pelo centro e nordeste do Brasil até o Paraguai e extremo norte da Argentina. Pinto (1964) reconhece quatro subespécies (*P. s. superciliaris*, *P. s. jacupemba*, *P. s. major* e *P. s. ochromitra*), sendo *P. s. jacupemba* a subespécie que tem ocorrência no estado (Pinto 1938, 1964, Delacour e Amadon 1973).

Delacour e Amadon (1973), com base no critério utilizado por Pinto (1938, 1964), também reconhecem três subespécies para *P. obscura*: *P. o. bridgesi* da Bolívia central e extremo noroeste da Argentina; *P. o. obscura* do sul do Paraguai, nordeste da Argentina, extremo sul do Brasil e parte do Uruguai; e *P. o. bronzina* dos complexos serranos do sudeste do Brasil (Serra do Mar e Serra da Mantiqueira). *Pipile jacutinga* ocorre do sul do estado da Bahia ao Rio Grande do Sul (Brasil), sudeste do Paraguai e extremo nordeste da Argentina (Collar *et al.* 1992).

Sick (1985, 1993) sugeriu que as espécies da família Cracidae pertencentes a um mesmo gênero tendem a ter distribuições alopátricas, ao passo que espécies pertencentes a gêneros diferentes podem viver sintopicamente em uma mesma área. No entanto, ao referir-se às distribuições de *P. obscura* e *P. superciliaris* no litoral do estado de São Paulo, o autor considera a possibilidade de que ambas as espécies possam viver juntas em sintopia.

No presente estudo revisam-se as citações antigas de ocorrências de *P. obscura*, *P. superciliaris* e *P. jacutinga* em localidades do estado de São Paulo, assim como aportam-se dados recentes de distribuição e de requerimento de hábitats.

MÉTODOS

Entre fevereiro de 1987 e setembro de 1994, sete áreas do estado de São Paulo com vegetação nativa foram visitadas periodicamente a fim de se obter dados sobre a utilização de hábitats por espécies de cracídeos (Parque Estadual de Carlos Botelho, P. E. Intervales, P.E. da Ilha do Cardoso, P.E. das Fontes do Ipiranga, Serra do Japi, Mata do Pau Furado, Ouro Fino Paulista). Paralelamente foram feitas visitas esporádicas em 12 áreas adicionais com o fim de detectar a presença de cracídeos (Reserva Estadual de Morro Grande, Estação Experimental de Zootecnia de Sertãozinho, Área de Proteção Ambiental da Serra do Mar, Fazenda Santa Carlota, Faz. Capricórnio, Faz. São Vicente, Faz. Sta. Úrsula, Gleba de Sousas, Rio Paranapanema, Hidrelétrica Armando Laydner, Cássia dos Coqueiros e Parque Nacional do Itatiaia) (Apêndice).

Dadas as condições de altitude do Parque Nacional de Itatiaia, estado do Rio de Janeiro (onde a Floresta Pluvial Atlântica ocorre em cotas mais elevadas que na Serra do Mar; Hueck 1972a,b) e a proximidade com o limite do estado de São Paulo, esta área também foi incluída.

As observações de campo foram feitas percorrendo-se a pé trilhas, estradas de terra (em uso ou abandonadas), e leitos de rios e riachos em áreas de floresta. Também foram percorridos bordas de mata, capoeiras e cerrados. Considerou-se um «encontro» à observação de um ou mais indivíduos de cada espécie em um dado local.

Os estágios de sucessão das formações vegetais em que se detectaram cracídeos foram estabelecidos com base no tempo de regeneração (a partir da última interferência antrópica conhecida), na estrutura e na composição da vegetação (cf. Brown e Lugo 1990). Cada formação vegetal foi classificada em: *florestas maduras.* Geralmente florestas que passaram por um único episódio de desmatamento ou corte seletivo e que foram abandonadas há mais de 80-100 anos; *florestas secundárias tardias.* Idem ao anterior, porém com aproximadamente 50 a 80 anos de abandono; *florestas secundárias jovens.* Com 20 a 40 anos, desde o último desmatamento ou corte seletivo de árvores; *capoeiras de mata.* Áreas de floresta que foram desmatadas por primeira vez há 5-15 anos, ou que passaram por vários episódios de desmatamento (Guix 1995).

Os dados de ocorrência das espécies de *Penelope* e de *P. jacutinga* nas áreas de estudo foram comparados com os dados de coleta (somente localidades do estado de São Paulo) nas coleções do Museu de Zoologia da Universidade de São Paulo e do American Museum of Natural History (N. Y.), com registros de ocorrência das espécies em relatos antigos de naturalistas e viajantes, e com os registros de ocorrência publicados nas últimas décadas. Quando disponíveis, informações complementares relacionadas com as características do ambiente nos locais onde os animais foram encontrados (ex: tipo de formações vegetais, proximidade dos rios), também foram considerados. Em alguns casos estas informações foram checadas com o testemunho de antigos coletores do Museu de Zoologia (Werner C. A. Bokermann e Emílio Dente).

Todo o conjunto dos dados foi repartido em dois grupos, tendo como base o ano em que a espécie foi vista ou coletada: a- registros de ocorrência em localidades e regiões até o ano de 1969 (figura 1); b- registros de ocorrência em localidades, desde 1977 até o ano de 1994 (figura 2). Não foram encontradas informações sobre registros de ocorrência referentes ao período de 1970 a 1976.

A fim de situar as localidades de coleta mais antigas, foram consultados mapas do estado publicados no século XIX e início do século XX.

RESULTADOS

Distribuição espacial. Das 19 áreas visitadas detectaram-se cracídeos em 11: *P. obscura bronzina* em seis áreas, *P. superciliaris* em seis e *P. jacutinga* em três áreas (tabela 1).

Penelope superciliaris ocorreu no litoral (ex: Ilha do Cardoso) e no interior de São Paulo (Fazenda Santa Carlota, Região de Cajuru), enquanto que a maioria dos encontros com *P. obscura* e *P. jacutinga* estiveram restritos à Serra do Mar e regiões circunvizinhas; também à Serra da Mantiqueira (no caso de *P. obscura*) e à Ilha do Cardoso (no caso de *P. jacutinga*) (figura 2). *Penelope superciliaris* não foi avistada em nenhuma área situada na Serra do Mar.

Distribuição altitudinal. No litoral *P. superciliaris* ocorreu desde os 2 m (junto a linha da praia) até os 60 m de altitude (Morro do Pereirinha, Ilha do Cardoso). Na Serra do Japi da cota de 700 m até a cota de 1.100 m e no noroeste do estado, foi encontrada entre as altitudes de 500 e 944 m (Cássia dos Coqueiros e Fazenda Santa Carlota).

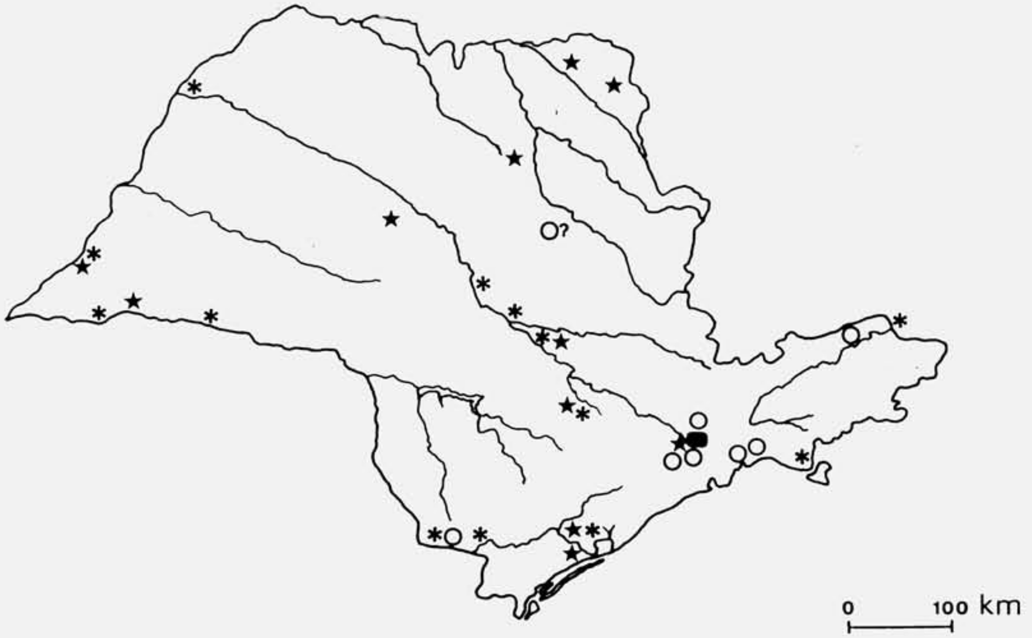

Figura 1. Registros de ocorrência de *Penelope obscura* (O), *Penelope superciliaris* (★) e *Pipile jacutinga* (∗) no estado de São Paulo, até o ano de 1969. Dados coligidos a partir das localidades de coleta e observações: American Museum of Natural History (NY), Museu de Zoologia da Universidade de São Paulo, Florence 1826-1827 (1977), Pinto (1938, 1945), Camargo (1946), Hempel (1949), E. Dente, com. pess. (1986), Collar *et al.* (1992); W.C.A. Bokermann, *in litt.* (1992, 1993).

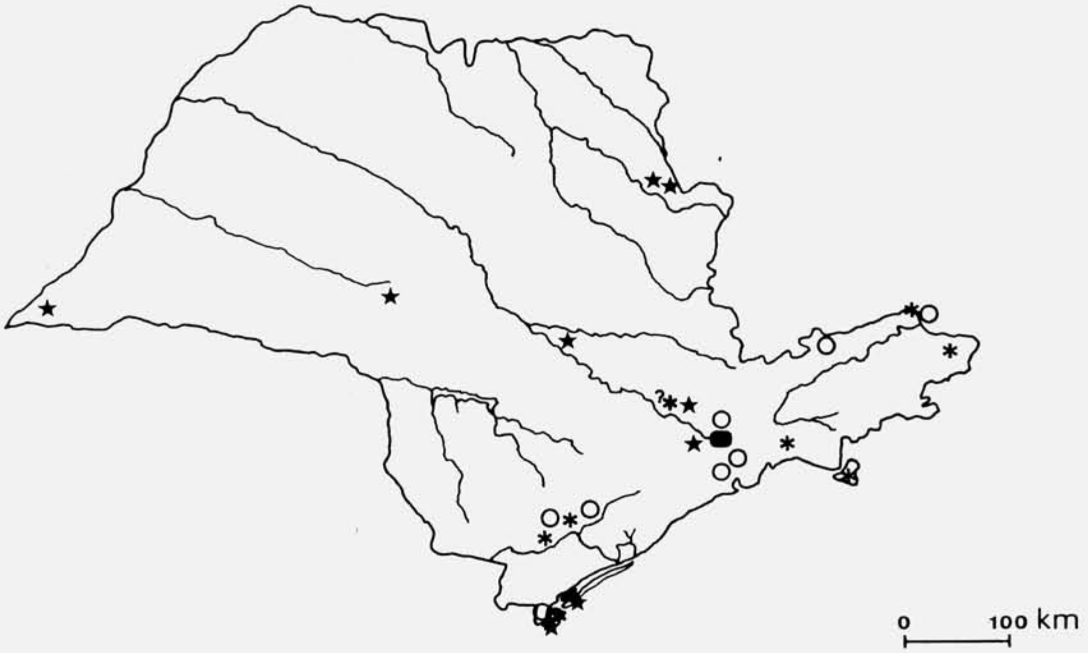

Figura 2. Registros de ocorrência de *Penelope obscura* (O), *Penelope superciliaris* (★) e *Pipile jacutinga* (∗) no estado de São Paulo, obtidos entre 1977 e 1994. Dados obtidos nas áreas de estudo e completados com observações de outros autores: Willis e Oniki (1981), Sick (1985), Graham (1986a,b), WPA (1988), Martuscelli (1990), Martuscelli com. pess. (1990), Collar *et al.* (1992), Bokermann *in litt.* (1992, 1993).

Tabela 1. Ocorrência de *Penelope obscura* (**PO**), *Penelope superciliaris* (**PS**) e *Pipile jacutinga* (**PJ**) em 11 áreas do estado de São Paulo e uma do estado do Rio de Janeiro, a partir de dados coletados no presente estudo, entre fevereiro de 1987 e setembro de 1994.

	Espécies		
Áreas	**PO**	**PS**	**PJ**
Parque Estadual de Carlos Botelho	x		x
P. E. Intervales	x		x
P. E. da Ilha do Cardoso		x	x
P. E. das Fontes do Ipiranga	*	*	
Parque Nacional do Itatiaia (RJ)	x		
APA da Serra do Mar	x		
Serra do Japi		x	
Mata do Pau Furado		x	
Fazenda Santa Carlota		x	
Ouro Fino Paulista	x		
Cássia dos Coqueiros		x	

* Exemplares possivelmente escapados do cativeiro.

Penelope obscura ocorreu entre os 30 m de altitude (Parque Estadual de Carlos Botelho) e a cota de 1.400 m (Parque Nacional de Itatiaia). *Pipile jacutinga* ocorreu desde os 40 m de altitude (Parque Estadual Intervales) até a cota de 900 m (tabela 2 e figura 3).

Formações vegetais utilizadas. A maioria dos encontros com *P. superciliaris* ocorreu em matas secundárias jovens e tardias (N = 38 encontros; ou 65,5 %), porém a espécie também foi encontrada em capoeiras de mata (N = 15; ou 25,9 %), em restinga arbustiva (N = 2; ou 3,4 %), em cerrado secundário (N = 2; ou 3,4 %) e em floresta madura (N = 1; ou 1,7 %); total 58 encontros (tabela 3). Na Fazenda Santa Carlota, Município de Cajuru, *P. superciliaris* foi avistada em floresta subtropical mesofítica semi-decídua, capoeiras de mata e em cerrado de tipo semi-aberto, porém não foi encontrado nas florestas ripárias úmidas que alí ainda existiam.

Penelope obscura foi observada em Floresta Pluvial Atlântica de planície costeira (N = 10 encontros; 20,4 %) e de encosta montanhosa (N = 39; 79,6 %). Esses encontros ocorreram em florestas maduras (N = 43; 87,8 %) e secundárias (N = 6; 12,2%).

Pipile jacutinga foi observada em Floresta Pluvial Atlântica de planície costeira (N = 11 encontros; 17,5 %) e de encosta montanhosa (N = 52; 82,5 %). Esses encontros ocorreram em florestas maduras (N = 51; 81 %) e secundárias tardias e jovens (N = 12; 19 %) (tabela 3).

DISCUSSÃO

Distribuição altitudinal. Os registros de altitude obtidos para as três espécies sugerem que, dentre as áreas estudadas, *P. obscura* é a que atualmente ocorre nas cotas mais altas (ex: até a cota de 1.400 m no P. N. de Itatiaia, Serra da Mantiqueira). Del Hoyo *et al.* (1994) citam como registro de altitude máxima para a espécie a cota de 2.200 m. No estado de São Paulo, também há registros recentes de *P. obscura* em altitudes superiores (ex: entre 1.500 e 1.700 m no P. E. de Campos do Jordão, Serra da Mantiqueira: Willis e Oniki 1981, Bokermann *in litt.* 1993).

Embora nas áreas de estudo *P. jacutinga* somente tenha sido avistada entre os 40 e 900 m de altitude, Gardner (1846, 1975) cita a espécie na Serra dos Órgãos, RJ (onde

Tabela 2. Distribuição altitudinal de *Penelope obscura* (**PO**) e *Pipile jacutinga* (**PJ**), desde a orla marítima até as Serras do Mar e da Mantiqueira, com o número de encontros por intervalo de altitude.

	Espécies	
Intervalo de altitude (m)	**PO**	**PJ**
1301 - 1400	1	
1201 - 1300	1	
1101 - 1200		
1001 - 1100		
901 - 1000	2	3
801 - 900	10	9
701 - 800	7	5
601 - 700	2	3
501 - 600	4	8
401 - 500	5	8
301 - 400	1	7
201 - 300	3	4
101 - 200	3	5
0 - 100	10	11
Total	49	63

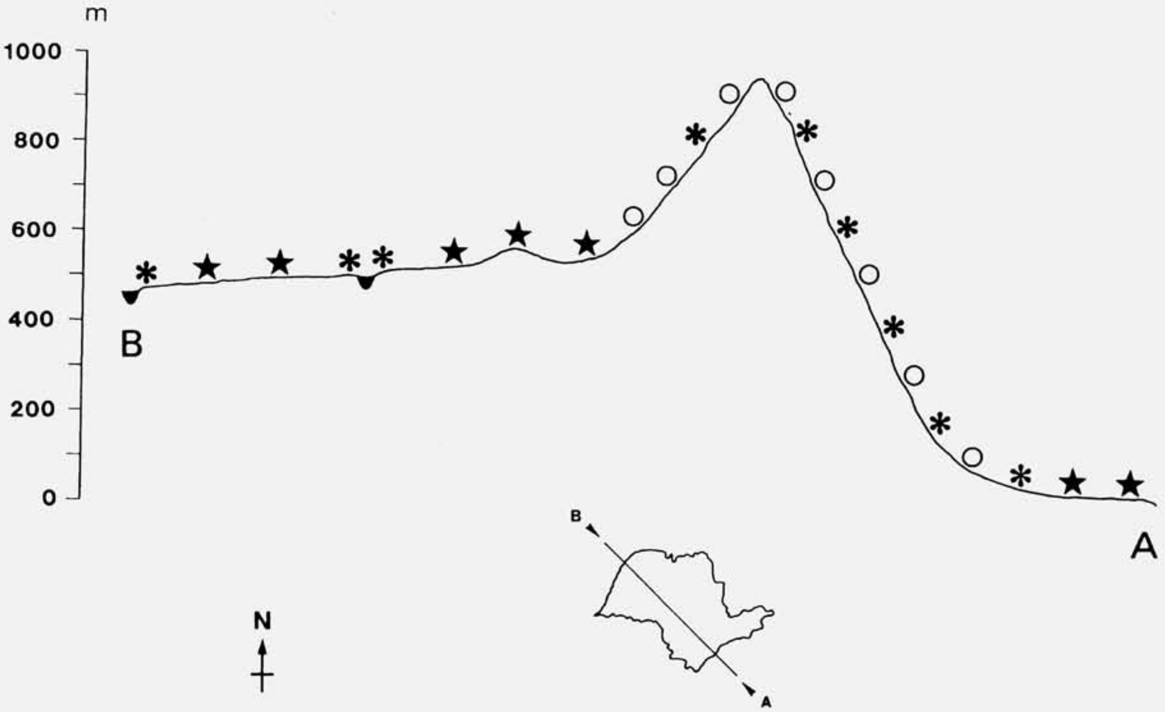

Figura 3. Distribuição altitudinal de *Penelope obscura* (○), *Penelope superciliaris* (★) e *Pipile jacutinga* (∗), vista em perspectiva de relevo, de acordo com uma linha traçada da costa do estado de São Paulo até o rio Paraná.

a Floresta Pluvial Atlântica atinge cotas mais elevadas; Hueck 1972b) a uma altitude próxima aos 1.800 m e Del Hoyo *et al.* (1994) até os 1.850 m.

Distribuição geográfica, simpatria e sintopia. As localidades de coleta compartilhadas por exemplares de *P. superciliaris* e *P. jacutinga*, depositados no Museu de Zoologia da Universidade de São Paulo, poderiam representar um exemplo de área de sintopia entre estas espécies no passado (ex: Porto Cabral, junto ao Rio Paraná e Ipanema, antiga localidade próxima a Sorocaba; Pinto 1964). Na Fazenda Barreiro Rico, junto à confluência dos Rios Tietê e Piracicaba, consta que *P. jacutinga* (hoje localmentente extinta) e *P. superciliaris* ocorriam na mesma área (Werner C. A. Bokermann *in litt* 1992) (figura 1).

Também na zona de transição entre a Floresta Pluvial Atlântica e as Florestas Subtropicais, no limite do Planalto de São Paulo, havia zonas de contato entre *P. obscura* e *P. superciliaris*, ex: «Altos do Ipiranga» (Pinto 1938) (= Parque do Estado; atualmente Parque Estadual das Fontes do Ipiranga) (Pinto 1945, Werner C. A. Bokermann, com. pess. 1994). No presente estudo foram avistados regularmente (durante cinco anos) três indivíduos de *P. superciliaris* e um indivíduo isolado de *P. obscura*, nas matas do Parque Estadual das Fontes do Ipiranga, o que poderia ser a confirmação de uma zona de contato entre as duas espécies. Porém, como desde há décadas está instalado o Zoológico de São Paulo no interior desse parque, não se descarta a possibilidade de que esses indivíduos tenham escapado do cativeiro e se adaptado às condições dessa mata residual.,

Por outra parte a localidade de «São Carlos do Pinhal» (= atual São Carlos) que consta no catálogo de Pinto (1938) para *P. obscura bronzina* (nº 7.699, Civatti col., 1908), poderia ser um erro pois, apesar de na região terem existido manchas residuais de florestas de araucária, esse registro «interioriza» muito a distribuição da espécie no estado.

No sudoeste do estado do Paraná recentemente registrou-se uma área de simpatria entre *P. obscura*, *P. superciliaris* e *P. jacutinga*, em uma região dominada por Florestas Subtropicais (Straube 1988).

Apesar de que no passado (registros anteriores a 1977) aparentemente foram detectadas zonas de contato entre *P. superciliaris* e *P. obscura* (e/ou *P. jacutinga*) no estado de São Paulo, atualmente o único registro disponível corresponde aos limites entre a Floresta Pluvial Atlântica da planície costeira e a Restinga arbórea da Ilha do Cardoso; contato *P. superciliaris* e *P. jacutinga* (presente estudo) e contato entre as três espécies (P. Martuscelli, com. pess. 1990).

Cabe destacar ainda que na Ilha Comprida, outrora majoritariamente coberta por restingas arbóreas e arbustivas, somente detectou-se a presença de *P.*

superciliaris (P. Martuscelli, com. pess. 1990).

Tabela 3. Ocorrência de *Penelope superciliaris* (**PS**), *Penelope obscura* (**PO**) e *Pipile jacutinga* (**PJ**) em relação às formações vegetais do estado de São Paulo. Para a distribuição potencial das formações vegetais do estado de São Paulo, utilizaram-se as aproximações de Hueck (1956, 1972a). Estágios sucessionais das formações florestais: C = capoeiras de mata; S = secundárias; M = maduras.

		Espécie		
Formações vegetais		PS	PO	PJ
Restinga arbustiva		+(2)		
Restinga arbórea	C	+(2)		
	S	+(12)		
Floresta Pluvial	C			
Atlântica da	S		+(2)	+(1)
planície costeira	M	LB, LC	+(8)	+(10)
Floresta Pluvial	C			
Atlântica das	S	*(4)	+(4)	+(11)
encostas montanhosas	M	LC	+(35)	+(41)
Florestas	C	+(8)		
Subtropicais	S	+(20)	LB?	
	M	+(1)	LB?	
Áreas de transição:	C	+(5)		
Fl. Pl. Atlântica /	S	+(2)	LF	
Fl. Subtropicais	M		LF	
Florestas ripárias		LB?		LA, LD
	C			
Cerrados	S	+(2)		
	M			
Floresta de	S			
Araucaria	M		LE	
(*A. angustifolia*)				
TOTAL		(58)	(49)	(63)

+ = Observações efetuadas durante o presente estudo, com o número de encontros (entre parênteses) por formação vegetal.

L = Registros de localidades de coleta e/ou observações obtidos por outros autores até o ano de 1980, em que estão disponíveis informações e/ou descrições do tipo de ambiente e da formação vegetal; LA = Florence (1977); LB = Pinto (1938, 1945, 1964); LC = Sick (1985); LD = Emílio Dente, com. pess.; LE = Willis e Oniki (1981); LF = Hempel (1949) (somente para formações vegetais ou estágios sucessionais em que as espécies não foram detectadas no presente estudo).

* Morro do Pereirinha, Ilha do Cardoso (pequena montanha isolada em meio à restinga.

No oeste do estado de São Paulo, onde as populações de *P. jacutinga* provavelmente já foram extintas (Collar *et al.* 1992), é possível que no passado *P. superciliaris* e *P. jacutinga* também se excluíssem ecologicamente. Nessas regiões, *P. jacutinga* aparentemente ocorria nas matas mais úmidas, como manchas locais de Floresta Subtropical Mesofítica perenifólia (donde «Serra da Jacutinga», junto a Agudos) e florestas ripárias dos rios maiores (Tietê, Paraná, Paranapanema, Mogi-Guaçu, etc.), enquanto que *P. superciliaris* habitava as matas mais secas (semidecíduas e decíduas) e os cerrados (Pinto 1938, 1945, 1964, Florence 1977 e outras localidades assinaladas no material depositado no Museu de Zoologia da Universidade de São Paulo). O mesmo parece ocorrer em outras áreas de Floresta Subtropical do interior do continente (ex: Parque Nacional do Iguaçu, Brasil, e em Misiones, Argentina), onde *P. jacutinga* não é detectada em matas mais distantes que 100 m das margens dos rios (Collar *et al.* 1992).

Em diversos casos, as informações ecológicas correspondentes às localidades de coleta mais antigas coincidem bastante com o tipo de florestas onde as espécies foram encontradas no presente estudo. Porém, em outros casos parecem não coincidir (cf. tabela 3 *versus* figura 1). Uma explicação para essa discordância entre a informação antiga e a atual poderia ser que algumas das localidades antigas não correspondem a «localidades de coleta» e sim a «localidades designadas» *a posteriori*. Essas localidades poderiam ter sido designadas em função dos referenciais geográficos mais próximos que eram conhecidos em épocas em que não existiam cidades e vilas em extensas regiões do estado (ex: ao longo dos rios Paraná e Paranapiacaba). Se isso for certo, essas localidades não podem ser tomadas ao «pé da letra» quando se pretende situar as espécies em um determinado tipo de formação vegetal, a menos que venham acompanhadas de informações complementares.

Apesar de, no presente estudo, somente haver se detectado a presença de uma espécie de cracídeo na Serra do Japi (*P. superciliaris*), a «World Pheasant Association» assinala a ocorrência de *P. jacutinga* nesta Serra (WPA 1988), o que seria o único caso atualmente conhecido de sintopia entre as duas espécies, no estado de São Paulo. No entanto, a espécie também não consta nas listagens de aves do Japi feitas por outros pesquisadores (Willis e Oniki 1981, Silva 1992) e não foi encontrado qualquer registro de que *P. jacutinga* houvesse habitado esta Serra, no passado.

Uma possibilidade seria a de que um ou mais indivíduos, escapados do cativeiro (ex: uma avicultura que mantinha espécies indígenas de aves, entre elas *P. jacutinga*, na periferia de Jundiaí durante a década de 1980), tivessem atingido a Serra do Japi.

Dados de distribuição vertical das espécies em relação à estrutura das florestas estudadas na Serra de Paranapiacaba, mostraram uma tendência de *P. jacutinga* para explorar os estratos mais altos, enquanto que *P. obscura bronzina* com freqüência explora os estratos médio e baixo, havendo uma sobreposição na faixa do dossel (Guix 1995). Essa aparente «divisão parcial dos estratos» permitiria uma segregação de parte dos recursos alimentares (frutos) entre as duas espécies, o que possibilitaria a sintopia.

Por outro lado, *P. superciliaris* aparentemente pode explorar todos os estratos disponíveis das matas estudadas, em diferentes estágios de sucessão (Guix 1995). Assim, uma potencial competição pelos recursos poderia induzir a uma exclusão ecológica e geográfica. Isso em parte explicaria porque as populações de *P. superciliaris*, que vivem na restinga arbórea da Ilha do Cardoso, não sobem a encosta do maciço acompanhando a fenologia de frutificação.

CONCLUSÃO

Penelope obscura e *P. jacutinga* são sintópicas nas regiões da Serra do Mar e da Serra da Mantiqueira, e exploram as florestas mais úmidas das serras e da planície costeira (Floresta Pluvial Atlântica, *sensu* Hueck 1972a,b). *Penelope superciliaris* explora as florestas mais secas (Subtropical semidecídua e decídua) do interior do estado, as florestas de transição (Florestas Subtropicais-Floresta Pluvial Atlântica), os Cerrados e as Restingas arbórea e arbustiva do litoral; *sensu* Hueck 1972a,b).

A associação (ou sintopia) *P. obscura* + *P. jacutinga* (a) e a espécie *P. superciliaris* (b), excluem-se ecologicamente no leste do estado de São Paulo.

As populações de *P. obscura* do estado de São Paulo são de aptidão serrana, e apesar de também utilizarem zonas cobertas por florestas de araucária, têm como hábitat preferencial a Floresta Pluvial Atlântica.

AGRADECIMENTOS

Werner C. A. Bokermann auxiliou-me na tarefa de situar as localidades antigas e forneceu-me valiosas informações sobre os tipos de florestas que lá existiam. Carlos Yamashita (IBAMA) e Josep del Hoyo (Lynx Ed., Barcelona) recompilaram algumas das localidades de coleta de exemplares depositados no Museu de Zoologia da Universidade de São Paulo e do American Museum of Natural History (N. Y.), respectivamente. Dois revisores anônimos fizeram comentários e sugestões que melhoraram muito a redação do manuscrito. O Instituto Florestal de São Paulo, a Fundação Florestal, a Prefeitura de Cotia, o CEPARNIC e a Família Sampaio Moreira (Fazenda Santa Carlota), prestaram-me apoio logístico. Paulo Martuscelli auxiliou-me na coleta de dados na Ilha do Cardoso.

REFERÊNCIAS

Brown, S. e A. E. Lugo (1990) Tropical secondary forests. *J. Trop. Ecol.* 6:1-32.

Camargo, H. F. A. (1946) Sôbre uma pequena coleção de aves de Boracéia e do Varjão do Guaratuba (Estado de S. Paulo). *Papéis Avul. Dep. Zool., São Paulo* 7:143-164.

Collar, N. J., L. P. Gonzaga, N. Kraubbe, A. Madroño Nieto, L. G. Naranjo, T. A. Parker III e D. C. Wege (1992) *Threatened birds of the Americas; The ICBP/IUCN Red Data Book.* Third edition, part 2. Cambridge: International Council for Bird Preservation.

Delacour, J. e D. Amadon (1973) *Curassows and related birds.* New York: Am. Mus. Nat. Hist./Chanticleer Press/Amilcare Pizzi.

Del Hoyo, J., A. Elliot e J. Sargatal (orgs.) (1994) *Handbook of the birds of the world.* Vol. 2. New World Vultures to Guineafowl. Barcelona: Lynx Edicions.

Florence, H. (1977) *Viagem fluvial do Tietê ao Amazonas de 1825 a 1829* (trad. Visconde de Taunay). São Paulo: Ed. Cultrix / Ed. Univ. São Paulo.

Gardner, G. (1846) *Travels in the interior of Brazil.* First ed.. London: Reeve, Brothers.

___ (1975) *Viagem ao interior do Brasil.* (trad. Milton Amado). Belo Horizonte: Ed. Univ. São Paulo / Ed. Itatiaia.

Graham, D.J. (1986a) *Lista das aves da Reserva Estadual da Cantareira.* São Paulo: Inst. Florestal de São Paulo.

Guix, J. C. (1995) *Aspectos da frugivoria, disseminação e predação de sementes por vertebrados nas florestas nativas do Estado de São Paulo, sudeste do Brasil.* Tese de doutorado. Barcelona: Facultat de Biologia. Univ. Barcelona.

Hempel, A. (1949) Estudo da alimentação natural de aves silvestres do Brasil. *Arq. Inst. Biol., São Paulo* 19: 237-268.

Hueck, K. (1956) Mapa fitogeográfico do Estado de São Paulo. *Bol. Paul. Geogr.* 22: 19-25.

___ (1972a) *Mapa de la vegetación de América del Sur* (1:8.000.000). Forstliche Forschungsanstalt Munchen. Stuttgart: Gustav Fisher Verlag.

___ (1972b) *As florestas da América do Sul, ecologia, composição e importância econômica* (trad. H. Reichart). São Paulo: Ed. Univ. Brasília / Ed. Polígono.

Pinto, O. (1938) Catálogo das aves do Brasil, 1° Parte. *Rev. Mus. Paulista* 22:XVII + 566 p.

___ (1945) Cinqüenta anos de investigação ornitológica. *Arq. Zool., São Paulo* 4(8):261-340.

___ (1964) *Ornitologia Brasiliense; catálogo descritivo e ilustrado das aves do Brasil.* Vol. I. São Paulo: Departamento de Zoologia da Secretaria da Agricultura do Estado de São Paulo.

Sick, H. (1970) Notes on Brazilian Cracidae. *Condor* 72:106-108.

___ (1985) *Ornitologia brasileira; uma introdução.* 1. Brasília: Ed. Univ. Brasília.

___ (1993) *Birds in Brazil; a natural history.* New Jersey: Princeton Univ. Press.

Silva, W. R. (1992) As aves da Serra do Japi. Pp. 238-263. *In:* L. P. C. Morellato (org.) *História natural da Serra do Japi.* Campinas: Ed. UNICAMP/FAPESP.

Straube, F. C. (1988) Contribuições ao conhecimento da avifauna da Região sudoeste do Estado do Paraná (Brasil). *Biotemas* 1:63-75.

Willis, E. O. e Y. Oniki (1981) Levantamento preliminar de aves em treze áreas do Estado de São Paulo. *Rev. Brasil. Biol.* 41:121-135.

WPA (1988). WPA Brazil. WPA (World Pheasant Assoc.) *News* 21.

APÊNDICE

Áreas de estudo

Parque Estadual de Carlos Botelho. 37.644 ha. Situado na Serra de Paranapiacaba, entre os Municípios de São Miguel Arcanjo, Tapiraí, Capão Bonito e Sete Barras (24°10'S, 47°55'W). Altitudes: entre 22 e 1.003 m.

Parque Estadual Intervales. 38.356 ha. Situado na Serra de Paranapiacaba, entre os Municípios de Ribeirão Grande, Eldorado, Guapiara, Iporanga e Sete Barras (24°20'S, 48°15'W). Altitudes: entre 20 e 1.095 m.

Parque Estadual da Ilha do Cardoso. 22.500 ha. Situado na Ilha do Cardoso, Município de Cananéia, junto à divisa entre os Estados de São Paulo e Paraná (25°10'S, 48°00'W). Altitudes: entre 0 e 800 m.

Parque Estadual das Fontes do Ipiranga (antigo Parque do Estado). 542 ha. Situado na zona metropolitana da Cidade de São Paulo, limite com o Município de Diadema (23°36'S, 46°38'W). Altitudes: entre 600 e 700 m.

Parque Nacional do Itatiaia (R. J.). 11.943 ha. Situado na Serra da Mantiqueira, no limite entre os Estados de São Paulo e Rio de Janeiro (22°37'S, 44°45'W). Altitudes: entre 816 e 2.787 m.

Reserva Estadual de Morro Grande (Caucaia do Alto). 10.700 ha. Município de Cotia (23°45'S, 47°30'W). Altitudes: entre 500 e 700 m.

Estação Experimental de Zootecnia de Sertãozinho. Quatro glebas que totalizam 675 ha de matas. Município de Sertãozinho (21°08'S, 47°59'W). Altitudes: entre 500 e 600 m.

Área de Proteção Ambiental da Serra do Mar. Dados coligidos na encosta da Serra, Município de Cubatão. Altitudes: entre 150 e 700 m.

Serra do Japi. Cerca de 8.000 ha. Municípios de Jundiaí e Campinas (23°11'S, 46°52'W). Altitudes: entre 700 e 1.170 m.

Mata do Pau Furado. Cerca de 200 ha. Situado no Município de Itapevi a 3 km da Cidade de Cotia (23°31'S, 46°51'W). Inclui o atual Condomínio Transurb. Altitudes: entre 700 e 800 m.

Fazenda Santa Carlota. 6.292 ha. Município de Cajuru (21°22'S, 47°15'W). Altitudes: entre 600 e 944 m.

Fazenda Capricórnio. Situada a 6 km da Cidade de Ubatuba. Município de Ubatuba (23°23'S, 45°04'W). Altitudes: entre 10 e 400 m.

Fazenda São Vicente. Junto ao Rio Atibaia, Município de Campinas. Altitudes: entre 500 e 600 m.

Fazenda Santa Úrsula. 40 ha. Situada a 2 km da cidade de Jaguariuna, Município de Jaguariuna. Altitudes: entre 500 e 600 m.

Ouro Fino Paulista. 150 ha. Vale situado no limite entre os Municípios de Ribeirão Pires e Suzano, a 2 km de Vila de Ouro Fino Paulista (23°40'S, 46°26'W). Altitudes: entre 500 e 650 m.

Gleba de Sousas. 200 ha. Situada a aproximadamente 8 km da cidade de Sousas (22°52'S, 46°59'W), Município de Campinas. Altitudes: entre 500 e 600 m.

Rio Paranapanema. Região de Ourinhos, junto ao Rio Paranapanema. Altitudes: entre 400 e 550 m.

Cássia dos Coqueiros. Diversas glebas de mata situadas próximas à Cidade de Cássia dos Coqueiros e da Cachoeira do Itambé, Município de Cássia dos Coqueiros. Altitudes: entre 500 e 650 m.

Hidrelétrica Armando Laydner. Junto a Represa Jurumirim. Municípios de Avaré e Itaí. Altitudes: entre 400 e 600 m.

Ararajuba 5(2):203-208
dezembro de 1997

Ecology and behavior of wintering *Falco peregrinus* (Falconiformes: Falconidae) in southeastern Brazil

Robson Silva e Silva

Rua São José, 48 apt.31, 11040-200, Santos, SP, Brazil. E-mail: rsil@coastalway.com.br

Recebido em 20 de março de 1997; aceito em 17 de julho de 1997

RESUMO. **Ecologia e comportamento de Falco peregrinus (Falconiformes: Falconidae) invernando no sudeste do Brasil.** Entre 1991 e 1996, foram monitorados os falcões-peregrinos (*Falco peregrinus*) que invernaram na área urbana da cidade de Santos, no sudeste do Brasil. Os falcões adultos foram observados usando os mesmos pontos de pouso, sempre em edificações, e áreas de caça repetidamente durante todo o período de estudo. Desde sua chegada em outubro, até a partida em abril, o macho e a fêmea adultos interagiram diversas vezes e apresentaram comportamento de côrte. Os falcões imaturos e adultos foram observados voando juntos e ocupando a mesma área, sugerindo que algumas famílias de falcões poderiam migrar em grupo até as áreas de invernada. As principais presas consumidas foram pombos (*Columba livia*) (80,9 %) e morcegos (11,7 %). São feitas comparações das presas consumidas em outras áreas de invernada conhecidas no Brasil.

PALAVRAS-CHAVE: ambiente urbano, área de invernada, comportamento, dieta, ecologia, Falco peregrinus, sudeste brasileiro.

ABSTRACT. Between 1991 and 1996, Peregrine Falcons (*Falco peregrinus*) wintering in the urban area of Santos city, southeastern Brazil, were monitored. Adult falcons were observed using the same perches, always on buildings, and hunting grounds repeatedly throughout the study period. From their arrival in October, to their departure in April, male and female adult falcons interacted several times and showed courtship displays. Immature and adult falcons were observed flying together and occupying the same area, suggesting that some falcon families may migrate in group to the wintering grounds. The main prey species were the Rock Dove (*Columba livia*) (80.9 %) and bats (11.7 %). Comparisons of prey items of other known wintering areas in Brazil are made.

KEY WORDS: behavior, ecology, *Falco peregrinus*, prey species, southeastern Brazil, urban environment, wintering area.

In North America, the Peregrine Falcon is a well known species, throughout its breeding range, and recently, its migration routes in the northern hemisphere (Herbert and Herbert 1965, Cade *et al.* 1968, Hunt *et al* 1975, Dekker 1980, Cade 1982, Burnham and Mattox 1984, Court *et al.* 1988). On the other hand, there is little information on wintering Peregrine Falcons in Central and South America. This is significant because some falcons spend almost half of their lives there, and some wintering areas present significant sources of organochlorine contamination for the falcons (Henny *et al.* 1982). Consequently, there is a great need for information on the species' ecology in that region.

Urban habitats are attractive both to breeding and wintering Peregrine Falcons. In both cases the Rock Dove (*Columba livia*) being their main food resource (Hickey and Anderson 1969, Cade and Bird 1990, Risebrough *et al.* 1990, Schneider and Wilden 1994). In Brazil Peregrine Falcons have been widely recorded, but only six wintering areas are currently known, all in urban areas: Salvador (12°59'S, 38°31'W), Bahia state; Rio de Janeiro (22°54'S, 43°14'W), Rio de Janeiro state; São Paulo (23°32'S, 46°37'W) and Santos (23°57'S, 46°20'W), São Paulo state; and Porto Alegre (30°02'S, 51°12'W) and Rio Grande (32°01'S, 52°05'W), Rio Grande do Sul state (Silva e Silva 1996). Observations on wintering Peregrine Falcons in Brazil were first reported from Rio de Janeiro by Sick (1960), while a later, more detailed study was conducted at Porto Alegre (Albuquerque 1984). Information on the species' ecology and behavior have been reported from other South American countries (Risebrough *et al.* 1990).

STUDY AREA

The study was carried in Santos, a city of 450,000 people, located on São Vicente Island (about 6,000 ha in area), on the coast of São Paulo state, southeastern Brazil. The annual mean temperature is 20° C, but it regularly exceeds 30° C during the summer, with common records up to 40° C. Precipitation averages 2,183 mm/yr, with no dry season, although most rain falls between December and March (RADAMBRASIL 1983).

The island is isolated from the mainland by narrow mangrove-lined channels and is dominated by urban areas, with remnant native vegetation only on the steepest slopes of the hills at the center of the island. A park along the seven km of the beach front supports numerous Tropical Almond (*Terminalia catapa*) trees, which attract many fruit bats during the fruiting season. The city has many large buildings, particularly along the seashore, where 10-16 story buildings predominate. Another important feature of the city is its seaport, the largest in Latin America, where shipments of grains sustain huge populations of Rock Doves and Ruddy Ground-doves (*Columbina talpacoti*), important food resources for Peregrine Falcons using the area.

METHODS

Falcons located in the study area were systematically followed by foot, motorcycle or car to their perches. The habitual perches were regularly checked for falcons and their behavior recorded ad libitum (Altman 1974). Some of the most frequently used perches could be observed from my apartment, making it easy to locate the falcons. Observations were made from ground level or nearby buildings, with the aid of binoculars. Falcons were photographed whenever possible for individual recognition (individuals can be distinguished by peculiarities of their malar stripes and other distinctive plumage markings). Prey species were identified when falcons were observed hunting and via remains collected at perches. Data were gathered during five consecutive wintering seasons: 30 November 1991 to 9 April 1992, 26 October 1992 to 12 April 1993, 26 October 1993 to 13 April 1994, 21 October 1994 to 14 April 1995, and 19 October 1995 to 6 April 1996.

RESULTS AND DISCUSSION

Origins and taxonomy. Two subspecies of Peregrine Falcons, *F. p. tundrius* and *F. p. anatum* have been recorded in Brazil, with overlapping winter ranges (Silva e Silva 1996). Three males collected in Santos fit the description and measurements of *tundrius* (White 1968), and two of these, immature and adult are housed in the Museu de Zoologia da Universidade de São Paulo (MZUSP.73739 and 74338). In addition, banded individuals captured in Santos have come from the range of *tundrius*. A male, banded at its nest in Manitiisoq, Greenland (66°53'N, 50°57'W) on 5 August 1989, and later recaptured at the Chincoteague National Wildlife Refuge in Virginia, USA on 1 October 1989, was found in Santos with a broken wing on 13 January 1992 (W. Mattox pers. comm.). Another male, banded in Virginia (37°00'N, 75°50'W), USA on 2 October 1991, was recaptured at the Santos port on 26 April 1995 (Bird Banding Laboratory).

General habits. Peregrine Falcons used many perches distributed over the urban area, mostly along the beach front, the port and downtown. Summing the five seasons during which I saw three to five different Peregrine Falcons annually (table 1), 59 buildings were used (each building used by falcons was considered as a different roost, although the falcons could use different perches on it). Most perches were air-conditioners or their supports, TV and a radio antennas, ledges or sheltered spaces, windows and verandas. An adult female was mostly observed along the beach front and the port, while an adult male, apparently its mate (see below) used areas further inland. Buildings in the late construction stage (almost finished but still not inhabited) were often used as roost sites inland (they could be abandoned after they became inhabited), but all used beach front buildings were inhabited.

Most buildings used by Peregrine Falcons (78 % of records) were 9 to 16 floors high, but falcons were also observed roosting on buildings as low as three floors tall. Adult falcons tended to exhibit great site fidelity to some perches, which were repeatedly used during my study. Falcons in immature plumage did not exhibit perch site fidelity but used perches frequented by adults. On 26 January 1994 an immature male was captured and banded in one of these perches, and on 25 December 1996 was recaptured in Santos. In Rio de Janeiro some perches were reportedly used for 12 years (Sick 1997), and similar records have been reported from elsewhere in South America (Risebrough *et al.* 1990). Site fidelity in the wintering areas perhaps recalls the fact that Peregrine Falcons also show great fidelity to their nest sites, especially the males (Court *et al.* 1988). Daily activities of adult falcons appeared to be strongly influenced by temperature. On hotter days (30° to 40° C), Peregrine Falcons rested throughout the day in shaded places, grooming and sometimes sleeping, and moving to another shaded perch on the building when they became exposed to full sunlight. During the strong summer downpours the falcons could be seen on TV antennas exposing themselves to the rain and bathing. Only a few times they were observed soaring over the beach-front.

Hunting periods were usually the first hours of the morning and late afternoon to dusk. Falcons would hunt during other periods on overcast days or after a few days of continuous rain (which prevented them from hunting). At dusk the falcons flew to a roosting site. I found six of these sites along the beach-front and three inland.

Interspecific relations. The presence of a Peregrine Falcon caused a mobbing reaction by other birds similar to that described for other Falconiformes (Sick 1997). Attacks or mobbing flight directed at falcons were frequent, each bird species showing a different behavior. Blue-and-white Swallows (*Notiochelidon cyanoleuca*) flew around perched falcons, always at a distance, in groups ranging from one to 15 individuals. Great Kiskadees (*Pitangus sulphuratus*) mostly mobbed falcons at their perches by repeatedly hovering and diving at the perched falcon (up to 26 consecutive times), which would duck at each attack. Kiskadees would mob falcons either alone or in groups of up to three, acting at the same time and taking breaks between mobbing bouts. Tropical Kingbirds (*Tyrannus melancholicus*) had the same behavior, but were more agressive and sometimes nipped at the falcon. Glittering-

Table 1. Numbers of Peregrine Falcons in Santos.

Season	Individuals	Total
1991-1992	2 ad. males and 1 ad. female	3
1992-1993	1 ad. male, 1 ad. female and 1 imm. female	3
1993-1994	1 ad. male, 1 ad. female, 2 imm. and 1 imm. male	5
1994-1995	2 ad. males, 1 ad. female, 1 imm. male and 1 sub-ad. male	5
1995-1996	2 ad. males, 1 ad. female, 1 sub-ad. male and 1 imm.	5

throated Emeralds (*Amazilia fimbriata*) and Swallow-tailed Hummingbirds (*Eupetomena macroura*) would fly around the falcon, attacking it from all directions, alone or in groups of up to three. Hummingbirds, especially the Emerald, were very bold and persistent, sometimes perching on the same antenna used by the falcon. I also witnessed several species mobbing falcons together. Once six Blue-and-white Swallows started circling a perched falcon, attracting a Great Kiskadee, a Tropical Kingbird and two Glittering-throated Emeralds, which attacked it continuously until the falcon flew away, being chased for 200 m.

On 23 November 1993, at 15:00, I observed a Roadside Hawk (*Rupornis magnirostris*) flying with prey in its talons being mobbed from above by some birds. A male Peregrine Falcon joined the birds and dove on the hawk, which turned and grabbed the falcon's talons. The locked raptors fell spinning close to the ground before releasing each other and flying in different directions. An adult Peregrine Falcon was also observed chasing two Yellow-headed Caracaras (*Milvago chimachima*) at the port on 22 February 1996 at 17:30.

What might be interpreted as play behavior was witnessed twice. On 30 January 1993 at 17:25 an adult male falcon was seen hunting a pigeon at low speed, touching it four times before giving up. Also, on 7 April 1994 at 18:00, a falcon soaring over a thermal with eight Black Vultures (*Coragyps atratus*) twice approached and touched a vulture with its talons.

Intraspecific interactions. Throughout the study period the study area was occupied by a pair of adult Peregrine Falcons, plus ummated adult males and immature birds. From pictures taken from the birds, the same adult pair used the area year after year. The Peregrine pair was observed flying or perched together from their arrival to departure in 7.7 % of the observation days. On 13 February 1992, at 11:20 the male was observed calling while flying after the female. The male dropped a Rock Dove to the female, who grabbed the food in mid-air and perched atop a building to feed. The adult falcons mostly perched together on a radio antenna at a beach-front building, the highest point in the area used by the female to hunt, before engaging in chases after each other among the buildings and over the beach, before returning to the perch. This behavior was repeated up to four times in a row, usually during the afternoon. On 26 December 1993 at 16:55 the adult female perched on a ledge on a building facing the port, and 30 min later the adult male perched on the same ledge, and resting 10 m from the female, with no reaction or visible interaction. Albuquerque (1988) stated that pre-mating behavior can occur at the wintering areas, as his observations of courtship behavior in Porto Alegre show. This behavior has also been observed elsewhere in South America among wintering Peregrines (Risebrough *et al.* 1990). In Salvador, an adult Peregrine Falcon pair was observed repeatedly using the same wintering area for several years until one of the birds was killed (P. Lima pers. com.). My results in Santos agree with the previous observations, and show that some pairs stay together throughout the post breeding period at the wintering areas, even showing courtship behavior.

Immature Peregrine Falcons were occasionally observed flying or perched with adults (32 % of all observations of immatures). On 23 December 1993, an adult male, an adult female and one immature were observed perched on a ledge on a building facing the port. There is currently no proof that family groups use the same wintering areas, although it is known that such groups migrate together along the east coast of the USA (Sherrod 1983, W. Mattox pers. com.). My observations suggest that family groups may use the same wintering quarters.

More complex interactions between adult and immature falcons were recorded a few times. On 13 January 1994, at 18:30, an immature male was observed chasing an adult male 10 m above a busy traffic avenue, the immature uttering begging calls. I observed the same behavior, again involving an immature and an adult on 13 February 1994 in southern Brazil, at the town of Pelotas (31°46'S, 52°20'W), Rio Grande do Sul state. However on 15 January 1995, a sub-adult Peregrine Falcon (second year plumage) was hunting a Rock Dove when an adult falcon drove it away from the area, vocalizing. These observations suggest that, at least in my study area, adult Peregrine Falcons sometimes allow immature birds, which may be their own offspring, in their presumed winter hunting territories during their first year. For example, the immature bird I banded was captured in the same spot used the night before by an adult falcon. Nevertheless, I never observed an adult feeding, hunting with, or facilitating prey capture for a young bird.

Prey and food habits. In North America the diet of breeding Peregrine Falcons is made mostly of passerines (Cade *et al.* 1968, Burnham and Mattox 1984, Court *et al.* 1988, Rosenfield *et al.* 1995), while in Great Britain F. p. *peregrinus* prefer Rock Doves (Ratcliffe 1993). During migration other species are used as food, including waterfowl, small shorebirds (mainly sandpipers) and landbirds (Hunt *et al.* 1975, Dekker 1980). At wintering areas in South America the main prey are Rock Doves and bats in urban habitats and shorebirds and aquatic birds in wetlands (Sick 1989, Risebrough *et al.* 1990, Sick 1997).

Available informations on prey species taken by Peregrine Falcons in their Brazilian wintering areas came from four areas: Salvador (Lima 1991), Rio de Janeiro (Sick 1960, 1989, 1997), Santos (this study), Porto Alegre (Albuquerque 1984) and Rio Grande (Witeck 1988, Sick 1989, 1997) (only Albuquerque (1984) reported the numbers of each prey species). Additionally Sick (1997) observed Peregrines hunting Parakeets (*Brotogeris* sp.) in Amazonia and Lesser Golden-Plovers (*Pluvialis dominica*) in Mato Grosso.

Rock Doves are an important prey species, absent from the diet only at Rio Grande, where falcons fed mainly on shorebirds and aquatic birds, although the area is a seaport where doves are present. The presence of large wetlands rich in migratory birds close to the area may explain the falcon's diet choice there. The lack of passerine birds in the diet in all areas, except for the House Sparrow (*Passer domesticus*), is also striking.

The main prey species in Santos consumed (80.9 % of the records) was the Rock Dove (figure 1), abundant in the city especially along the seashore and the port (table 2). Similarly, Rock Doves (mostly fledglings) comprised 68.5 % of the prey records at Porto Alegre (Albuquerque 1984). Another important group used as prey in Santos were bats, with two species comprising 11.7 % of the prey records. Species unsuccessfully hunted by falcons were Blue-and-white Swallow, Shiny Cowbird (*Molothrus bonariensis*) and House Sparrows. Terns (*Sterna* sp) were persistently chased but without success (R. Seckendorff, pers. com.).

The data on prey use suggest that Peregrine Falcons specialize on a few prey species in their wintering areas. This may be a way of perfecting hunting techniques and minimizing energetic cost of hunting species whose escape behavior is unknown. The records of two captured Budgerigars (*Melopsittacus undulatus*) also suggest that

Figure 1. Wintering Falco peregrinus in Santos, southeastern Brazil, on 13 March 1993 (photo by R. Silva e Silva).

Table 2. Prey items of Peregrine Falcons at Santos, southeastern Brazil, recorded from 1991 to 1996.

Species		N	%
Rock Dove	*(Columba livia)*	55	69.6
Ruddy Ground-dove	*(Columbina talpacoti)*	1	1.3
Budgerigar	*(Melopsittacus undulatus)*	2	2.5
Plain Parakeet	*(Brotogeris tirica)*	1	1.3
Dark-billed Cuckoo	*(Coccyzus melacoryphus)*	1	1.3
Unidentified birds		11	13.8
Velvety Free-tailed Bat	*(Molossus molossus)*	7	8.9
Yellow-shouldered Bat	*(Sturnira lilium)*	1	1.3
Total		79	100

the falcons are opportunist by recognizing and capturing prey that may be more vulnerable because of their non-native status.

Foraging behavior. At Santos, Peregrine Falcons hunted in areas where Rock Doves congregated. The adult female hunted on the beach front and port area, while the male was mostly observed further inland. Hunting Peregrine Falcons perched on the highest available places, providing a good view of the vicinity. When suitable prey was located, the falcon flew after it at high speed or, in the case of perched prey species, stooped at the prey, making the capture after the bird took flight. Most prey (85 %) was captured while flying, but I witnessed the capture of a Rock Dove perched on a roof, and of another that dropped on the beach-front gardens after a stoop. All prey captured at Santos was eaten immediately, but in Rio Grande Peregrine Falcons cached food to eat one or two days after capture (Witeck 1988). Food storage was also observed in breeding Peregrine Falcons in an urban environment in Germany (Schneider and Wilden 1994). The occurrence of this behavior maybe related to the area's temperature, as prey decomposes more slowly in colder areas like Rio Grande, in southernmost Brazil, compared to more tropical areas like Santos. Captured prey was carried to often-used plucking perches, usually atop air-conditioners, windows and TV antennas. Prey was beheaded and the belly and chest feathers plucked, and the falcon fed on the pectoral muscles and some viscera. Only once, on 11 January 1995, observed an adult feeding while soaring, plucking and eating an unidentified bird.

Few complete hunting sequences were observed, as chases happened among the buildings and birds were lost from view before the outcome of the hunting flight could be determined. Of 37 capture attempts directed at birds, four (10.8 %) were successfull. In the case of bat-hunting falcons, six of 22 attempts were successfull (27. 6%). Hunting success varies widely other localities, being quite high in the breeding areas (*e.g.*, 35.8 % in England and 40 % in northern Alberta, Canada), and lowering to results comparable to mine during migration (*e.g.*, 9.8 % in central Alberta) and at some wintering areas (*e.g.*, 9.6 % in Fiji) (Dekker 1980). The inexperience of an immature was observed on 7 February 1994 when one attemped to capture a Rock Dove perched close to it on a roof by running after the pigeon, both birds running around atop the building until the falcon gave up.

Bat hunting. Although hunting of bats by Peregrine Falcons is known in South American wintering areas (Risebrough *et al.* 1990), including Brazil (Sick 1997), falcons in these areas hunted in places where large flocks of molossid bats were present (Sick 1961, Albuquerque 1984, Sick 1989). This has also been documented in New Mexico, USA (Stager 1941) and other localities.

At Santos the falcons hunted in areas where few (no more than 10) flying bats were present. A similar instance was observed at the town of Aracaju (10°55'S, 37°04'W), Sergipe state, where a Peregrine was hunting a few unidentified bats on 4 November 1994 (M. Sousa pers. com.).

An adult male was repeatedly observed at Santos in its bat-hunting routine at the beach front. Around 18:00 it would perch on the tallest building in the area (14 stories). When the bats arrived, it would single one and chase it over the estuary waters, circling over the water or perching before a new attack. These flights were made at intervals of about 1 min. Falcons stooped at bats and retreived them if they fell into the water after being struck. Some bats had one of the wings broken by the impact with the falcon, and were quickly captured on a second pass by the falcon. Captured bats were taken to a perch and completely consumed in about five min. Despite the presence of other potential prey like Rock Doves, Ruddy Ground-doves and Cayenne Terns (*Sterna eurygnatha*), this falcon ignored these, and hunted only the bats. Roberto Seckendorff who first showed me this hunting place, has observed this behavior throughout the falcons' stay in Santos (from October to April). It is likely that Peregrine Falcons hunt for bats in other areas but the behavior has rarely been noted due to the size of the study area and the short period falcons spent hunting bats each time.

ACKNOWLEDGMENTS

I wish to thank: Dr. Silvia Fazollari-Corrêa for identifying the bats, Leo T. Fukui for helping in fieldwork, Roberto W. von Seckendorff (Instituto de Pesca, Santos) for sharing valuable information on Peregrine Falcon hunting areas. Fábio Olmos for his support and help with the manuscript. Joseph B. Buchanan and Dr. Rob Bierrregaard for the rewiew of the original manuscript. Dr. William A. Burnham (The Peregrine Fund, Boise) sent me important books.

REFERENCES

Albuquerque, J. L. B. (1984) *The Peregrine Falcon (Falco peregrinus) in southern Brazil:aspects of winter ecology in an urban environment.* M. Sc. thesis, Provo: Brigham Young Univ.

___ (1988) Behavior and feeding habits of coinhabiting Peregrine Falcons wintering in Brazil, p.757-759 *In* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White (eds.), *Peregrine Falcon populations: their management and recovery.* Boise:The Peregrine Fund, Inc.

Altmann, J. (1974) Observational study of behavior: sampling methods. *Behaviour* 49:227-267.

Burnham, W. A. and W. G. Mattox (1984) Biology of the Peregrine and Gyrfalcon in Greenland. Medd. Grønl. Biosci. 14:1-28

Cade, T. J. (1982) *The falcons of the world.* London: William Collins Sons.

___ and D. M. Bird (1990) Peregrine Falcons, *Falco peregrinus*, nesting in an urban environment: a review.

*Can. Field-Nat.*104:209-218.

___, C. M. White and J. R. Haugh (1968) Peregrines and pesticides in Alaska. *Condor* 70:170-178.

Court, G. S., D. M. Bradley, C. C. Gates and D. A. Boag (1988) Turnover and recruitment in a tundra population of Peregrine Falcons *Falco peregrinus. Ibis* 131:487-496.

Dekker, D. (1980) Hunting success rates, foraging habits, and prey selection of Peregrine Falcons migrating through Central Alberta. *Can.Field-Nat.* 94:371-382.

Henny, C. J., F. P. Ward, K. E. Riddle and R. M. Prouty (1982) Migratory Peregrine Falcons, *Falco peregrinus*, accumulate pesticides in Latin America during winter. *Can.Field-Nat.* 96:333-338.

Herbert, R. A. and K. G. S. Herbert (1965) Behavior of Peregrine Falcons in the New York city region. *Auk* 82:62-94.

Hickey, J. J. and D. W. Anderson (1969) The Peregrine Falcon: life history and population literature, p.3-42 In J. J. Hickey (ed.), *Peregrine Falcon populations: their biology and decline.* Madison: Univ. of Wisconsin Press.

Hunt, W. G., R. R. Rogers and D. J. Slowe (1975) Migratory and foraging behavior Peregrine Falcons on the Texas coast. Can. Field-Nat. 89:111-123.

Lima, P. C. (1991) Comportamento do *Falco peregrinus* na Bahia. In: Resumos do XVIII Congresso Brasileiro de Zoologia, Salvador, 1991,p.380.

RADAMBRASIL (1983) *Levantamento de recursos naturais.* Vol.32. Folhas SF23/24. Rio de Janeiro/ Vitória.

Ratcliffe, D. (1993) *The Peregrine Falcon.*Second edition. London: T and A D Poyser.

Risebrough, R. W., A. M. Springer, S. A. Temple, C. M. White, J. L. B. Albuquerque, P. H. Bloom, R. W. Fyfe, M. N. Kirven, B. A. Luscombe, D. G. Roseneau, M. Sander, N. J. Schmitt, C. G. Thelander, W. G. Vasina and W. Walker II (1990) Observaciones del Halcon Peregrino, *Falco peregrinus* subspp. en America del Sur. *Rev.Brasil.Biol.* 50:563-574.

Rosenfield, R. N., J. W. Schneider, J. M. Papp and W. S. Seegar (1995) Prey of Peregrine Falcons breeding in West Greenland. *Condor* 97:763-770.

Schneider, R. and I. Wilden (1994) Choice of prey and feeding activity of urban Peregrine Falcons *Falco peregrinus* during the breeding season, p.203-209 In B.-U. Meyburg and R. D. Chancellor (eds.), *Raptor conservation today.* Berlin: WWGBP/The Pica Press.

Sherrod, S. K. (1983) *Behavior of fledgling peregrines.* Ithaca: The Peregrine Fund, Inc.

Sick, H. (1960) Notas sobre *Falco peregrinus anatum* Bonaparte no Brasil. *Publ. Avuls. Mus. Nac.* n 34.

___ (1961) Peregrine Falcon hunting bats while wintering in Brazil. *Auk* 78:646-648.

___ (1989) Der kanadische wanderfalke, *Falco peregrinus tundrius* in Brasilien. *Mitt. Zool. Mus. Berl.* 65, Suppl.: Ann. Orn. 13:27-36.

___ (1997) *Ornitologia Brasileira.* Rio de Janeiro: Ed. Nova Fronteira.

Silva e Silva, R. (1996) Records and geographical distribution of the Peregrine Falcon *Falco peregrinus* Tunstall, 1771 (Aves, Falconidae) in Brazil. *Papéis Avulsos Zool.* 39:249-270.

Stager, K. E. (1941) A group of bat-eating Duck Hawks. *Condor* 43:137-139.

White, C. M. (1968) Diagnosis and relationships of North American tundra-inhabiting Peregrine Falcons. *Auk* 85:179-191.

Witeck, A. J. (1988) Dados preliminares sobre *Falco peregrinus* na cidade de Rio Grande/RS. An. III Enc. Nac. Anilhadores de Aves, São Leopoldo, 1988, 117-119.

Ararajuba 5(2):209-218
dezembro de 1997

Aves do Arquipélago dos Abrolhos, Bahia, Brasil

Vania S. Alves[1], Ana Beatriz A. Soares[1,2], Gilberto S. do Couto[1], Anna Beatriz B. Ribeiro[1] e Márcio A. Efe[3]

[1] *Instituto de Biologia, Departamento de Zoologia, Universidade Federal do Rio de Janeiro, Centro de Ciências da Saúde, Ilha do Fundão, 21941-590, Rio de Janeiro, RJ, Brasil. E-mail: vsalves@acd.ufrj.br*
[2] *Pós-graduação em Biologia Animal, Universidade Federal Rural do Rio de Janeiro, Instituto de Biologia, DBA km 47, Seropédica, 23851-970, Rio de Janeiro, RJ, Brasil. E-mail: aroeira@abeu.com.br*
[3] *Rua Alzira Rosa de Aguiar nº 274, Rio Vermelho, 88058-770, Florianópolis, SC, Brasil*

Recebido em 31 de março de 1997; aceito em 04 de novembro de 1997

ABSTRACT. **Birds of Abrolhos Archipelago, Bahia state, Brazil.** Ecological and behavioral studies of the birds in Abrolhos Archipelago were carried out in 14 visits between August 1990 and July 1995. Thirty-two species were recorded among visitants and residents. The majority of the birds recorded is represented by six species of breeding seabirds. The occurrence and breeding of *Phaethon lepturus* was recently registered. *Caracara plancus* (two individuals) and *Passer domesticus* (a stablished population) are the landbird resident species. Seven migratory species of the north hemisphere were registered and another 16 are considered occasional visitants. The occurrence of visitant species indicates that distance is not the main reason for the lack of landbirds. The low vegetation of Abrolhos seems to be the main factor limiting the establishment of new species. Introduced rats and cats may be a serious threat to breeding seabirds. Studies of breeding cycles and ecology of species are essential for the management of this ecosystem.

KEY WORDS: Abrolhos Archipelago, ecology, seabirds.

RESUMO. Estudos sobre a ecologia e o comportamento das aves do Arquipélago dos Abrolhos, foram desenvolvidos em 14 excursões no período de agosto de 1990 a julho de 1995. Trinta e duas espécies, dentre residentes e visitantes, foram registradas. A maior parte da avifauna está representada por seis espécies marinhas nidificantes. Recentemente foi registrada a ocorrência e nidificação de *Phaethon lepturus*. *Caracara plancus* (dois indivíduos) e *Passer domesticus* (uma população estabelecida) são as espécies terrestres residentes. Foram assinaladas sete espécies migratórias do hemisfério norte e 16 consideradas visitantes ocasionais. O aparecimento de espécies visitantes indica que a distância não é a causa principal da carência de aves terrestres. O pequeno porte da vegetação de Abrolhos parece ser o principal fator limitante ao estabelecimento de novas espécies. Ratos e gatos introduzidos podem ser uma séria ameaça para as aves marinhas nidificantes. Estudos sobre os ciclos reprodutivos e a ecologia das espécies são essenciais ao manejo deste ecossistema.

PALAVRAS-CHAVE: Arquipélago dos Abrolhos, aves marinhas, ecologia.

Os estudos sobre aves marinhas na costa brasileira são escassos se comparados aqueles referentes às espécies terrestres. Este fato se deve, em parte, à dificuldade de acesso a muitas das ilhas onde existem colônias dessas aves, e a carência de estudos em alto mar à bordo de embarcações.

Algumas importantes contribuições para o conhecimento das espécies de aves marinhas na costa brasileira, são relatadas em Murphy (1915a,b, 1936), Novaes (1952), Watson (1966), Tickell e Woods (1972), Rumboll e Jehl (1977), Coelho (1981), Olson (1981), Oren (1982, 1984), Teixeira *et al.* (1985, 1986), Bege e Pauli (1988), Nacinovic e Teixeira (1989) e Antas (1991). Os resultados de muitos desses trabalhos evidenciam importantes áreas de reprodução para diversas espécies. Darwin em 1832 coletou em Abrolhos inúmeros exemplares de aves que, no entanto, não foram identificadas nem preservadas (Murphy 1936). Lucas (1890) coletou material osteológico e cita para Abrolhos *Sula cyanops* (= *Sula dactylatra*), *Phaethon aethereus* e *Fregata aquila* (= *Fregata magnificens*).

Murphy (1936) descreveu a vegetação de Abrolhos como composta apenas por cactos e pequenos arbustos. Relata que as ilhas são cobertas por ninhos de inúmeras aves marinhas, sobre as quais parece haver poucas informações. A única espécie identificada foi *S. dactylatra* mas, o autor comenta que sem dúvida outras espécies de atobás, fragatas, *Sterna fuscata* e uma ou as duas espécies do gênero *Anous*, devam constituir as populações de aves marinhas residentes.

Ihering (1941) relata aspectos do comportamento de pesca de *Sula leucogaster* e cita Mesquita (1924) que menciona esta espécie como sendo conhecida por "piloto" em Abrolhos. Este autor comenta que em finais de tarde, ao se recolherem à ilha Redonda, essas aves eram forçadas por pescadores a regurgitarem o peixe capturado.

Coelho (1981) efetuou observações sobre a avifauna de Abrolhos em 1969, tendo registrado *S. leucogaster, S. dactylatra, F. magnificens* e *P. aethereus* como espécies residentes. Também há o registro de *Anous stolidus, Charadrius semipalmatus, Arenaria interpres, Hirundo rustica erythrogaster* e um registro de *Gygis alba* próximo ao arquipélago. O autor cita outras espécies ocasionais, mas que foram observadas por moradores locais, durante a estação das chuvas, como bem-te-vis, anús-pretos, outras espécies de gaviões (Accipitridae), garças-brancas (possivelmente *Egretta thula*, Ardeidae) e marrecas (Anatidae).

Inês Nascimento (com. pess., 1989) observou no arquipélago *S. dactylatra, S. leucogaster, P. aethereus, F. magnificens, S. fuscata, A. stolidus, Passer domesticus* (cerca de 50 indivíduos na Ilha de Santa Bárbara), *C. semipalmatus, A. interpres, Numenius phaeopus, Vanellus chilensis, Bubulcus ibis, Egretta thula, Casmerodius albus* e *Athene cunicularia.*

Desde 1990 o Grupo de Estudos de Aves Insulares do Laboratório de Ornitologia da Universidade Federal do Rio de Janeiro vem pesquisando as aves marinhas que nidificam no Arquipélago dos Abrolhos, Bahia, Brasil. Espécies visitantes, migratórias ou não, são também comentadas no presente trabalho. Como este estudo vem sendo desenvolvido de modo sistemático há cerca de cinco anos, foi verificada uma variação temporal na ocorrência de espécies de aves terrestres.

MÉTODOS

Com o objetivo de realizar estudos sobre a ecologia e o comportamento das espécies nidificantes no arquipélago, foram realizadas excursões nos seguintes períodos: 1990, 19 a 23 de agosto (5 dias) e 15 a 31 de outubro (17 dias); 1991, 07 a 23 de fevereiro (17 dias) e 20 de abril a 05 de maio (16 dias); 1992, 15 a 26 de janeiro (12 dias), 26 de março a 04 de abril (10 dias), 25 a 30 de maio (6 dias); 1994, 06 a 10 de março (5 dias), 15 a 19 de julho (5 dias) e 27 a 31 de outubro (5 dias); 1995, 25 a 31 de março (7 dias), 30 de abril a 11 de maio (12 dias), 04 a 13 de junho (10 dias) e 29 e 30 de julho (2 dias).

Para o registro das espécies, utilizou-se binóculos de médio alcance (8 x 30, 7 x 35) e luneta com aumentos de 20 a 60 vezes. As aves marinhas foram marcadas com anilhas metálicas do Cemave (Centro de Pesquisas para a Conservação das Aves Silvestres/IBAMA). No momento do anilhamento comumente as aves regurgitam o alimento que ingeriram. Este material foi coletado, fixado em formol a 10% e preservado em álcool a 70 %, para posterior identificação da dieta.

As populações nidificantes das aves marinhas em cada período de estudo, foram avaliadas com base na contagem dos ninhos ativos (com ovos e/ou filhotes).

ÁREA DE ESTUDO

O arquipélago dos Abrolhos está localizado a aproximadamente 70 km do litoral sul da Bahia (17°58'S, 38°42'W) sendo composto por cinco ilhas: Santa Bárbara, Siriba, Sueste, Redonda e Guarita (figura 1). O Parque Nacional Marinho dos Abrolhos, primeiro do gênero criado no Brasil, em 1983, possui uma área aproximada de 266 milhas náuticas quadradas (91.300 ha). É composto por duas áreas distintas, a maior formada pelo Parcel dos Abrolhos e Arquipélago dos Abrolhos (excluindo-se deste a Ilha de Santa Bárbara sob jurisdição e controle da Marinha) e a menor, correspondendo aos Recifes de Timbebas (IBAMA-FUNATURA 1991).

Sua origem ainda é bastante discutida. Levantamentos magnetométricos, perfurações e a ocorrência de rochas magmáticas comprovam a origem vulcânica do seu substrato. Porém, face à complexidade de sua gênese, é adequado definir-se o Arquipélago dos Abrolhos como um complexo vulcânico intrusivo (Asmus 1989, com. pess. *apud* IBAMA-FUNATURA 1991).

A temperatura média mensal do ar em Abrolhos varia entre 24,2°C (julho) e 27°C (fevereiro-março); os valores médios mensais de precipitação oscilam entre 52,0 mm (agosto) e 113,8 mm (outubro), com um índice anual em torno de 718,5 mm; a direção dos ventos, na primavera e verão, varia entre norte e leste e no outono e inverno, entre sul e leste e a velocidade destes, durante tempestades, que ocorrem principalmente em abril e maio, pode ser superior a 30 nós (IBAMA-FUNATURA 1991).

Santa Bárbara é a maior ilha, com cerca de 1,5 km de extensão, 300 m de largura, estando a 35 m acima do nível do mar. Nesta ilha existe uma base da Marinha com oito residências, o farol, a estação-rádio, a casa de força, um paiol, uma capelą, e em média 18 moradores. Todas as construções foram feitas de modo a que o telhado funcione como coletor das chuvas, única fonte de água doce no arquipélago. Atualmente, é a única ilha onde há cabras (cerca de 60 a 80 indivíduos) que vivem soltas; as cabras que viviam na ilha Redonda foram retiradas em 1987. Siriba possui aproximadamente 300 m de extensão, 100 m de largura e está a 16 m acima do nível do mar. Sueste tem cerca de 500 m de extensão, 200 m de largura e 15 m de altitude, Redonda com cerca de 400 m de diâmetro e 36 m de altitude e Guarita, a menor ilha, com aproximadamente 100 m de extensão e 13 m de altitude (IBAMA-FUNATURA 1991). De Santa Bárbara à ilha mais distante, Sueste, são 1800 m, estando a ilha mais próxima, Guarita, a 350 m. Nas ilhas Siriba e Redonda os turistas desembarcam acompanhados por fiscais do IBAMA. Sueste e Guarita são consideradas áreas intangíveis, onde apenas com fins científicos o desembarque é permitido.

Características da vegetação das ilhas do Arquipélago dos Abrolhos. As ilhas apresentam uma cobertura vegetal de espécies herbáceas rasteiras e arbustivas, com raros espécimens de porte arbóreo introduzidos como *Terminalia catappa* (amendoeira) e *Cocos nucifera* (coqueiro). Esta vegetação seria resultado da distância do arquipélago em relação ao continente, do pouco solo existente que, dentre outros fatores, são limitantes ao aporte e estabelecimento de diásporos de espécies de grande porte (F. Agarez *in litt.* 1992).

A Ilha de Santa Bárbara é dominada por espécies ruderais, de pequeno porte, geralmente ervas. Em locais sombrios e com alguma disponibilidade de água destacam-se populações de *Nephrolepis exaltata*. Em cotas mais elevadas, há o predomínio de *Borreria verticillata*. Nas zonas de marés nas ilhas de Santa Bárbara, Siriba e Redonda ocorre predominantemente vegetação típica - *Alternanthera maritima* e *Blutaparon portulacoides*. Nas cotas mais elevadas da Ilha Redonda verifica-se o predomínio relevante de *Cyperus imbricatus* e nas cotas mais baixas, ocorrem espécies características de restingas, tais como, *Ipomoea pes-caprae, Stenotaphrum secundatum* e *Sophora tomentosa*. A maior parcela da Ilha Siriba é coberta por *Stenotaphrum secundatum* e por significativas populações de *Solanum nigrum* e *Cleome difusa*. De relevo suave, a Ilha Sueste é recoberta quase exclusivamente por espécies herbáceas e pequenos arbustos. Destaca-se o predomínio de populações de *Alternanthera brasiliana* e outras dispersas de *Solanum nigrum* e *Cyperus imbricatus*. Guarita constitui-se de um pequeno aglomerado de rochas, praticamente desprovida de solo e com reduzida vegetação, constituída por *Althernanthera maritima, Cyperus imbricatus* e *Blutaparon portulacoides* (F. Agarez *in litt.* 1992).

RESULTADOS E DISCUSSÃO

A Tabela 1 mostra as 32 espécies de aves, dentre residentes e visitantes, registradas no Arquipélago dos Abrolhos, no período de 1990 a 1995.

Aves Marinhas que nidificam em Abrolhos

Sula leucogaster - piloto-pardo. Reproduz-se durante todo o ano, havendo colônias reprodutivas nas ilhas Sueste e Redonda e casais isolados nas ilhas de Santa Bárbara e Siriba. Esta espécie tem preferência por áreas periféricas e acidentadas para construir seu ninho, utilizando vários tipos de materiais como gravetos, folhas e raízes. Os ninhos quando localizados perto da linha de maré, comumente são construídos próximos a rochas ou mesmo troncos trazidos pelo mar, que segundo Dodson e Fitzgerald (1980) funcionariam como anteparos permitindo uma maior densidade de ninhos.

O macho possui o bico afilado, amarelo-azulado e a pele em volta dos olhos azul. A fêmea possui o bico mais grosso, comprido e amarelo-rosado, uma mancha escura à frente de cada olho e porte mais desenvolvido.

Além disso a voz do macho é bem distinta da voz da fêmea. As exibições aéreas, comuns do piloto-pardo, provavelmente ajudam a consolidar a formação do par e reforçam o vínculo com o local do ninho (Simmons 1967, Nelson 1970, 1978). Na fase de côrte o macho escolhe um local para o ninho e tenta atrair a atenção da fêmea, através da exibição de comportamentos como o de apontar o céu. Este comportamento consiste em esticar o pescoço, apontar o bico verticalmente para cima, levantar a cauda, agitando um pouco as asas sem afastá-las do corpo, emitindo vocalização típica. Esta é a única espécie de atobá que também exibe este comportamento em vôo (Nelson 1970, 1978).

Após a formação do casal, no período que antecede à postura dos ovos, ocorrem muitos comportamentos relacionados à construção do ninho (como pegar e ajeitar material no ninho), e à manutenção do par (como tocar bicos, vocalizar, arrumar a plumagem do parceiro, etc).

Entre março e julho dos anos de 1994 e 1995 foi registrado o maior número de ninhos com ovos. Considerando apenas os ninhos com ovos e/ou filhotes, a população dessa espécie foi estimada, no mês de julho de 1994, em cerca de 400 indivíduos.

Sula dactylatra - atobá-branco. É a espécie mais comum em Abrolhos, reproduzindo-se em todas as ilhas do arquipélago, com as maiores concentrações nas ilhas de Santa Bárbara, Siriba e Sueste. O ninho, com pouco ou nenhum material, é construído preferencialmente, em áreas planas (Nelson 1978). Esta espécie é mais robusta e tem maior dificuldade em levantar vôo que o piloto-pardo, necessitando correr alguns passos antes de alçar vôo. Macho e fêmea são semelhantes morfologicamente. A côrte envolve deslocamentos no território, construção, em geral simbólica, do ninho e muita vocalização. Em julho de 1994 foram registrados cerca de 800 indivíduos com ovos e/ou filhotes no arquipélago.

Coelho (1981) cita como sendo comuns e abundantes as duas espécies de *Sula* em Abrolhos. Nosso estudo mostrou que *S. leucogaster* nidifica em menor número e praticamente em apenas duas ilhas (Sueste e Redonda). Em julho de 1994, o número de indivíduos com ovos e/ou filhotes, era equivalente a metade do número de *S. dactylatra* nestes estágios. É possível que o menor número de *S. leucogaster* em Abrolhos esteja ligado ao fato desta espécie ser menos pelágica, nidificar preferencialmente em penhascos (Nelson 1978) e ser mais arisca. As colônias estão restritas às áreas periféricas um pouco acidentadas das ilhas Sueste e Redonda, ocorrendo em maior número onde recebem de frente o vento predominante (nordeste), que facilita a decolagem. Este fato pode ser devido à carência de penhascos em Abrolhos. Deve ser comentado que a presença de anteparos entre ninhos pode influenciar na densidade das colônias do piloto-pardo permitindo maior proximidade destes (Dodson e Fitzgerald 1980). Por outro lado, Nelson (1970, 1978) comenta que o principal fator limitante de populações de aves marinhas tropicais é a oferta de alimento, sendo o espaço para nidificação raramente limitante.

Além disso, observações realizadas nas colônias das duas espécies conduziram a evidências de que o piloto-pardo é bem mais arisco que o atobá-branco, ressentindo-se de interferências próximas ao seu ninho, chegando a abandoná-lo temporariamente, mesmo quando contem

Tabela 1. Ocorrências das espécies de aves no Arquipélago de Abrolhos.

Espécies	Mês Ano	08 90	10 90	02 91	04-05 91	01 92	03-04 92	05 92	03 94	07 94	10 94	03 95	04-05 95	06 95	07 95
Phaethon aethereus		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Phaethon lepturus						X	X		X		X				
Sula dactylatra		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sula leucogaster		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fregata magnificens		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Casmerodius albus		X			X				X		X				X
Egretta thula								X			X	X			X
Bubulcus ibis					X										
Caracara plancus				X		X		X		X	X		X		
Falco peregrinus						X									
Pluvialis squatarola				X			X		X		X				
Charadrius semipalmatus				X	X	X	X	X	X	X	X	X	X	X	X
Arenaria interpres				X	X	X	X	X	X	X	X	X	X	X	X
Numenius phaeopus		X		X	X	X	X	X	X	X	X	X	X	X	X
Vanellus chilensis									X		X	X			
Larus (maculipennis)								X							
Sterna fuscata		X	X		X		X	X		X			X	X	X
Anous stolidus		X			X		X	X		X		X	X	X	X
Columbina picui				X											
Columbina talpacoti												X			
Coccyzus (*melacoryphus*)												X			
Satrapa icterophrys							X								
Tyrannus melancholicus							X		X			X			
Elaenia sp.							X					X			
Myiophobus fasciatus												X			
Notiochelidon cyanoleuca					X										
Stelgidopteryx ruficollis												X			
Hirundo rustica											X				
Leistes superciliaris				X											
Volatinia jacarina												X	X		
Dolichonyx oryzivorus								X							
Passer domesticus		X	X	X	X	X	X	X	X	X	X	X	X	X	X

filhote recém-nascido. Dorward (1962) cita o comportamento do piloto-pardo de abandonar rapidamente o ninho quando alarmado. A maior colônia de *S. leucogaster* em Abrolhos localiza-se justamente na Ilha Sueste, onde o desembarque é restrito.

Somente na ilha Sueste foram registrados ninhos das duas espécies bem próximos. Nas outras ilhas, onde nidificam, geralmente ocorre uma segregação por hábitat. As duas espécies de *Sula* reproduzem-se durante todo o ano. Muitas aves são afetadas no comportamento e na fisiologia pela exposição ao estímulo visual e auditivo de seus coespecíficos e atualmente existe forte evidência de que ocorre sincronismo de grupo em aves que se reproduzem em colônias (Nelson 1970). Durante este trabalho muitas vezes foram observadas variações no estágio do ciclo reprodutivo, principalmente de *S. dactylatra,* em relação às ilhas do arquipélago. Por exemplo, enquanto em uma ilha a maior parte dos indivíduos da colônia estava no ínicio da côrte, em outra, grande parte dos ninhos possuia filhotes de 1-3 meses de idade.

As duas espécies de *Sula* em geral põem dois ovos. No período de 1990 a 1995 foram registrados 2.075 ninhos de *S. dactylatra* com ovos, em 71,7 % havia dois ovos e em 28,3 % apenas um. No mesmo período foram registrados 946 ninhos de *S. leucogaster* com ovos, sendo 64,8 % com dois e 35,2 % com um.

O filhote é alimentado pelos adultos com peixes e lulas, até cerca de quatro meses de idade (Nelson 1978). As duas espécies de *Sula* em Abrolhos, consomem principalmente o peixe-voador (*Hemiramphus brasiliensis*). Raramente criam mais de um filhote, o segundo, caso nasça é expulso do ninho pelo mais velho, como tivemos a oportunidade de observar por diversas vezes. Segundo Nelson (1978), os ovos eclodem assincronicamente e é extremamente raro o segundo filhote sobreviver. Dorward (1962) afirma que apenas um filhote é criado independente da oferta de alimento e sugere que o segundo ovo, colocado cerca de cinco dias depois do primeiro, funcione como "uma segurança contra a perda de um durante a incubação". Simmons (1967) embora concorde com esta afirmação, a interpreta de forma mais ampla, como sendo parte do sistema de adaptações.

Coelho *et al.* (em prep.) registraram um caso de sucesso na criação de dois filhotes de *S. leucogaster* na Ilha de Cabo Frio em Arraial do Cabo, Rio de Janeiro. Em Abrolhos, em duas ocasiões, foram registrados dois filhotes de *S. leucogaster* (com cerca de sete semanas) em um mesmo ninho. Também registrou-se um caso semelhante para *S. dactylatra.* Bege e Pauli (1988) também registraram um caso de criação de dois filhotes em *S. leucogaster* nas Ilhas Moleques do Sul, em Santa Catarina.

Anous stolidus - benedito. Anualmente reproduz-se em Abrolhos, de março a setembro, e posteriormente migra para outras áreas. A principal colônia localiza-se na Ilha Guarita, havendo registros de ninhos isolados no costão sudeste da Ilha Santa Bárbara. Em março de 1995, no início do período reprodutivo e na mesma ilha, a população foi estimada em 3,000 indivíduos (Soares 1997).

Não há dimorfismo sexual aparente. A postura, em geral, de apenas um ovo, é feita diretamente no solo, ou em ninhos confeccionados com algas do gênero *Sargassum*, além de vegetais terrestres. Existem casos de dois ovos no mesmo ninho, o que pode ser devido à ocupação de um ninho já com ovo, ao rolamento de ovos de ninhos próximos, ou mesmo à postura de dois ovos. Diamond e Prys-Jones (1986) comentam sobre a possibilidade de uma porcentagem muito pequena de *A. stolidus* no Atol de Aldabra colocar dois ovos.

Phaethon aethereus - grazina. Reproduz-se em todas as ilhas, utilizando como local para ninho, reentrâncias em penhascos e cavidades entre blocos de rochas no solo. Desloca-se no solo com dificuldade, utilizando bico e asas no auxílio à essa locomoção.

Esta espécie não apresenta dimorfismo sexual. A côrte, essencialmente aérea, ocorre em grupos compostos por um ou mais pares, aos quais podem se associar indivíduos isolados. Em vôo, é comum um dos membros do par voar sobre o outro, emitindo uma vocalização típica e levantando bem as asas. O indivíduo que voa sob o outro por vezes também emite uma vocalização e ambos abaixam as asas perdendo altura. Buckley e Buckley (1970) descrevem comportamentos semelhantes para *Phaethon lepturus* e, com base em caracteres morfológicos, associam os indivíduos que voavam por cima a machos e os voando por baixo a fêmeas.

No mês de junho de 1992, foram registrados 70 casais em ninhos com ovo ou filhote nas quatro maiores ilhas de Abrolhos. Coelho (1981) cita esta espécie como pouco comum, nidificando em locais isolados nas ilhas de Santa Bárbara, Redonda e Sueste. Por outro lado, Antas (1991) comenta que a maior colônia dessa espécie, no litoral brasileiro, está em Abrolhos, sendo rara em Fernando de Noronha.

Phaethon lepturus - rabo-de-palha-de-bico-laranja. O primeiro registro de *P. lepturus* para Abrolhos ocorreu em janeiro de 1992, quando um indivíduo foi capturado na Ilha Redonda. Outro indivíduo foi localizado no ninho com um ovo, na Ilha de Santa Bárbara (Efe *et al.* em prep.). Em abril de 1992, foram observados cinco indivíduos em vôo e em outubro de 1994 um indivíduo foi registrado na Ilha de Santa Bárbara. Até então havia apenas o registro de nidificação desta espécie na costa brasileira no Arquipélago de Fernando de Noronha (Oren 1984, Nacinovic e Teixeira 1989).

Sterna fuscata - trinta-réis-das-rocas. Alguns poucos indivíduos utilizam a Ilha Guarita para nidificar, no mesmo período em que *A. stolidus*; a maior colônia no mundo localiza-se no Atol das Rocas (Schulz-Neto em prep.).

Fregata magnificens - tesourão. Esta espécie reproduz-se apenas na Ilha Redonda no lado oeste; o ninho é construído sobre touceiras de Ciperáceas, onde deposita pequenos gravetos que, juntamente com as fezes, tornam o ninho compacto. A postura é de apenas um ovo branco, que é incubado pelos adultos, em sistema de revezamento, por cerca de 40 dias. O filhote com um mês de idade apresenta penugem branca que vai sendo substituída pelas penas e, aos quatro meses, já ensaia seus primeiros vôos. Em fevereiro de 1991 foram registrados 123 ninhos ativos, a maioria com filhotes de 4-5 meses de idade. Em março de 1994 foram registrados 115 filhotes, sendo 65 com 5-6 meses de idade. Em outubro de 1994 a colônia apresentava 166 ninhos ativos, destes 54 com filhotes de um mês de idade, 20 com recém-nascidos e 92 com ovos. Em 1991 o ciclo reprodutivo em Abrolhos teve início em julho-agosto. Em janeiro de 1992, a maioria dos filhotes já estava com cerca de quatro meses.

Indivíduos adultos de fragatas, quando importunados, voam ou deslocam-se rapidamente pela colônia. Geralmente indivíduos jovens e às vezes adultos, podem causar a quebra de ovos, ferimentos e mesmo a morte de filhotes pequenos.

A fragata alimenta-se de peixes capturados na superfície da água e nas pequenas poças, que se formam quando a maré baixa. Pode ainda roubar o alimento de outras aves, como de *S. leucogaster, S. dactylatra* e *P. aethereus.* São comuns os registros de fragatas roubando o alimento dos atobás quando estes estão alimentando os filhotes. Foi observado, em duas ocasiões, fragata com ovo, semelhante ao de *A. stolidus*, no bico.

Foram freqüentes os registros de indivíduos, na maioria jovens, pousados nas escarpas do lado noroeste da Ilha de Santa Bárbara. Coelho (1981) cita indivíduos que dormiam pousados na borda superior do penhasco do lado sul desta ilha.

Aves terrestres residentes

Passer domesticus - pardal. Essa espécie, que apresenta uma população estabelecida, foi registrada principalmente na Ilha de Santa Bárbara sempre em bandos e tem-se notado que o número de indivíduos vem aumentando desde 1990. É comumente observada nas reentrâncias de rochas, nas poucas formas arbóreas (amendoeiras e coqueiros) e principalmente próximo às residências existentes nessa ilha, que possuem jardins e pequenas hortas.

Caracara plancus - caracará. Dois indivíduos foram freqüentemente registrados em Abrolhos, principalmente na Ilha Redonda. Efetuam incursões às outras ilhas. Em abril de 1991, foi observado um indivíduo com um *A. stolidus* no bico (A. N. Corrêa, com. pess., 1991).

Migrantes do hemisfério norte

Charadrius semipalmatus - batuíra-de-bando. Registrada em Abrolhos em praticamente todas as excursões. Costuma alimentar-se nas áreas periféricas das ilhas bem como nas áreas do topo, freqüentemente em companhia de *A. interpres*, formando bandos mistos.

Arenaria interpres - vira-pedras. Costuma se concentrar nas áreas do topo e da periferia das ilhas, juntamente com *C. semipalmatus*. Um grupo de seis indivíduos foi visto se deslocando rapidamente nas pedras, na maré baixa, capturando *Lygia* sp. (baratinha-da-praia-viúva).

Numenius phaeopus - maçaricão. Outra espécie igualmente freqüente em Abrolhos, sendo comum no topo das ilhas e nas pedras próximas ao mar, particularmente no período de maré baixa.

Pluvialis squatarola - batuiruçu-de-axila-preta. É uma espécie de hábito mais solitário, tendo sido registrada em apenas três ocasiões; em uma delas um indivíduo capturava poliquetas na praia da Ilha de Santa Bárbara.

Falco peregrinus - falcão-peregrino. Registrado nos dias 23 e 26 de janeiro de 1992. O indivíduo que foi visto deslocava-se de Santa Bárbara em direção à Ilha Redonda, e perseguiu um dos caracarás (*C. plancus*) que sobrevoava o local.

Dolichonyx oryzivorus - triste-pia. Registrado em 30 de maio de 1992, no topo da Ilha de Santa Bárbara, alimentando-se no solo. Segundo Sick (1997) esta espécie é migrante da América do Norte.

Hirundo rustica - andorinha-de-bando. Foi registrado um indivíduo sobrevoando a Ilha de Santa Bárbara em outubro de 1994. O trabalho de Coelho (1981) cita a ocorrência de um bando, com cerca de oito indivíduos de *Hirundo rustica erythrogaster* para o mesmo mês.

Outros visitantes

Casmerodius albus - garça-branca-grande. Visitante ocasional, registrado nos meses de agosto de 1990, abril de 1991, março e outubro de 1994 e julho de 1995.

Egretta thula - garça-branca-pequena. Foram registrados indivíduos em maio de 1992, outubro de 1994, março e julho de 1995. Inês Nascimento (com.pess., 1989) comenta o registro dessa espécie para as ilhas de Santa Bárbara e Redonda.

Bubulcus ibis - garça-vaqueira. Foi registrado um grupo de 16 indivíduos em 28 de abril de 1991 na Ilha de Santa Bárbara. Inês Nascimento (com. pess., 1989) observou essa espécie na mesma ilha.

Vanellus chilensis - quero-quero. Registros efetuados em março e outubro de 1994 e março de 1995. Inês Nascimento (com. pess., 1989) cita a presença desta espécie.

Larus (*maculipennis*) - gaivota-maria-velha. Indivíduo isolado, observado em duas ocasiões, sobrevoando a Ilha de Santa Bárbara em 25 de maio de 1992. Não foi observado em detalhes.

Columbina picui- rolinha-branca. Um indivíduo isolado registrado na Ilha Siriba em 17 de fevereiro de 1991.

Columbina talpacoti - rolinha. Um indivíduo observado em 25 de março de 1995 na Ilha Siriba.

Coccyzus (*melacoryphus*) - papa-lagarta. Um único indivíduo que não foi observado em detalhes, registrado na Ilha Siriba em 25 de março de 1995.

Satrapa icterophrys - suiriri-pequeno. Apenas um indivíduo pousado em fio em Santa Bárbara em 04 de abril de 1992.

Tyrannus melancholicus -suiriri. Quatro indivíduos pousados em fios na Ilha de Santa Bárbara em março-abril de 1992. Também registrados alguns indivíduos em março de 1994 e março de 1995.

Elaenia sp. Dois indivíduos tentando se abrigar do vento, pousados em amendoeira na Ilha Siriba em março-abril de 1992. Também registrada em março de 1995.

Myiophobus fasciatus - filipe. Registro de um exemplar na Ilha Redonda em 26 de março de 1995.

Notiochelidon cyanoleuca - andorinha-pequena-de-casa. Alguns indivíduos isolados foram vistos sobrevoando a Ilha de Santa Bárbara em 28 de abril de 1991.

Stelgidopteryx ruficollis - andorinha-serrador. Um exemplar sobrevoando a Ilha Redonda em 27 de março de 1995.

Leistes superciliaris - polícia-inglesa-do-sul. Único registro em 23 de fevereiro de 1991.

Volatinia jacarina - tiziu. Registros de grupos nos meses de março e maio de 1995.

Além destas espécies há registros de *Gygis alba*, a cerca de 7 km do arquipélago (Coelho 1981) e *Speotyto cunicularia*, observada na Ilha de Santa Bárbara por Inês Nascimento (com. pess., 1989).

Em contraste com a extrema riqueza da fauna marinha, pode-se dizer que a fauna terrestre do Arquipélago dos Abrolhos apresenta-se pobre, refletindo a limitação ambiental - pouco espaço disponível e reduzidas fontes alimentares (IBAMA-FUNATURA 1991). As ilhas possuem solos extremamente rasos e azonais, apresentando, portanto, acentuado caráter de imaturidade (IBAMA-FUNATURA 1991) o que não propiciaria o surgimento de uma vegetação mais diversa e exuberante, ainda que a distância de fontes colonizadoras fosse menor.

Pelo menos para alguns grupos de aves a capacidade de dispersão é um fator limitante na colonização de ilhas. Algumas espécies têm dificuldade em transpor a barreira representada pelo mar, de acordo com MacArthur *et al.* (1972) que comenta que formicarídeos tais como *Formicivora grisea* e *Thamnophilus doliatus* são aves cujo comportamento sugere que raramente cruzariam uma extensão de mar.

Em Abrolhos, espécies registradas ocasionalmente, mostram que a distância de fontes colonizadoras não é um fator limitante ao ponto de impedir o estabelecimento de novas espécies de aves. Por não fornecerem alimento suficiente, suporte para ninhos e, especialmente, abrigo para as aves, acreditamos que a vegetação, constituída de poucas espécies arbóreas introduzidas pelo homem, como coqueiros e amendoeiras, e basicamente por plantas de pequeno porte (gramíneas, herbáceas e ciperáceas) seja a razão principal do não estabelecimento de novas espécies de aves no arquipélago. Durante o inverno, quando é comum a ocorrência de fortes ventos na região, esta carência é mais evidente.

Várias espécies de aves terrestres foram registradas ao longo deste estudo (Tabela 1). Em geral eram indivíduos isolados, como *C. picui, C. talpacoti, L. superciliaris, e M. fasciatus,* com apenas uma ocorrência. Em alguns casos, como em *V. jacarina* e *T. melancholicus*, foram vistos pequenos grupos. *Volatinia jacarina* permaneceu de março a maio de 1995. Observou-se com certa freqüência *T. melancholicus* (março-abril de 1992, março de 1994 e março de 1995) porém não se estabeleceram.

De acordo com Pacheco e Gonzaga (1994), indivíduos de populações originárias do sul como os tiranídeos *T. melancholicus, S. icterophrys* e *M. fasciatus* parecem deslocar-se para o norte durante o inverno austral e chegar ao Rio de Janeiro, convivendo temporiamente com as populações locais ou substituindo parte da população do estado que também migrou para o norte. *Volatinia jacarina* ocorre em todo o Brasil, e em regiões mais meridionais (p. ex. São Paulo), desaparece durante o inverno. As populações do sul do Brasil de *Notiochelidon cyanoleuca* e *Stelgidopteryx ruficollis* são migratórias (Sick 1997).

É importante ressaltar que os ventos do sul são os mais fortes e em Abrolhos ocorrem principalmente no período de março a agosto (IBAMA-FUNATURA 1991). O maior número de visitantes - nove espécies (*E. thula, V. chilensis, C. talpacoti, Coccyzus* (*melacoryphus*), *T. melancholicus, Elaenia* sp, *M. fasciatus, S. ruficollis* e V. *jacarina*) foi registrado no mês de março de 1995, provavelmente em decorrência desses fortes ventos.

Para aves insetívoras como *T. melancholicus* ou certas granívoras como *V. jacarina*, que foi observada alimentando-se nas ciperáceas da Ilha de Santa Bárbara, a ausência de vegetação de maior porte que ofereça abrigo parece ser o principal fator limitante ao estabelecimento dessas espécies. Por outro lado, *P. domesticus*, bastante oportunista, está bem adaptado na Ilha de Santa Bárbara, encontrando abrigo nos telhados das residências e em reentrâncias das rochas e mesmo obtendo água nas cisternas das residências.

As aves marinhas, que nidificam no arquipélago, representam o grupo mais expressivo da fauna das ilhas. Aves limícolas comumente observadas são *C. semipalmatus, A. interpres* e *N. phaeopus.*

Deve ser ressaltado que a introdução acidental ou não, de animais estranhos à fauna insular é um aspecto a ser considerado e que deve ser melhor estudado. Em Abrolhos existem cabras, coelhos, gatos e ratos. Os dois últimos são conhecidos predadores de ovos e filhotes de aves marinhas. Os gatos foram levados para a Ilha de Santa Bárbara como um modo de controlar os ratos. Esses são atualmente pouco abundantes nessa ilha, mas, na ausência de predadores naturais, os gatos proliferaram. Pelo menos uma espécie de rato (*Rattus rattus*) está presente em todas ilhas. As cabras atualmente estão restritas à ilha de Santa Bárbara, onde vivem soltas, sendo em parte responsáveis pela destruição da vegetação, dificultando sua reconstituição e provocando erosão do solo.

Segundo Atkinson (1985) *R. rattus* é a espécie que mais freqüentemente está ligada ao declínio de populações de aves nas catástrofes induzidas por ratos em ilhas. De acordo com o mesmo autor, algumas aves como as terrestres endêmicas de pequeno porte (não previamente expostas à predação por mamíferos), as que nidificam em buracos, no solo ou próximo a este, e as que se utilizam de cavidades nas árvores são mais vulneráveis que outras. Johnstone (1985) afirma que *R. rattus* e *R. norvegicus* predam ovos e filhotes pequenos em ninhos desprotegidos de petréis que nidificam em buracos, em ilhas subantárticas. *Rattus norvegicus* e *R. rattus* uma vez estabelecidos, são um perigo real para aves marinhas segundo Antas (1991). Em Abrolhos, fezes de ratos são encontradas freqüentemente nos ninhos de grazinas (*P. aethereus*), o que evidencia a presença desses roedores nesses locais e sugere uma possível competição por espaço (entre rochas) onde estas aves nidificam. Nas ilhas Galápagos *R. rattus* também utiliza locais entre rochas. Alimenta-se de vegetais (preferindo frutos e sementes), também predando filhotes e ovos de aves. As fêmeas, em estágio de procriação, consomem mais itens de origem animal, sejam vivos ou mortos (Carrillo e Travéz 1983). Segundo Antas (1991), a introdução de gatos, ratos e talvez do lagarto (*Tupinambis teguixin*) em Fernando de Noronha, é um sério problema para as aves marinhas que nidificam no solo da ilha principal.

Numa comparação da avifauna marinha de Abrolhos com a de outras ilhas como Atol das Rocas e Fernando de Noronha, verifica-se que apesar de sua relativa proximidade da costa, Abrolhos possui espécies marinhas pelágicas como *S. dactylatra, A. stolidus, P. aethereus* e *P. lepturus* que também ocorrem naquelas ilhas, mais afastadas. Entretanto, estas três ilhas diferem muito entre si em aspectos como área, relevo, vegetação, distância da costa, etc. Fernando Noronha, por exemplo, possui uma área bem maior, vegetação de grande porte e populações de aves terrestres estabelecidas como os endemismos *Vireo gracilirostris, Zenaida auriculata noronha, Elaenia spectabillis ridleyana* (Oren 1984).

Phaethon aethereus tem sua maior colônia reprodutiva, no Brasil, em Abrolhos, nidificando também em Fernando de Noronha (Antas 1991); o autor comenta que seu status, como espécie reprodutora, é potencialmente vulnerável, embora as duas colônias reprodutivas conhecidas sejam em Parques Nacionais. Enfatiza a necessidade de censos da população nidificante desta espécie em Abrolhos, espe-

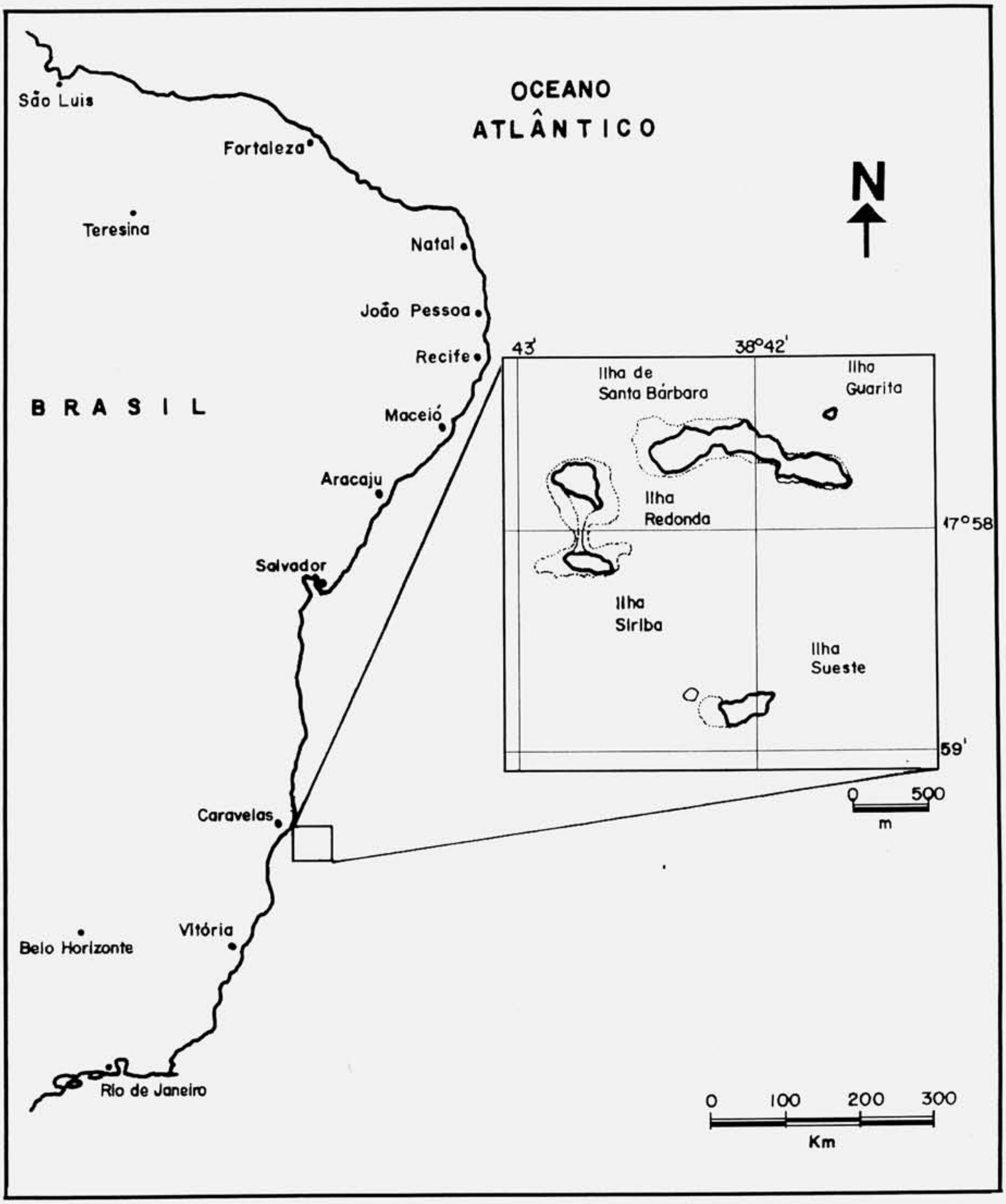

Figura 1. Área estudada com as ilhas Santa Bárbara, Redonda, Siriba, Sueste e Guarita.

cialmente na Ilha de Santa Bárbara, juntamente com uma avaliação da ameaça representada pelos ratos.

Sula dactylatra reproduz-se em todas as ilhas do arquipélago, estando as maiores concentrações nas ilhas de Santa Bárbara, Siriba e Sueste. Em decorrência da retirada das cabras em 1987, a vegetação do platô, constituída quase que totalmente por ciperáceas, expandiu-se de tal forma que atualmente se verifica uma acentuada redução do espaço disponível para nidificação de *S. dactylatra* nesta ilha.

As ilhas Sueste e Redonda são as duas únicas onde há colônias de *S. leucogaster.* Em Sueste não há desembarque, exceto com fins de pesquisa. Em Redonda é permitido o acesso de turistas, mas estes são orientados a não se aproximarem dos locais de nidificação, o que preserva, de certo modo, as colônias de viúva nesta ilha.

O atobá-branco (*S. dactylatra*) é mais tolerante à aproximação humana quando comparado ao piloto-pardo (*S. leucogaster*) que, ao abandonar temporariamente o ninho, pode causar a morte do filhote em decorrência das altas temperaturas registradas em Abrolhos, principalmente durante a estação do verão.

Sendo Abrolhos uma área de turismo, bastante intenso, nos meses de verão, o conhecimento do ciclo reprodutivo das espécies nidificantes, bem como dos aspectos de seu comportamento é fundamental no manejo deste ecossistema. Mesmo em face da problemática ambiental representada pelos predadores citados, o Parque Nacional Marinho dos Abrolhos, como Unidade de Conservação, tem sido importante na manutenção e aumento das populações de aves nidificantes, além de servir como local de descanso e alimentação para outras espécies ocasionais.

AGRADECIMENTOS

Dedicamos este trabalho à memória de Elias Pacheco Coelho pela sua incansável luta na preservação das aves marinhas. E também à Adolfo N. Corrêa (*in memoriam*), funcionário do IBAMA no Parque dos Abrolhos, que sempre nos apoiou durante nossa permanência no arquipélago. Agradecemos à Fundação Universitária José Bonifácio (FUJB-UFRJ), ao Centro de Pesquisas para Conservação das Aves Silvestres (CEMAVE-IBAMA), à FAPERJ (Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro) e à Associação Brasileira para Conservação das Aves (PROAVES) o apoio financeiro concedido. Ao Conselho Nacional de Desenvolvimento Científico Tecnológico (CNPq) pelas bolsas de Iniciação Científica e Aperfeiçoamento concedidas. Ao Instituto Brasileiro dos Recursos Naturais Renováveis (IBAMA), pelo apoio logístico nas estadias em Caravelas e no arquipélago. Ao IBAMA, em Brasília, a autorização para pesquisar a avifauna do Parque Nacional Marinho dos Abrolhos. À Marinha do Brasil o apoio e a autorização para o desenvolvimento do projeto na ilha de Santa Bárbara. À Universidade Federal do Rio de Janeiro (UFRJ), ao Departamento de Zoologia e ao Instituto Biologia pelo incentivo e apoio a nossas pesquisas. Agradecimento especial à amiga Maria Bernadete B. da Silva "Berna" (funcionária do IBAMA) que sempre nos auxiliou nas atividades de campo.

REFERÊNCIAS

Antas, P. de T. Z. (1991) Status and conservation of seabirds breeding in Brazilian waters. *ICBP Tech. Publ.* 11:141-159.

Atkinson, A. E. (1985) The spread of commensal species of *Rattus rattus* to oceanic islands and their effects on island avifaunas. *ICBP Tech. Publ.* 3:35-81.

Bege, L. A. R. e B. T. Pauli (1988) *As Aves nas Ilhas Moleques do Sul- Santa Catarina: Aspectos da Ecologia, Etologia e Anilhamento de Aves Marinhas.* Florianópolis: FATMA.

Buckley, P. A. e F. G. Buckley (1970) Notes on the distribution of some Puerto Rican birds and on the courtship behavior of White-tailed Tropicbirds. *Condor* 72:483-486.

Carrilo, G. O. e G. Travéz (1983) *Control de la rata negra en las zonas pobladas de las Islas Galapagos.* Estacion Cientifica Charles Darwin - Programa de Educacion Ambiental - Islas Galapagos. Puerto Ayora, Isla de Santa Cruz.

Coelho, A. G. M. (1981) Observações sobre a avifauna do Arquipélago dos Abrolhos, Bahia. *Univ. Fed. Pernambuco, Publ. Avuls.* 1:1-7.

Diamond, A. W. e R. P. Prys-Jones (1986) The biology of terns nesting at Aldabra Atoll, Indian Ocean, with particular reference to breeding seasonality. *J. Zool. Lond.* (A) 210:527-549.

Dodson, J. J. e G. J. Fitzgerald (1980) Observations on the breeding biology of the boobies (Sulidae) at Clipperton Island, Eastern Pacific. *Naturaliste Canadien* 107:259-267.

Dorward, D. F. (1962) Comparative biology of the White Booby and the Brown Booby *Sula* spp at Ascension. *Ibis* 103b:174-220.

IBAMA - FUNATURA (1991) *Plano de Manejo - Parque Nacional Marinho dos Abrolhos.* Brasília: Aracruz Celulose S.A.

Ihering, R. von (1941) *Dicionário dos Animais do Brasil.* São Paulo: Sec. Agric. Ind. Com. Est. São Paulo.

Johnstone, G. W. (1985) Threats to birds on subantarctic islands. *ICBP Tech. Publ.* 3:101-121.

Lucas, F. A. (1890) Catalogue of skeletons of birds collected at the Abrolhos islands, Brazil, the straits of Magellan, and the Galapagos islands in 1887-88 (Scient. Results of exploration by the U.S. Fish Commission Steamer Abrolhos, nº XIII. *Proc. U. S. Nat. Mus. Washington* 13(798):127-130.

MacArthur, R. H., J. M. Diamond e J. R. Karr (1972) Density compensation in island faunas. *Ecology* 53:330-342.

Mesquita, J. (1924) Algumas notas sobre a pesca em nossas costas. *Voz do Mar* nº 31 - Ano III. Rio de

Janeiro.

Murphy, R. C. (1915a) Ten hours at Fernando Noronha. *Auk* 32:41-50.

___ (1915b) The bird life of Trinidad Islet. *Auk 32*:332-348, pls. 23-25.

___ (1936) *Oceanic Birds of South America*. Vol 1 e 2. New York: Am. Mus. Nat. Hist.

Nacinovic, J. B. e D. M. Teixeira (1989) As aves de Fernando de Noronha: Uma lista sistemática anotada. *Rev. Bras. Biol.* 49:709-729.

Nelson, J. B. (1970) The relationship between behaviour and ecology in the Sulidae with reference to other sea birds. *Oceanogr. Mar. Ann. Rev.* 8:501-574.

___ (1978) *The Sulidae - Gannets and Boobbies*.Oxford: Oxford Univ. Press.

Novaes, F. C. (1952) Resultados ornitológicos da "Expedição João Alberto" à Ilha de Trindade. *Rev. Bras. Biol.* 12:219-228.

Olson, S.T. (1981) Natural history of vertebrates on the Brazilian islands of the Mid South Atlantic. *Nat. Geogr. Soc. Res. Reports* 13:481-492.

Oren, D. C (1982) Avifauna do Arquipélago de Fernando de Noronha. *Bol. Mus. Paraense Emílio Goeldi* 118:1-21.

___ (1984) Resultados de uma nova expedição zoológica à Fernando de Noronha. *Bol. Mus. Paraense Emílio Goeldi* 1:19-44.

Pacheco, J. F. e L. P. Gonzaga (1994) Tiranídeos do Estado do Rio de Janeiro provenientes de regiões austrais da América do Sul. *Notulas Faunisticas* 63:1-4.

Rumboll, M. A. E. e J. R. Jehl, Jr. (1977) Observations on pelagic birds in the South Atlantic Ocean in the austral spring. *Trans. San Diego Soc. Nat. Hist.* 19:1-16.

Sick, H. (1997) *Ornitologia Brasileira*. Rio de Janeiro: Ed. Nova Fronteira.

Simmons, K. E. L. (1967) Ecological adaptations in the life history of the Brown Booby at Ascension island. *Living Bird* 6:187-212.

Soares, A B.A . (1997) Biologia reprodutiva de *Anous stolidus* (Aves: Charadriiformes) no Arquipélago dos Abrolhos, Bahia. Tese de Mestrado. Rio de Janeiro: Univ. Fed. Rural Rio de Janeiro.

Teixeira, D. M., J. B. Nacinovic e R. Novelli (1985) Notes on some Brazilian seabirds. *Bull. Brit. Orn. Cl.* 105:49-51.

___ , ___ , I. M. Schloemp e E. E. Kischlat (1988) Notes on some Brazilian seabirds. (3). *Bull. Brit. Orn. Cl.* 108:136-139.

Tickell, W. L. e R. W. Woods (1972) Ornithological observations at sea in the South Atlantic Ocean, 1954 - 1964. *Br. Antarct. Surv. Bull.* 31:63-84.

Watson, G. E. (1966) *Seabirds of the Tropical Atlantic Ocean*. Smithsonian, Identification Manual. Washington, D.C.: Smithsonian Press.

Ararajuba 5(2):219-228
dezembro de 1997

O uso do tártaro emético no estudo da alimentação de aves silvestres no estado do Rio de Janeiro

Francisco Mallet-Rodrigues[1,2,4], **Vânia Soares Alves**[1] e **Maria Luisa Marinho de Noronha**[1,3]

[1] *Departamento de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, 21944-970, Rio de Janeiro, RJ, Brasil. E-mail: vsalves@acd.ufrj.br*
[2] *Pós-graduação em Zoologia, Museu Nacional, UFRJ, Quinta da Boa Vista s/n, 20940-040, Rio de Janeiro, RJ*
[3] *Instituto Municipal de Medicina Veterinária "Jorge Vaitsman"- Secretaria Municipal de Saúde, Av. Bartolomeu de Gusmão 1120, São Cristovão, 20641-160, Rio de Janeiro, RJ*

Recebido em 13 de junho de 1997; aceito em 29 de agosto de1997

ABSTRACT. **The use of tartar emetic in the study of diet of wild birds in Rio de Janeiro state.** Diet samples were obtained from wild birds forced to regurgitate using antimony potassium tartrate (tartar emetic) in a preliminary evaluation of this technique as applied to birds of restinga scrubland and Atlantic forest in three areas situated on Rio de Janeiro state, southeastern Brazil. Of the 214 birds (229 administrations) of 46 species that were given the emetic, 188 (82 %) regurgitated. Most of the positive response to the emetic was of birds belonging to the families Tyrannidae (100 %, N = 21), Emberizidae (90 %, N = 64) and Furnariidae (90 %, N = 41). Six birds (2,6 %) died after administration of the chemical, three of these having regurgitated. Twenty-three birds (12,5 %) of 12 species have been recaptured subsequently, some of these several times, and all were in good condition even after repeated administrations of the emetic.

KEY WORDS: Atlantic Forest, diet, regurgitation, restinga scrubland, Rio de Janeiro, tartar emetic

RESUMO. Foram obtidas amostras da dieta de aves através da regurgitação forçada pelo uso do Tartarato de Antimônio e Potássio (tártaro emético), numa avaliação preliminar realizada em ambientes de restinga e Floresta Atlântica, em três áreas situadas no estado do Rio de Janeiro, sudeste do Brasil. Foram realizadas 229 administrações do emético, em 214 indivíduos de 46 espécies, sendo que 188 (82 %) bem sucedidas. As famílias Tyrannidae (100 %, N = 21), Emberizidae (90 %, N = 64) e Furnariidae (90 %, N = 41) foram as que apresentaram melhor resposta ao emético. Seis indivíduos (2,6 %) morreram após a administração do emético, tendo três deles regurgitado antes do óbito. Vinte e três indivíduos (12,5 %) de 12 espécies foram recapturados em várias ocasiões, estando em boas condições, mesmo após sucessivas administrações do emético.

PALAVRAS-CHAVE: alimentação, Mata Atlântica, regurgitação, restinga, Rio de Janeiro, tártaro emético.

A alimentação das aves silvestres brasileiras é um assunto que vem sendo tratado desde o século passado, inicialmente de forma bastante esparsa, como nos trabalhos de Wied (1830-1833) e Burmeister (1856), recebendo neste século maior atenção. Moojen *et al.* (1941) apresentaram um trabalho sobre a alimentação de 189 espécies oriundas principalmente dos estados de Minas Gerais e Mato Grosso; Hempel (1949), em trabalho póstumo, abordou 61 espécies; Jimbo (1957) se ocupou dos Tinamidae, Schubart *et al.* (1965) estudaram 1900 espécimes de cerca de 600 espécies e subespécies de aves e Aguirre (1973, 1974, 1975) deu valiosa contribuição ao conhecimento da alimentação das avoantes. A análise do conteúdo gástrico de exemplares coletados foi o método utilizado por todos esses autores na determinação da dieta das aves. O recente avanço no conhecimento da alimentação das aves brasileiras vem sendo realizado através de diferentes métodos, como a análise do conteúdo gástrico (Cintra *et al.* 1990, Marini 1992, Penha 1995), das fezes (Pineschi 1990) e das pelotas regurgitadas (Silva-Porto e Cerqueira 1990, Motta-Júnior e Taddei 1992, Motta-Júnior e Talamoni 1996), bem como através da observação direta no campo (Brandt e Machado 1990, Magalhães 1990a, b, Alves 1991, Munson e Robinson 1992, Galetti e Pedroni 1996, Pizo 1996, Sick 1997).

Nos estudos sobre a ecologia de populações de aves, principalmente naqueles com a marcação de indivíduos com anilhas, a coleta de espécimes, para o exame do conteúdo gástrico, não é desejável, devido às alterações provocadas na população local pela retirada de indivíduos.

---

[4] *Bolsista* CNPq

Da mesma forma, considerações éticas e/ou dificuldades na coleta de grande número de espécimes por vezes inviabilizam estudos baseados em análises do conteúdo gástrico. Alternativamente, outros métodos para a obtenção de amostras da dieta vêm sendo utilizados, como a lavagem do tubo digestivo por ingestão forçada de solução salina (Moody 1970, Laursen 1978) e a administração de uma substância emética à ave. Kadochnikov (1967) desenvolveu o método do tártaro emético (Tartarato de Antimônio e Potássio) em aves para obter amostras do conteúdo gástrico por regurgitação após a ingestão da substância química. Esse método vem sendo utilizado recentemente por vários autores (Prys-Jones *et al.* 1974, Tomback 1975, Zach e Falls 1976, Lederer e Crane 1978, Poulin *et al.* 1992, 1994a,b, Poulin e Lefebvre 1995, 1996). Inédito ainda na literatura ornitológica brasileira, o método vem sendo por nós utilizado no estado do Rio de Janeiro, tendo sido tratados em sua maioria passeriformes insetívoros e onívoros.

MÉTODOS

O estudo relata os resultados obtidos entre fevereiro de 1996 e abril de 1997 em três áreas do estado do Rio de Janeiro, sendo uma área de Mata Atlântica primária de encosta, relativamente perturbada, a cerca de 350 m de altitude na Serra dos Órgãos (Município de Guapimirim - 22°31'S, 43°01'W); uma área de restinga bem preservada, ao nível do mar (Município de Carapebus - 22°16'S, 41°39'W) e Ilha de Santana (Município de Macaé - 22°24' S, 41°41'W), em ambientes de restinga e Mata Atlântica, moderadamente alterados. Nas três áreas as aves são capturadas com redes ornitológicas (12 x 2,5 m e malha 36 mm), anilhadas e tratadas com o emético antes de serem soltas.

A substância emética (solução à 1 % de Tartarato de Antimônio e Potássio) é fornecida oralmente às aves, logo após a captura, através de um tubo plástico flexível de 2,8 mm de diâmetro ligado a uma seringa plástica de 1 ou 3 cm^3. O tubo é cuidadosamente inserido até o esôfago da ave e a solução administrada lentamente na dosagem de 0,8 cm^3 para 100 g de massa corporal da ave. Após a administração do emético o indivíduo é acondicionado em uma caixa plástica coberta por um pano escuro para minimizar o estresse. Após 15 min. a ave é libertada e o material regurgitado, coletado com o auxílio de pinça e pincel, é preservado em álcool à 70 %. Posteriormente, o material é triado utilizando-se uma lupa estereoscópica, e os itens alimentares identificados ao menor nível taxonômico possível.

RESULTADOS

Foram tratados com o emético, nas três áreas, 214 indivíduos (229 tratamentos) pertencentes a 46 espécies (23 em Guapimirim, 19 em Carapebus e 9 na Ilha de Santana), de 13 famílias (tabelas 1 e 2). Apenas um dos indivíduos tratados em Guapimirim pertencia a espécie com peso médio abaixo de 15 g, enquanto em Carapebus e na Ilha de Santana foram tratados indivíduos com peso médio entre 10 e 225 g. Foram obtidas 188 amostras viáveis para análise após as 229 administrações do emético, o que corresponde a um sucesso de 82 %. As proporções de insucesso foram de 17% em Guapimirim, 14% em Carapebus e 10 % na Ilha de Santana. Seis indivíduos (2,6 %) morreram após a administração do emético (dois em Carapebus e quatro em Guapimirim), sendo que destes, três regurgitaram antes de morrer. Todos os demais indivíduos tratados voaram normalmente quando libertados.

Nas análises preliminares os itens de origem animal mais encontrados foram pedaços de élitros, cabeças de insetos, mandíbulas e quelíceras (figura 1). É importante citar a presença de muitos insetos inteiros encontrados na amostra de várias espécies de aves (figura 2). A presença de sementes inteiras (figura 3) também é comum nas amostras de certas espécies.

Dezoito espécies (39 %) apresentaram alguma resposta negativa ao tratamento com o emético, com pelo menos um indivíduo não regurgitando. Em três espécies tratadas não foram obtidas amostras, talvez pelo fato de apenas um indivíduo ter sido submetido ao emético em cada uma dessas espécies.

Sete espécies responderam por 54,5 % (125 indivíduos) do total tratado. Para a maior parte das espécies tratadas (74 %) foram obtidas no máximo cinco amostras, tendo sido *Pyriglena leucoptera* e *Philydor atricapillus* as espécies com as maiores amostras obtidas.

Analisando por família (tabela 2), considerando tamanho de amostra ≥ 10, a família com melhor resposta ao emético foi Tyrannidae, tendo Emberizidae e Furnariidae também apresentado bons resultados. A menor proporção de sucesso foi na família Dendrocolaptidae, seguida pela família Turdidae.

Distribuindo os indivíduos tratados em classes de massa corporal (intervalos de cinco gramas) não foi constatada relação significativa entre a resposta ao emético e o tamanho da ave ($x^2 = 14,56$, $p > 0,30$) (figura 4).

Itens de origem animal foram encontrados exclusivamente em 17 espécies (36,1 %). Em sete espécies (14,8 %) foram encontrados apenas itens vegetais, como sementes, cascas e polpa de frutos e 23 espécies (49,1 %) podem ser consideradas onívoras, por apresentarem itens de origem animal e vegetal nas amostras.

Vinte e três indivíduos (12,5 % dos 182 soltos após o tratamento com o emético), pertencentes à 12 espécies, foram recapturados. Um indivíduo de *Philydor atricapillus* foi submetido a quatro tratamentos com o emético, em ocasiões distintas, num período de dez meses, com intervalos entre os tratamentos de 44, 133 e 139 dias. Esse mesmo indivíduo foi recapturado 57 dias após o quarto tratamento, sem apresentar qualquer problema aparente. Dois indivíduos de *P. atricapillus* foram tratados em três ocasiões distintas, com um intervalo mínimo, entre duas capturas, de 64 dias e máximo de 105 dias. Todos os

Tabela 1. Espécies tratadas com o emético. Os números representam tratamentos (Área 1 - Guapimirim, Área 2 - Carapebus, Área 3 - Ilha de Santana).

Espécies	Área 1	Área 2	Área 3	Emético	Regurgitação	Sucesso (%)	Óbito
Leptotila rufaxilla	-	-	1	1	0	0	-
Malacoptila striata	1	-	-	1	1	100	-
Baryphthengus ruficapillus	2	-	-	2	2	100	-
Selenidera maculirostris	2	-	-	2	2	100	-
Picumnus cirratus	-	2	-	2	2	100	1
Veniliornis maculifrons	3	-	-	3	1	33	1
Formicivora rufa	-	1	-	1	1	100	-
Pyriglena leucoptera	30	-	-	30	22	73	2
Myrmeciza loricata	1	-	-	1	0	0	-
Formicarius colma	3	-	-	3	3	100	-
Conopophaga melanops	2	-	-	2	2	100	-
Anabazenops fuscus	1	-	-	1	1	100	-
Philydor atricapillus	26	-	-	26	24	92	1
Automolus leucophthalmus	9	-	-	9	8	89	-
Sclerurus scansor	5	-	-	5	4	80	-
Dendrocincla turdina	8	-	-	8	5	62,5	-
Sittasomus griseicapillus	1	-	-	1	1	100	-
Lepidocolaptes fuscus	13	-	-	13	8	61,5	-
Camptostoma obsoletum	-	2	-	2	2	100	-
Elaenia flavogaster	-	2	-	2	2	100	-
Elaenia cf. albiceps	-	4	-	4	4	100	-
Lathrotriccus euleri	1	-	2	3	3	100	-
Cnemotriccus fuscatus	-	1	-	1	1	100	-
Satrapa icterophrys	-	1	-	1	1	100	-
Myiarchus ferox	-	2	3	5	5	100	-
Myiarchus tyrannulus	-	1	-	1	1	100	-
Pitangus sulphuratus	-	1	-	1	1	100	-
Tyrannus melancholicus	-	1	-	1	1	100	-
Platycichla flavipes	1	1	1	3	2	66,5	-
Turdus rufiventris	2	-	-	2	2	100	-
Turdus leucomelas	-	-	6	6	4	66,5	-
Turdus amaurochalinus	-	6	-	6	3	50	-
Turdus albicollis	11	-	-	11	7	63,5	-
Cyclarhis gujanensis	1	-	-	1	1	100	-
Vireo chivi	-	-	4	4	3	75	-
Thlypopsis sordida	-	-	2	2	2	100	-
Tachyphonus coronatus	6	1	-	7	7	100	-
Trichothraupis melanops	21	-	-	21	21	100	-
Habia rubica	10	-	-	10	9	90	-
Ramphocelus bresilius	-	3	11	14	11	78,5	1
Thraupis sayaca	-	-	1	1	0	0	-
Euphonia chlorotica	-	1	-	1	1	100	-
Tangara peruviana	-	2	-	2	2	100	-
Zonotrichia capensis	-	2	-	2	1	50	-
Sicalis flaveola	-	2	-	2	2	100	-
Saltator maximus	2	-	-	2	2	100	-
TOTAL	162	36	31	229	188	82*	6

*Média

Tabela 2. Número de espécies e indivíduos tratados com o emético, e porcentagem de sucesso (regurgitação) por família.

Famílias	Espécies	Indivíduos	Sucesso (%)
Columbidae	1	1	0
Momotidae	1	2	100
Bucconidae	1	1	100
Ramphastidae	1	2	100
Picidae	2	5	60
Formicariidae	4	35	74
Conopophagidae	1	2	100
Furnariidae	4	41	90
Dendrocolaptidae	3	22	63.5
Tyrannidae	10	21	100
Turdidae	5	28	64
Vireonidae	2	5	80
Emberizidae	11	64	90
TOTAL	46	229	82*

* Média

indivíduos que receberam o emético mais de uma vez regurgitaram normalmente em todas as ocasiões. Um indivíduo de *Lepidocolaptes fuscus* foi recapturado em boas condições 224 dias após ter reagido negativamente ao emético (tabela 3).

DISCUSSÃO

O método do tártaro emético, utilizado em aves inicialmente por Kadochnikov (1967), em passeriformes do Velho Mundo, apesar de não ser ainda amplamente utilizado pelos ornitólogos, parece ter potencial para se tornar um método rotineiro no estudo da alimentação das aves. A administração do emético é processo simples, fácil de usar e constitui-se em uma alternativa ao sacrifício de indivíduos.

Pela prática adquirida no decorrer do estudo, concluímos que dos seis óbitos após a administração do emético, dois ocorreram devido à inexperiência inicial. A ave deve ser mantida com o ventre para baixo, e o tubo, ligado a seringa, inserido o suficientemente profundo no esôfago de forma a evitar o refluxo, seguido de falsa via (entrada do emético pela traquéia), geralmente fatal para a ave. Assim, é de fundamental importância que a inserção do tubo, bem como o fornecimento do emético sejam realizados de forma mais suave e lenta possível. Os outros quatro óbitos

Figura 1. Material regurgitado por *Sclerurus scansor*, revelando cabeças de Blattariae (B) e de Formicidae (F), patas de Coleoptera (C) e fragmentos de Opilionida (O).

Figura 2. Larvas de Sciaridae (Diptera) e Formicidae adulto encontrados em amostra regurgitada por *Formicarius colma*.

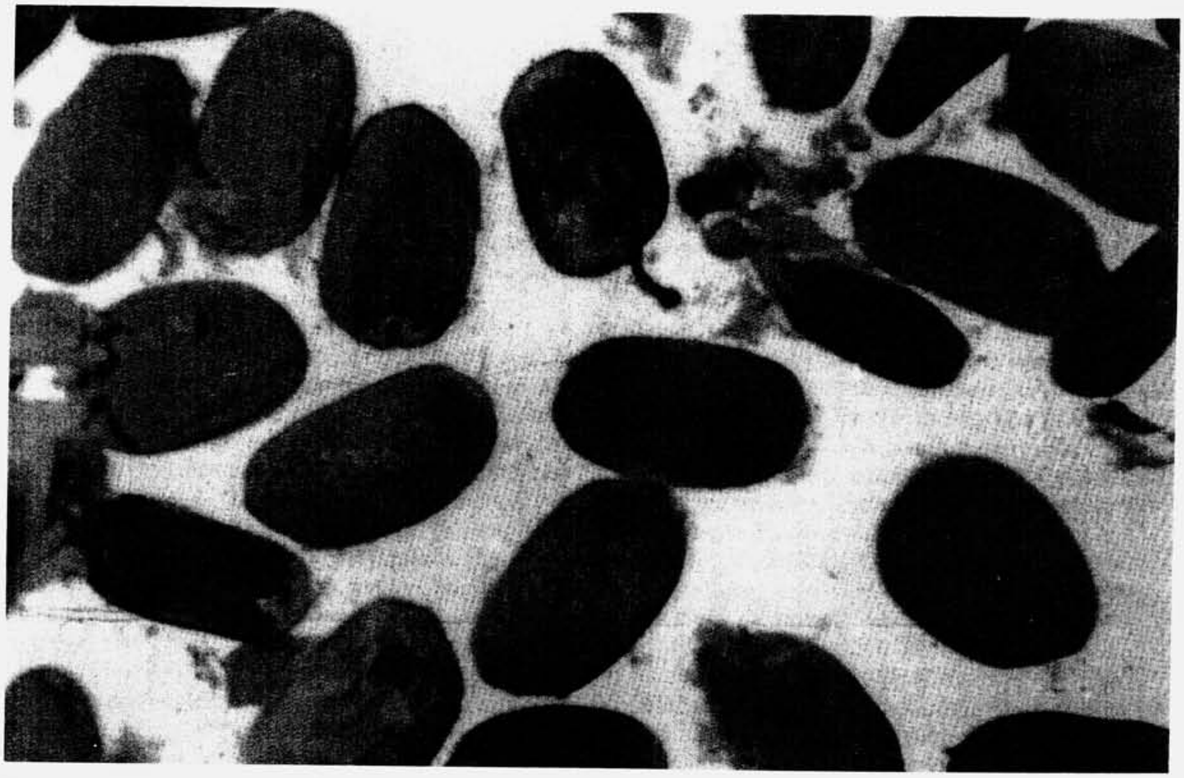

Figura 3. Sementes regurgitadas por *Baryphtengus ruficapillus*.

Tabela 3. Recapturas de indivíduos submetidos ao emético em sucessivas ocasiões.

Indiv.	Espécie	Capt.	Emet.	1º Recap.	Dias[1]	Emet.	2º Recap.	Dias[1]	Emet.	3º Recap.	Dias[1]	Emet.	4º Recap.	Dias[1]	Emet.
1	*Formicivora rufa*	18/ago	sim	18/out[2]	61	não	-	-	-	-	-	-	-	-	-
2	*Pyriglena leucoptera*	6/jul	sim	7/dez	154	não	-	-	-	-	-	-	-	-	-
3	*Pyriglena leucoptera*	1/set	sim	25/jan	146	não	-	-	-	-	-	-	-	-	-
4	*Formicarius colma*	9/jun	sim	13/jul	34	não	-	-	-	-	-	-	-	-	-
5	*Formicarius colma*	7/jul	sim	28/mar	264	sim	-	-	-	-	-	-	-	-	-
6	*Anabazenops fuscus*	22/jun	sim	12/abr	294	não	-	-	-	-	-	-	-	-	-
7	*Philydor atricapillus*	5/abr	sim	19/abr	44	sim	29/set	133	sim	15/fev	139	sim	13/abr	57	não
8	*Philydor atricapillus*	23/jun	sim	22/set	91	sim	22/mar	171	não	-	-	-	-	-	-
9	*Philydor atricapillus*	5/abr	sim	27/abr	22	não	-	-	-	-	-	-	-	-	-
10	*Philydor atricapillus*	5/abr	sim	8/jun	64	sim	21/set	105	sim	-	-	-	-	-	-
11	*Philydor atricapillus*	10/fev	sim	28/abr	78	sim	14/jul	77	sim	-	-	-	-	-	-
12	*Automolus leucophthalmus*	22/jun	sim	21/set	91	sim	-	-	-	-	-	-	-	-	-
13	*Automolus leucophthalmus*	8/jun	sim	13/jul	35	não	-	-	-	-	-	-	-	-	-
14	*Automolus leucophthalmus*	19/mai	sim	10/nov	175	não	16/fev	98	sim	12/abr	55	não	-	-	-
15	*Dendrocincla turdina*	22/jun	sim	7/jul	15	não	21/set	76	sim	-	-	-	-	-	-
16	*Lepidocolaptes fuscus*	31/ago	sim[3]	12/abr	224	não	-	-	-	-	-	-	-	-	-
17	*Turdus albicollis*	28/set	sim	22/mar -	175	não	23/mar	1	não	-	-	-	-	-	-
18	*Trichothraupis melanops*	8/jun	sim	9/jun	1	não	-	-	-	-	-	-	-	-	-
19	*Trichothraupis melanops*	22/jun	sim	7/jul	15	sim	-	-	-	-	-	-	-	-	-
20	*Trichothraupis melanops*	7/jul	sim	13/jul	6	sim	-	-	-	-	-	-	-	-	-
21	*Trichothraupis melanops*	8/jun	sim	22/jun	14	sim	-	-	-	-	-	-	-	-	-
22	*Habia rubica*	29/set	sim	7/dez	69	não	-	-	-	-	-	-	-	-	-
23	*Saltator maximus*	9/jun	sim	31/ago	83	sim	-	-	-	-	-	-	-	-	-

[1] Dias após à captura anterior

[2] (L.P. Gonzaga, *com. pess.*)

[3] não regurgitou

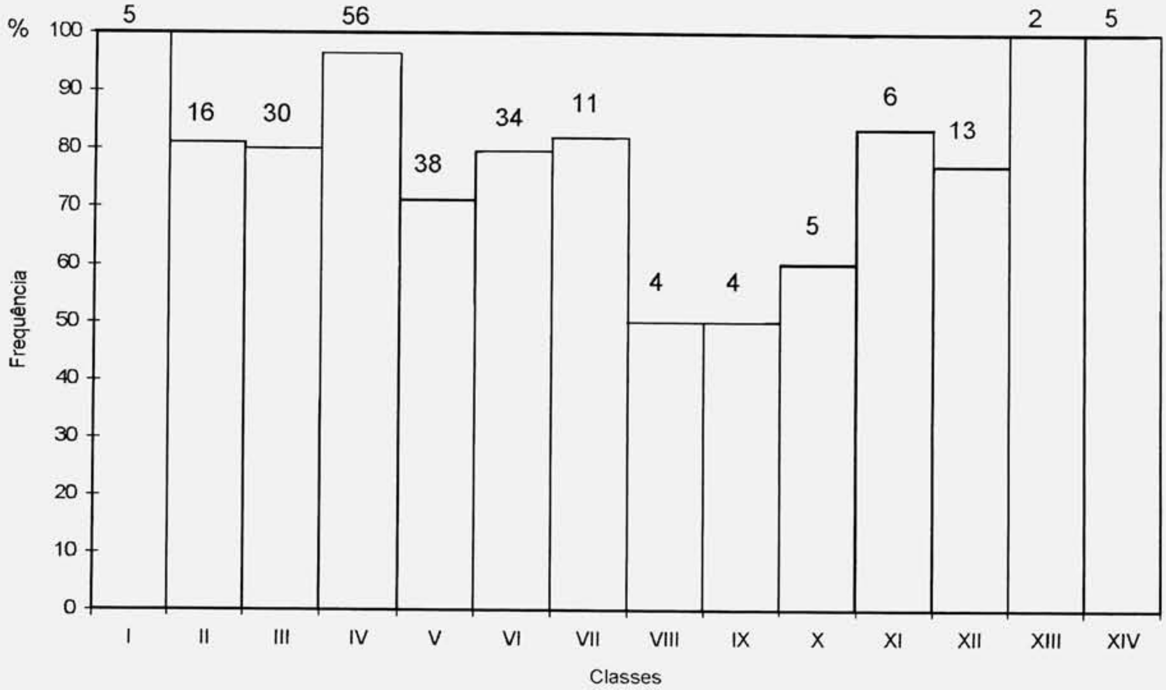

Figura 4. Freqüência de indivíduos que regurgitam por classes de massa corporal, em gramas (Classes: I = 7,5 - 12,4g; II = 12,5 - 17,4g; III = 17,5 - 22,4g; IV = 22,5 - 27,4g; V = 27,5 - 32,4g; VI = 32,5 - 37,4g; VII = 37,5 - 42,4g; VIII = 42,5 - 47,4g; IX = 47,5 - 52,4g; X = 52,5 - 57,4g; XI = 57,5 - 62,4g; XII = 62,5 - 67,4g; XIII = 67,5 - 72,4g; XIV = > 72,5g). Os números acima das colunas representam o total de indivíduos tratados em cada classe.

ocorreram em indivíduos que regurgitaram, porém mostraram sinais de apatia e morreram instantes depois. Taxas consideráveis de mortalidade foram obtidas por Zach e Falls (1976) e Lederer e Crane (1978). A mortalidade causada pelo uso do emético varia muito de acordo com a espécie tratada, a dose e concentração utilizadas e o próprio estresse provocado pela administração da substância. Ford *et al.* (1982), estudando espécies nectarívoras, e Zann *et al.* (1984), com vários granívoros, ambos na Austrália, não obtiveram sucesso com o emético, tendo encontrado uma elevada taxa de mortalidade. Zach e Falls (1976) obtiveram uma taxa de mortalidade de 12,5 % em *Seiurus aurocapillus,* em cativeiro, em decorrência da recusa das aves em se alimentar, após a administração do emético. Esses mesmos autores observaram uma mortalidade de 50 % para os indivíduos daquela espécie tratados logo após a captura, tornando evidente que o estresse é um importante fator responsável pela mortalidade. Lederer e Crane (1978) constataram uma mortalidade de 20 % em *Passer domesticus* tratados com o emético. Assim, a taxa de mortalidade de 2,6 % encontrada no presente estudo é surpreendentemente baixa quando comparada com aquelas obtidas por outros autores.

Nenhuma discussão concreta pode ser facilmente realizada sobre a taxa de mortalidade das aves tratadas, após retornarem ao seu ambiente. Torna-se difícil delimitar a influência de fatores diversos na taxa de recaptura encontrada, como o estresse durante a captura. O registro de alguns indivíduos tratados três e até quatro vezes com o emético num período de vários meses, e sem apresentar nenhuma anormalidade, significa que, pelo menos em algumas espécies, múltiplos tratamentos nem sempre resultam em elevada mortalidade, como se referem Rosenberg e Cooper (1990). Prys-Jones *et al.* (1974) e Poulin *et al.* (1994a) não encontraram diferença significativa entre as taxas de recaptura dos indivíduos tratados e dos não tratados com o emético, embora as primeiras tenham sido um pouco mais baixas que as últimas.

Embora com uma amostra bem menor, nossos resultados foram bastante similares aos de Poulin *et al.* (1994a). A proporção de sucesso de 82 % encontrada por nós aproxima-se dos 89 % obtidos por aqueles autores, e não muito distante dos 73,1 % de Poulin e Lefebvre (1995).

Ainda comparando com os resultados obtidos por Poulin *et al.* (1994a), conclui-se que a eficiência do emético foi mais distinta entre as diferentes famílias neste trabalho do que naquele. Possivelmente essa variação está relacionada com o menor tamanho da amostra. Entretanto, observa-se que Tyrannidae, Vireonidae e Emberizidae, em ambos os trabalhos, estão entre os agrupamentos taxonômicos com maiores índices de sucesso no tratamento com o emético. Poulin *et al.* (1994a) afirmam que a porcentagem de indivíduos que não regurgitou foi significativamente maior em Bucconidae e Formicariidae. No presente trabalho, a amostra de Bucconidae foi muito pequena para qualquer análise, mas a amostra de Formicariidae revelou uma razoável proporção de indivíduos que regurgitou (74 %). A baixa mortalidade encontrada por Poulin *et al.* (1994a) em Tyrannidae e Vireonidae talvez esteja relacionada a uma maior tolerância dos indivíduos dessas famílias ao emético, sendo fortalecida essa hipótese pelas elevadas taxas de regurgitação encontradas nessas famílias no presente trabalho.

O método do tártaro emético, como foi inicialmente desenvolvido, é baseado na crença de que a eficiência da substância é a mesma para espécies de diferentes tamanhos, desde que seja respeitada a dosagem recomendada. Entretanto, Tomback (1975), aumentando a concentração da solução de 1 para 1,5 %, encurtou o período de resposta de várias espécies de 25 para 10 min., sem prejuízos às aves. A mesma autora também aumentou a dosagem do emético para espécies menos sensíveis, elevando à 0,5 cm^3 para 30 g de massa corporal. Porém, Prys-Jones *et al.* (1974), Zach e Falls (1976) e Robinson e Holmes (1982) levantaram a hipótese que, independente da massa corporal, espécies altamente insetívoras são mais prováveis de regurgitar em resposta ao emético, num período de dois a três min. usando uma solução à 1 %. Herrera (1975), sugere que espécies granívoras tendem a regurgitar mais facilmente e são menos afetadas pelo emético que espécies insetívoras. Entretanto, Prys-Jones *et al.* (1974) afirmam que somente 50 a 60 % dos granívoros tratados com o emético regurgitaram, levantando a hipótese que a moela mais desenvolvida nessas aves atua efetivamente como uma barreira à regurgitação.

Nesse trabalho não foi constatada relação entre a eficiência do emético e a massa corporal das aves. Entretanto, Poulin *et al.* (1994a) encontraram uma relação negativa entre o tamanho da ave e a eficiência do emético para 2 ou 2,5 % em aves com mais de 50 g para uma resposta mais efetiva. Embora não tenhamos utilizado em nosso estudo soluções de emético com concentração acima de 1 %, acreditamos que concentrações mais altas possam permitir a redução da dose a ser ministrada às aves de maior porte, para um volume de líquido mais facilmente aplicável.

Embora não tenha sido realizada uma comparação de forma sistemática, o material regurgitado mostrou-se menos fragmentado que o obtido com análise de material fecal, aspecto também relatado por Poulin e Lefebvre (1995) sobre a maior eficiência do emético no estudo da alimentação das aves. Certamente a resposta está no mais avançado estado de digestão em que se encontram os fragmentos nas fezes.

Rosenberg e Cooper (1990), discutindo os diferentes métodos de análise da dieta das aves, afirmam que a utilização de eméticos químicos permite apenas a obtenção de amostras parciais do conteúdo gástrico dos indivíduos tratados. Gavett e Wakeley (1986) analisaram estômagos de *Passer domesticus* sacrificados após o tratamento com o emético, e obtiveram uma média de 58 % do conteúdo total de cada estômago nas amostras regurgitadas. Apesar da ausência de alguns itens alimentares, as amostras derivadas de regurgitações representaram bem o conteúdo gástrico das aves. Assim, para o estudo da composição de dietas específicas, recomenda-se a utilização de amostras com maior tamanho possível, de forma a evitar análises subestimadas. Mesmo que a utilização do emético resulte em amostras parciais do conteúdo gástrico, esse resultado sería compensado pela possibilidade de obtenção de amostras distintas do mesmo indivíduo em várias recapturas, permitindo estudos de variação individual da dieta, bem como pela opção ao não sacrifício de exemplares.

Outro fato a ser considerado é a hora de administração do emético às aves. Os indivíduos devem ser tratados no período de maior atividade de forrageamento. Quando tratados imediatamente após o amanhecer é grande a probabilidade das aves estarem com o trato digestivo ainda vazio, o que, segundo Poulin *et al.* (1994a), aumenta a possibilidade de óbito do animal.

Assim, concluimos que o método do tártaro emético é efetivo para o estudo da alimentação de diversas espécies, necessitando apenas de mais informações sobre a letalidade e eficiência em alguns grupos de aves silvestres para seu aperfeiçoamento.

AGRADECIMENTOS

Somos gratos à Francisco José Palermo e Lúcio Flávio Vieira Bueno, proprietários do Parque Salvaterra, pela cordial hospitalidade. Ao Centro Almirante Moraes Rêgo, da Marinha do Brasil, pela permissão de acesso à Ilha de Santana. À Mônica da Cunha Moreira, Verônica Souza da Mota Gomes, Elmiro de Carvalho Mendonça, Anna Beatriz Barcellos Ribeiro e Gilberto Soares do Couto pelo auxílio no trabalho de campo. Aos Veterinários Marlon Vicente da Silva, Alexandre Nunes de Oliveira, Carlos Eduardo Rodrigues Caetano e Rosinéa Correia Fernandes, pela preparação da solução emética e orientação quanto ao uso do material. À José Fernando Pacheco e aos Professores Rui Cerqueira e Luiz Pedreira Gonzaga pela revisão e sugestões à primeira versão do trabalho. Luiz P. Gonzaga também forneceu o emético.

REFERÊNCIAS

Aguirre, A. C. (1973) Contribuição para o estudo do conteúdo gástrico da *Zenaida auriculata* (Ders Murs). *Brasil Florestal* 4(16):71-75.

___ (1974) Contribuição para o estudo do conteúdo gástrico da *Zenaida auriculata* (Ders. Murs.). *Brasil*

Florestal 5(18):61-67.

___ (1975) Contribuição para o estudo do conteúdo gástrico da *Zenaida auriculata* (Ders. Murs.). *Brasil Florestal* 6(24):59-68.

___ (1976) Contribuição para o estudo do conteúdo gástrico da *Zenoida* (sic) *auriculata* (Ders Murs). *Brasil Florestal* 7(27):38-44.

Alves, M. A. S. (1991) Dieta e táticas de forrageamento de *Neothraupis fasciata* em Cerrado no Distrito Federal, Brasil (Passeriformes: Emberizidae). *Ararajuba* 2:25-29.

Brandt, A. e R. B. Machado (1990) Área de alimentação e comportamento alimentar de *Anodorhynchus leari*. *Ararajuba* 1:57-63.

Burmeister, H. (1856) *Systematische Ubersicht der Thiere Brasiliens*. Vol. 2. Berlin: Georg Reiner.

Cintra, R., M. A. S. Alves e R. B. Cavalcanti (1990) Dieta da rolinha *Columbina talpacoti* no Brasil Central - Comparação entre sexos e idades. *Rev. Brasil. Biol.* 50(2):469-473.

Ford, H. A., N. Forde e S. Harrington (1982) Non-destructive methods to determine the diets of birds. *Corella* 6:6-10.

Galetti, M. e F. Pedroni (1996) Notes on the diet of Peach-fronted Parakeet *Aratinga aurea* in the Serra do Cipó, Minas Gerais, Brazil. *Cotinga* 6:59-60.

Gavett, A. P. e J. S. Wakeley (1986) Diets of House Sparrow in urban and rural habitats. *Wilson Bull.* 98:137-144.

Hempel, A. (1949) Estudo da alimentação natural de aves silvestres do Brasil. *Arq. Inst. Biol. S. Paulo* 19:237-268.

Herrera, C. M. (1975) A note on the emetic technique for obtaining food samples form passerines birds. *Doñana, Acta Vertebrata* 2(1):1-6

Jimbo, S. (1957) A flora na alimentação das aves brasileiras II. *Pap. Avuls. Zool. S. Paulo* 13(8):99-108.

Kadochnikov, N. P. (1967) [Um procedimento de estudo dos hábitos alimentares de aves adultas em vida] *Byull. mosk. Obshch. Ispyt. Prir., otd. Biol.* 72:29-34.

Laursen, K. (1978) Interspecific relationships between some insectivorous passerine species, illustrated by their diet during spring migration. *Ornis Scand.* 9:178-192.

Lederer, R. J. e R. Crane (1978) The effects of emetics on wild birds. *North Am. Bird Bander* 3:3-5.

Magalhães, C. A. de (1990a) Hábitos alimentares e estratégia de forrageamento de *Rostrhamus sociabilis* no Pantanal de Mato Grosso, Brasil. *Ararajuba* 1:95-98.

___ (1990b) Comportamento alimentar de *Busarellus nigricollis* no Pantanal e Mato Grosso, Brasil. *Ararajuba* 1:119-120.

Marini, M. Â. (1992) Foraging behavior and diet of the Helmeted Manakin. *Condor* 94:151-158.

Moody, D. T. (1970) A method for obtaining food samples from insectivorous birds. *Auk* 87:579.

Moojen, J., J. C. M. Carvalho e H. S. Lopes (1941) Observações sobre o conteúdo gástrico das aves brasileiras. *Mem. Inst. Oswaldo Cruz* 36(3):405-444.

Motta-Júnior, J. C. e V. A. Taddei (1992) Bats as prey of Stygian Owls in Southeastern Brazil. *J. Raptor Res.* 26(4):259-260.

___ e S. A. Talamoni (1996) Biomassa de presas consumidas por *Tyto alba* (Strigiformes: Tytonidae) durante a estação reprodutiva no Distrito Federal. *Ararajuba* 4(1):38-41.

Munson, E. S. e W. D. Robinson (1992) Extensive folivory by Thick-billed Saltators (*Saltator maxillosus*) in southern Brazil. *Auk* 109:917-919.

Penha, J. M. F. (1995) Alimentação de *Rhynchotus rufescens* na serra de São Vicente, município de Santo Antônio de Leverger, Mato Grosso (Tinamiformes: Tinamidae). *Ararajuba* 3:55-56.

Pineschi, R. B. (1990) Aves como dispersoras de sete espécies de *Rapanea* (Myrsinaceae) no maciço do Itatiaia, estados do Rio de Janeiro e Minas Gerais. *Ararajuba* 1:73-78.

Pizo, M. A. (1996) Feeding ecology of two *Cacicus* species (Emberizidae, Icterinae). *Ararajuba* 4:87-92

Poulin, B. e G. Lefebvre (1995) Additional information on the use of Tartar emetic in determining the diet of tropical birds. *Condor* 97:897-902.

___ e ___ (1996) Dietary relationships of migrant and resident birds from a humid forest inCentral Panama. *Auk* 113:277-287.

___, ___ e R. McNeil (1992) Tropical avian phenology in relation to abundance and exploitation of food resources. *Ecology* 73:2295-2309.

_____, _____ e _____ (1994a) Effect and efficiency of Tartar emetic in determining the diet of tropical land birds. *Condor* 96:98-104.

___, _____ e_____ (1994b) Diets of land birds from northeastern Venezuela. *Condor* 96:354-367.

Prys-Jones, R. P., L. Schifferli e D. W. MacDonald (1974) The use of an emetic in obtaining food samples from passerines. *Ibis* 116:90-94.

Robinson, S. K. e R. T. Holmes (1982) Foraging behavior of forest birds: the relationships among search tactics, diet, and habitat structure. *Ecology* 63:1918-1931.

Rosenberg, K. V. e R. J. Cooper (1990) Approachs to avian diet analysis, p. 80-90 *In*: Morrison, M. L., C. J. Ralph, J. Verner e J. R. Jehl, Jr. (eds.) *Avian foraging: theory, methodology, and applications*. Lawrence: Cooper Ornithological Society (Studies in Avian Biology 13).

Schubart, O., A. C. Aguirre e H. Sick (1965) Contribuição para o conhecimento da alimentação das aves brasileiras. *Arq. Zool. S. Paulo* 12:95-249.

Sick, H. (1997) *Ornitologia Brasileira*. Rio de Janeiro: Ed. Nova Fronteira.

Silva-Porto, F. e R. Cerqueira (1990) Seasonal variation in the diet of the Burrowing Owl *Athene cunicularia* in a restinga of Rio de Janeiro State. *Ciênc. e Cult.*

42:1182-1186.

Tomback, D. F. (1975) An emetic technique to investigate food preferences. *Auk* 92:581-583.

Wied, M. Prinz zu (1830-1833) *Beitrage zur Naturgeschichte von Brasilien, Vogel*, Vol. III-IV. Weimar: Landes-Industries-Comptoirs.

Zach, R. e J.B. Falls (1976) Bias and mortality in the use of Tartar emetic to determining the diet of Ovenbirds (Aves: Parulidae). *Can. J. Zool.* 54:1599-1603.

Zann, R. e R.B. Straw (1984) A non-destructive method to determine the diet of seed-eating birds. *Emu* 84:40-42.

Ararajuba 5(2):229-232
dezembro de 1997

Uso de poleiros artificiais e ilhas de vegetação por aves dispersoras de sementes

Marcelino Carneiro Guedes, Valério Andrade Melo[1] e James Jackson Griffith[2]

Universidade Federal de Viçosa, Departamento de Engenharia Florestal, 36571-000, Viçosa, MG. [1] *E-mail: v.andrade@aquarius.com.br.* [2] *E-mail: griffith@mail.ufv.br*

Recebido em 05 de novembro de 1996; aceito em 23 de dezembro de 1996

ABSTRACT: **Use of artificial perches in islands of vegetation by bird seed dispersers.** Considering that vegetative sucession begins with seed dispersal, the principal aim of this study was to identify which bird species use artificial perches on a hillside degraded by landscape terracing. Twenty-two bird species belonging to 11 families were observed, of which eight were seen resting on the perches. The results suggest that the generalist frugivores, mainly Tyrannidae, use artificial perches which may increase seed dispersal in open-space lands that have been modified or degraded.

KEY WORDS: artificial perches, restoration of degraded lands, seed dispersal.

PALAVRAS-CHAVE: dispersão de sementes, poleiros artificiais, recuperação de áreas degradadas.

A dispersão de sementes é o processo que inicia a sucessão vegetal. Se não houver um suprimento adequado de propágulos, o sucesso da recuperação de uma área degradada pode ficar comprometido. A comunidade vegetal que se estabelece em uma área, iniciando a sucessão, depende da dispersão natural associada às condições bióticas e abióticas do local, que afetam a germinação e o estabelecimento dessas sementes (Redente *et al.* 1993).

Árvores isoladas em pastagens funcionam como foco de atração de animais dispersores de sementes, notadamente de aves e morcegos, que as utilizam como ponto de pouso, descanso e, eventualmente, alimentação (Guevara *et al.* 1986). Vários autores (Uhl 1982, Kolb 1993) têm observado que a tendência natural da sucessão vegetal é avançar na forma de manchas ou ilhas de vegetação, que se expandem para ocupar os espaços vazios entre si. Essas ilhas de vegetação no meio da área degradada servem de "postos avançados" para propagar o recobrimento vegetal (Griffith *et al.* 1996). Ao permanecerem na ilha, animais dispersam os propágulos (frutos ou sementes) que originarão novas plantas. A entrada e o estabelecimento desses propágulos aumenta a diversidade da vegetação, amenizando o solo e o microclima do entorno da ilha. Como consequência, a comunidade vegetal avança por novas áreas, até que cubra totalmente o local anteriormente degradado.

Segundo McDonnel e Stiles (1983), o ingresso de sementes dispersas por aves está diretamente relacionado com a complexidade estrutural da vegetação. Árvores aumentam a complexidade estrutural de campos abandonados e servem como focos de recrutamento de sementes dispersas por aves. Assim, a deposição de sementes por aves influencia o padrão de distribuição da vegetação e a presença de focos de recrutamento na vegetação influencia os padrões de dispersão das sementes ornitocóricas por afetar a distribuição das aves.

A dispersão zoocórica de sementes para uma área depende da distância da fonte dessas sementes e da disponibilidade de pontos de pouso para animais dispersores. Segundo McClanahan (1986), fontes distantes a mais de 400 m do local onde as sementes caem, não contribuem significativamente com a entrada de sementes nesse local. A disponibilidade de poleiros é mais importante que a distância da fonte de sementes na predição dos tipos e quantidade de sementes ornitocóricas (McClanahan e Wolfe 1987).

No presente trabalho associaram-se poleiros artificiais a ilhas de vegetação. Os poleiros foram construídos para atrair as aves, até que as árvores plantadas atinjam porte para tal. Procurou-se registrar quais espécies de aves utilizam a área e pousam nos poleiros e verificar a eficiência dos poleiros para atrair aves, em comparação com as plantas das ilhas.

MÉTODOS

O experimento foi instalado no município de Viçosa, região da Zona da Mata do estado de Minas Gerais. Viçosa está localizada a 20º45'S e 42º55'W, entre serras com altitudes que variam de 650 a 750 m. A antiga formação florestal de Mata Atlântica semi decidual vem sendo devastada para ceder lugar a atividades como agropecuária e urbanização e para atender a demanda de madeira. A atual cobertura florestal encontra-se reduzida a alguns vestigiais remanescentes de mata secundária, plantações de *Eucaliptus* e *Pinus*. Essas modificações do ambiente têm dificultado a sobrevivência de várias espécies de aves. Devido a esse processo de devastação, várias espécies de aves já desapareceram da região, entre elas: *Tinamus solitarius*, *Crypturellus noctivagus*, *Odontophorus capueira*, *Penelope obscura* e *Cairina moschata* (Monteiro *et al.* 1983). Esses pesquisadores registraram 292 espécies de aves, distribuídas em 17 ordens e 50 famílias, no município de Viçosa.

A área experimental, com aproximadamente um hectare e localizada próxima ao Departamento de Educação Física da Universidade Federal de Viçosa, foi delimitada por cerca de arame farpado. É constituída por taludes e bermas que formam bancadas sucessivas descendentes, consequência das obras que produziram a expansão do campus da Universidade na década de 80. Antes do início do experimento, a cobertura vegetal da área consistia apenas em duas árvores na borda superior e alguns arbustos na borda inferior. Apresentava processos de erosão laminar e em sulcos, além de uma voçoroca (erosão que se aprofunda no perfil do solo) no talude mais baixo. O experimento está localizado entre dois remanescentes de Mata Atlântica secundária, que podem funcionar como fonte de sementes. Um distante cerca de 200 m possui uma área de 25 ha e o outro localizado a cerca de 300 m, possui 10,46 ha. Ambos, como a maioria da vegetação existente na região, são fragmentos de Mata Atlântica em estágio secundário de sucessão.

O clima é classificado, segundo Köppen, como Cwb. Clima tropical de altitude, mesotérmico, caracterizado por verões brandos, chuvosos e invernos frios e secos (Golfari 1975). A temperatura média mensal é de 20,9º C e a precipitação média anual gira em torno de 1200 mm.

Foram introduzidas na área 24 ilhas de vegetação com dimensões de 6 x 6 m (36 m^2). Essas ilhas foram implantadas com três composições florísticas diferentes: *Acacia mangium* (Leguminosae exótica), *Leucaena leucocephala* (Leguminosae exótica) e uma mistura de espécies nativas *Tibouchina granulosa* (Melastomataceae), *Schyzolobium parahyba*, *Parkia multijuga*, *Hymenaea stilbocarpa* e *Senna reticulata* (todas da família Leguminosae). Todas as composições foram plantadas em duas densidades: 9 m^2 por planta e 4 m^2 por planta. Para cada densidade de plantio foram implantadas 12 ilhas. Na época de realização do experimento, essas composições apresentavam as seguintes alturas, em média: Acácia, 173 cm; Leucena, 144 cm e a mistura, 108 cm.

Os poleiros foram instalados em janeiro de 1995, distribuídos por 12 ilhas e localizados em seu centro. As outras 12 ilhas, sem poleiros, foram usadas como controle. Os poleiros foram confeccionados com postes de eucalipto, no topo dos quais foram pregados dois pontos de pouso de 1 m de comprimento e 1 cm de diâmetro, dispostos em cruz, a 3 m da superfície do solo.

As aves foram registradas através de binóculo Mirakel Special 8 x 30 mm, de um ponto onde era possível observar todos os poleiros ao mesmo tempo. Procuramos observar as aves sempre nas primeiras horas do dia e ao entardecer, no período de fevereiro a agosto do ano de 1995, totalizando 108 horas de observação.

RESULTADOS E DISCUSSÃO

Vinte e duas espécies de aves, pertencentes a 11 famílias, foram registradas na área de estudo (tabela 1). Somente as espécies *Leptoptila* sp., *Xolmis cinerea*, *X. velata*, *Empidonomus varius*, *Pitangus sulphuratus*, *Tolmomyias sulphurescens*, *Mimus saturninus* e *Turdus rufiventris* foram vistas pousando nos poleiros artificiais. Os tiranídeos representam 62,5 % das espécies de aves que visitaram os poleiros, incluindo *X. cinerea*, a espécie mais frequentemente observada. Das oito espécies observadas nos poleiros, seis são frugívoros generalistas que se alimentam também de insetos.

O pequeno número de espécies pode ser devido à pequena heterogeneidade ambiental da área estudada, que dispõe de poucos habitats para as aves. Elas são visitantes ocasionais da área, não havendo ainda registro de nenhuma espécie residente ou se reproduzindo no local. A maioria das plantas das ilhas são árvores jovens e pouco desenvolvidas que ainda não frutificaram e não oferecem abrigo seguro para as aves. As espécies não observadas pousando nos poleiros, encontravam-se pousadas em duas árvores isoladas de *Enterolobium contortisiliquum* (orelha-de-negro) e em alguns arbustos remanescentes na área. Foram registradas somente as aves que pousavam dentro da área delimitada pela cerca, não sendo consideradas as espécies que apenas sobrevoaram o local.

Xolmis cinerea foi a espécie mais frequentemente observada pousando nos poleiros (32,0 % das observações; N = 22), seguida de *M. saturninus* (27,0 % das observações; N = 22). No entanto, *M. saturninus* foi observada em todos os meses, enquanto *X. cinerea* somente a partir de abril.

Não se detectou concorrência de atração entre os poleiros e as plantas ao redor deles na ilha de vegetação, pois não se verificou nenhuma ave pousando nessas plantas. Atribuímos esse resultado à menor altura das plantas em relação aos poleiros e às outras espécies vegetais da área, que são mais altas e se encontram numa posição

Tabela 1. Aves observadas na área de estudo, suas dietas e registro de utilização dos poleiros. Nomenclatura segundo Sick (1985).

FAMÍLIA/ESPÉCIE	DIETA[1]
COLUMBIDAE	
Columba speciosa	gr
Columbina talpacoti	gr
*Leptotila sp.**	fr
PSITTACIDAE	
Aratinga leucophtalmus	fr
CUCULIDAE	
Crotophaga ani	in
Guira guira	in
ALCEDINIDAE	
Ceryle torquata	pi
PICIDAE	
Colaptes campestris	in
TYRANNIDAE	
Xolmis cinerea *	in, fr
Xolmis velata *	in, fr
Empidonomus varius *	in, fr
Pitangus sulphuratus *	in, fr
Tolmomyias sulphurescens *	in
Elaenia sp.	in, fr
MIMIDAE	
Mimus saturninus *	in, fr
TURDIDAE	
Turdus rufiventris *	fr, in
ICTERIDAE	
Gnorimopsar chopi	in, fr
THRAUPIDAE	
Thraupis sayaca	fr, in
FRINGILLIDAE	
Volatinia jacarina	gr, in
Sporophilla nigricollis	gr, in
Sicalis flaveola	gr, in
Ammodramus humeralis	gr, in

[1] Dieta: in - Insetívoro; fr - Frugívoro; gr - Granívoro; pi - Piscívoro. Segundo dados próprios e Schubart *et al.* (1965) e segundo Motta-Júnior (1991). * Espécies observadas pousando nos poleiros.

topográfica bem mais elevada. Isso indica que, para introdução de ilhas de vegetação numa área degradada com o propósito de atrair aves dispersoras de sementes, numa fase inicial é necessária a associação com poleiros artificiais, que cumprem esse papel até que as árvores atinjam porte para tal.

Dos 12 poleiros instalados, dois foram responsáveis por 50,0 % das observações de aves pousadas (N = 22). Pelo teste do qui-quadrado ($X^2 = 8,82$; $p < 0,05$) rejeitou-se a hipótese de que não houve diferença no número de visitas das aves entre os poleiros. Isso pode ser devido à localização dos dois poleiros mais visitados em uma das bordas da área de estudo, um local mais aberto na extremidade do talude, onde os poleiros sobressaem e permitem melhor visualização pelas aves, pois não detectamos qualquer condição especial nas suas proximidades.

De maneira geral, com destaque para os mais visitados, foi observada, sob os poleiros, maior deposição de sementes associadas a fezes ou regurgitados das aves do que na área testemunha sem essas estruturas. Isso também foi constatado por McDonnel e Stiles (1983) e por Uhl *et al.* (1991), que em áreas de pastagens degradadas no Sul do Pará, encontraram 400 vezes mais sementes em bandejas colocadas sob arbustos dentro de pastagens do que naquelas colocadas em áreas cobertas somente por gramíneas.

Os poleiros artificiais funcionaram como foco de atração das aves, aumentando a complexidade estrutural da área, atraindo dispersores de sementes e incrementando a entrada de propágulos vegetais, contribuindo também para a interação entre as comunidades vegetal e animal.

Neste trabalho, as sementes não foram coletadas pois espera-se que, de acordo com os resultados obtidos por Campbell *et al.* (1990), após o desenvolvimento das plantas nas ilhas de vegetação, seja criado um ambiente favorável ao seu estabelecimento, que está sendo monitorado. Não notamos germinação de sementes sob os poleiros, possivelmente devido à remoção por formigas e pequenos roedores. Além disso, a área pode ainda apresentar condições de microclima e solos desfavoráveis ao estabelecimento de plântulas.

As aves mais importantes para a dispersão de sementes em áreas abertas, alteradas ou degradadas, são os frugívoros generalistas (McKey 1975) destacando-se aqueles da família Tyrannidae, a família mais observada neste estudo. Essas aves alimentam-se de árvores frutificando, tanto em ambientes florestais, principalmente nas bordas das matas, como em capoeiras e plantas isoladas. Ao se alimentarem também de insetos em locais abertos, onde podem localizá-los e capturá-los mais facilmente, levam sementes de espécies pioneiras para as áreas alteradas, acelerando a sucessão vegetal e diminuindo o tempo de recobrimento e maturação da vegetação secundária que ali irá se estabelecer. Eles podem ter, portanto, um papel fundamental na recuperação de áreas degradadas, através da dispersão de sementes. É importante essa observação à medida que os frugívoros especialistas de McKey são, em sua maioria, espécies de ambientes florestais que não frequentam as áreas abertas.

AGRADECIMENTOS

A Rômulo Ribon e Elias Silva, pela leitura e sugestões ao manuscrito original. A Paulo De Marco Jr., pelas valiosas críticas à versão final. A Eduardo Francia Carneiro Campello e Alexandre Nunes Vasconcelos, pelas sugestões feitas no início do trabalho. A Abílio Rodrigues Neves, pelas correções linguísticas. Ao PIBIC CNPq/UFV, pela bolsa de Iniciação Científica concedida a M.C.G.

REFERÊNCIAS

Campbell, B. M., T. Lynam e J. C. Hatton (1990) Small-scale patterning in the recruitment of forest species during sucession in tropical dry forest, Mozambique. *Vegetatio* 87:51-57.

Golfari, L. (1975) *Zoneamento ecológico do Estado de Minas Gerais para reflorestamento*. Rio de Janeiro: PRODEPEF (Série Técnica, 3).

Griffith, J. J., L. E. Dias e I. Jucksch (1996) Recuperação de áreas mineradas no Brasil, usando vegetação nativa. *Saneamento Ambiental* 37:28-37.

Guevara, S., S. E. Purata, e E. v. d. Maarel (1986) The role of remnant forest trees in tropical secondary succession. *Vegetatio* 66:77-84.

Kolb, S. R. (1993) *Islands of secondary vegetation in degraded pastures of Brazil: their role on reestablishing Atlantic Coastal Forest.*Tese de doutorado. Athens: Univ. Georgia.

McClanahan, T. R. (1986) The effect of a seed source on primary sucession in a forest ecosystem. *Vegetatio* 65:175-178.

___ e R. W. Wolfe (1987) Dispersal of ornitochorus seeds from forest edges in central Florida. *Vegetatio* 71:107-112.

McDonnel, M. J. e E. W. Stiles (1983) The structural complexity of old field vegetation and the recruitment of bird-dispersed plant species. *Oecologia* 56:109-116.

McKey, D. (1975) The ecology of coevolved seed dispersal systems, p. 159-191. *In*: L. Gilbert e P. H. Raven (eds.) *Coevolution of animal and plants*. Austin: Univ. of Texas Press.

Monteiro, A. R., G. T. de Mattos e J. L. Pontes (1983) Avifauna observada e identificada no município de Viçosa, Minas Gerais, Brasil. *Experientiae* 29(3):31-47.

Motta-Júnior, J. C. (1991) *A exploração de frutos como alimento por aves de mata ciliar numa região do Distrito Federal*. Tese de Mestrado. Rio Claro: Univ. Estadual Paulista.

Redente, E. F., T. McLendon e E. J. DePuit (1993) Manipulation of vegetation community dynamics for degraded land rehabilitation, p. 265-278. *In*: I Simpósio Brasileiro de Pesquisa Florestal, Belo Horizonte, 1993. *Anais.*. Viçosa: Sociedade de Investigações Florestais.

Schubart, O., A. C. Aguirre e H. Sick (1965) Contribuição para o conhecimento da alimentação das aves brasileiras. *Arq. Zool.* 12:95-249.

Sick, H. (1985) *Ornitologia brasileira, uma introdução*, v. I e II. Brasília: Ed. Univ. Brasília.

Uhl, C. (1982) Recovering following disturbance of different intensities in the Amazon Rain Forest of Venezuela. *Interciencia* 7:19-24.

___, D. Nepstad, J. M. C. Silva e I. Vieira (1991) Restauração da floresta em pastagens degradadas. *Ci. Hoje* 13(76):22-31.

Ararajuba 5(2):233-235
dezembro de 1997

Evidence for the possible advantage of heterospecific social foraging in *Furnarius rufus* (Passeriformes: Furnariidae)

José Ragusa-Netto[1]

Departamento de Zoologia, Universidade Estadual Paulista, C. P. 199, 13506-900, Rio Claro, São Paulo, Brasil

Recebido em 13 de janeiro de1997; aceito em 04 de agosto de1997

RESUMO. **Socialidade heteroespecífica e evidência quanto a possível vantagem na procura de alimento em *Furnarius rufus* (Passeriformes: Furnariidae).** Indivíduos de *Furnarius rufus* são freqüentemente observados seguindo grupos de *Mimus saturninus* quando procuram por alimento no chão. A possibilidade de *F. rufus* obter benefícios na presença de *M. saturninus* foi verificada através da eficiência na obtenção de alimento, a partir do registro do ritmo de bicadas ao forragear com e sem *M. saturninus*. Os resultados demonstram um ritmo de bicadas duas vezes maior na condição heteroespecífica. Possivelmente por explorar a socialidade e a vigilância de *M. saturninus*, *F. rufus* disponha de mais tempo para procurar por alimento.

PALAVRAS-CHAVE: bandos mistos, forrageamento, *Furnarius rufus*, socialidade, vigilância.

KEY WORDS: foraging behavior, *Furnarius rufus*, mixed flocks, sociability, vigilance.

Many foraging birds are constrained by two different activities: efficient food searching, and scanning for predators. An element of surprise is fundamental for a successful attack (Lindström 1989), so the organization of bird mixed species flock can be interpreted as a mechanism to increase predator detection, due to better vigilance (reviewed by Powell 1985). In flocks, individuals exploit each other's vigilance periods although flock vigilance is higher and members acquire both extra protection and time to search for food (Pullian 1973).

A common heterospecific association is observed between *Mimus saturninus* and *Furnarius rufus*. Both species overlap highly in distribution, and are commonly observed foraging. The first species is social, lives in groups of two-eight birds, and sentinels perform the vigilance, while *F. rufus* is less social, and individuals interrupt foraging on the ground to scan for predators (Sick 1985, Ridgely and Tudor 1989, 1994 pers. obs.). As both species inhabit open areas, they are at high risk while foraging on the ground. So, *F. rufus* may improve its alertness by exploiting *M. saturninus* vigilance. Acquiring better protection, *F. rufus* probably can employ more time in foraging.

I evaluated *F. rufus* foraging efficience by the pecking rate in three field situations: a) when individuals were isolated, b) in homospecific groups, or c) with *M. saturninus*. The possibility of increasing *F. rufus* pecking rate in the presence of *M. saturninus* should explain their behavior of following *M. saturninus* when foraging on the ground.

METHODS

I observed the birds from June to September 1996 in Brotas (São Paulo state) near Represa do Lobo (22°10'S, 47°55'W, altitude 750 m), at the edge of a small unpaved 3 Km farm road, that crosses several ranches. The vegetation in this site is represented by low grasses, used as pasture, and scattered trees. I walked randomly along the road from 07:00 to 10:00. When foraging *F. rufus* were at sight, I focused on the most accessible individual. This was done with a 8 x 30 binocullars within a minimum period of 30 s, until the bird was out of sight. The maximum observation period was of six min. I usually observed the birds for one-two min. I dictated observations in a portable recorder for later transcription. When *F. rufus* was found (isolated or in groups), efforts were made to observe each individual only once, so after one observation I immediately switched to another one, when they were in groups. During feeding *F. rufus* swallows without handling food items, therefore during the observations only pecking events against a substrate were recorded. Birds were assumed to be in a heterospecific flock if *F. rufus* followed *M. saturninus* for at least five min. Because *F. rufus* is a very tame

---

[1] Present adress: Departamento de Ciências do Ambiente, CEUC, UFMS, C.P. 252, 79304-020, Corumbá, MS, Brazil

species, observations within three m were possible. During the morning no more than two flocks, found in different points, were observed, to assure the independence of samples. To the data analysis, each observation of an isolated bird was taken as a replicate. For birds in groups, I used the mean pecking rate of each observed group, to avoid pseudoreplication. As this study was conducted in the dry season, observations after the scarce rains were avoided. Birds were not observed in a stripe of five m near cover. Statistical procedures followed Sokal and Rolf (1981).

RESULTS AND DISCUSSION

Mean pecking rate for isolated *F. rufus* was 8.8 ± 3.6 (N = 13). For conspecific groups (2-3 individuals), it was 8.2 ± 3.3 (N = 22). When following *M. saturninus* (N = 14), the pecking rate of *F. rufus* was higher (17.9 ± 5.2; Kruskal-Wallis test, H = 24.11; $p < 0.0001$; figure 1), being more than twice the conspecific rate, when data for *F. rufus* feeding alone or in conspecific flocks are grouped (8.4 ± 3.4; N = 35).

Powell (1985) pointed that the surveillance enhancement is a widely accepted hipothesis for bird mixed species flocks adaptative significance. Studies on vigilance in mixed flocks proved that each species reduces its own vigilance, lowering the scan time and/or rate (Metcalfe 1984, Beveridge and Deag 1987, Popp 1988). Sullivan (1984) found in *Picoides pubescens* both a reduction in head-cocking and an enhancement in the feeding rate at the expense of *Parus atricapillus* and *P. bicolor* alertness. Carrascal and Moreno (1992) verified advantages to *Parus major* individuals in mixed flocks by the lengthening of the time spent for feeding, as a result of the conversion of vigilance time into feeding time.

Alves and Cavalcanti (1996) studied the sentinel behavior of *Neothraupis fasciata* in cerrado (Brazilian savanna). In mixed flocks, the sentinels of this species watches less than when they are in conspecific groups. *Neothraupis fasciata* is also a facultative cooperative breeder, and in mixed flocks showed to be the nuclear

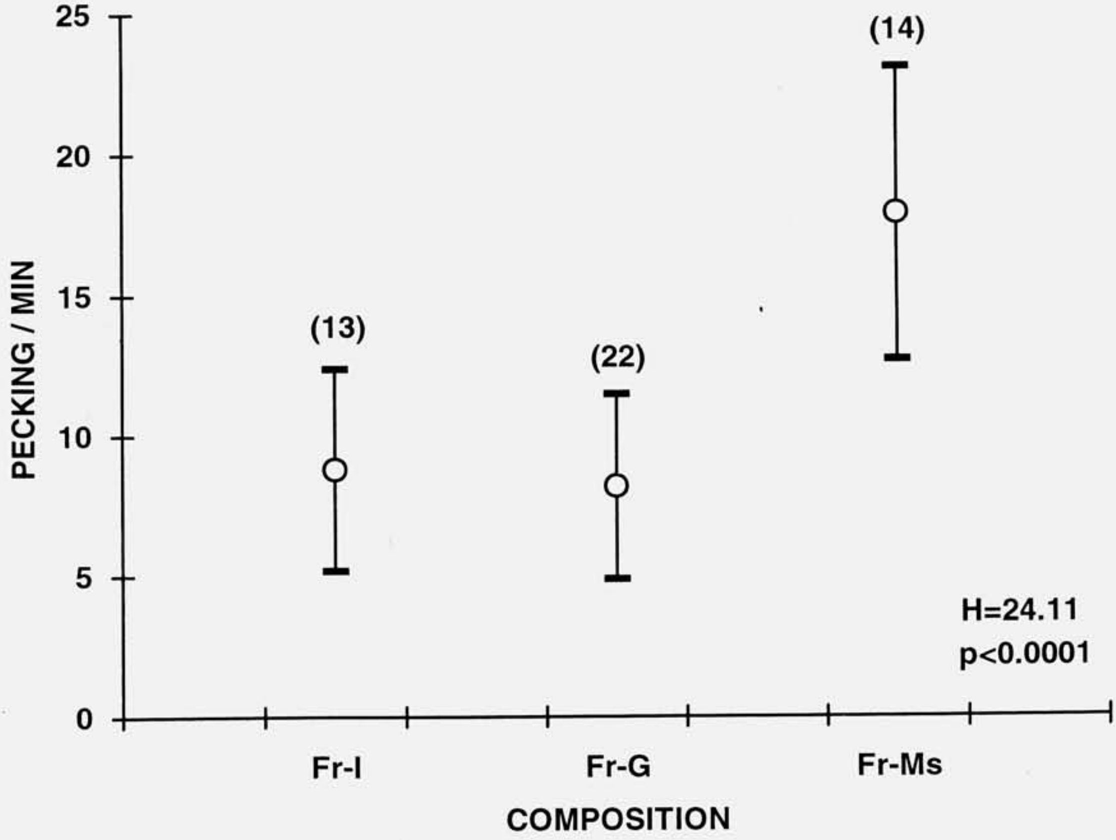

Figure 1. Mean (± s.d.) *Furnarius rufus* pecking rate in the three foraging situations. Sample size above each mean, H value (Kruskal-Wallis test) and probability are also given. (Fr-I: isolated *F. rufus*, Fr-G: 2-3 *F. rufus* individuals, Fr-Ms: *F. rufus* with *Mimus saturninus*).

species (Alves 1990).

In bird mixed flocks, nuclear species are usually followed, instead of following the other species (Moynihan 1962, Munn and Terborgh 1979). Nuclear species also tend to be intraspecifically gregarious, with regard to the attendant species (Powell 1985). The high sociability of nuclear species seems to attract others which exploit much of the nuclear species behavior (Moynihan 1962). In this study *F. rufus* was observed when following *M. saturninus*, a more social species with sentinel behavior. It is important to consider that *F. rufus* could be following *M. saturninus* only for foraging improvement. However, these species searched for prey some meters apart from each other. The niche diversity, the uniform use of habitat and the homogeneous food distribution are also characteristics of neotropical mixed flock ecology (Powell 1985). In this way, the chances of *F. rufus* copying *M. saturninus* feeding behavior to increse its foraging efficience are remote. Furthermore, I never observed interespecific agression resulting from prey competition, or *F. rufus* being attracted to a food rich patch where *M. saturninus* was intensely foraging. The absence of these behaviors reinforce *M. saturninus* alertness as a major characteristc as a nuclear species. Although only measurements of a reduction in *F. rufus* vigilance related to an increase in the pecking rate could confirm the advantage of the heterospecific foraging, the conflicting nature of activities such as scanning while foraging suggests that an increase in the pecking rate probably results from a reduction in the scan rate and/or time. So, the results of this study may at least be an evidence of the advantage of *F. rufus* attendant species behavior. This relationship is probably of high value, mainly in the dry season, when food availability probably is reduced and the days are shorter. In this period, at the study site, aerial predators such as *Falco sparverius*, *F. femoralis*, *Elanus leucurus*, *Milvago chimachima* and *Buteo magnirostris*, among others, commonly threatened these birds (pers. obs.), an event also observed in a different area with a *F. femoralis* successful attack (I. Sazima pers. com.).

ACKNOWLEDGMENTS

The author is grateful to Roberto Goiten from Department of Zoology, UNESP, Rio Claro for the final review of the manuscript, and to José Galizia Tundizi from CRHEA -USP for logistical support. Two anonymous reviewers made helpful comments that improved the manuscript. This study was supported with a grant from Brazilian National Research Council (CNPq).

REFERENCES

Alves, M. A. S. (1990) Social system and helping behavior in the white-banded tanager (*Neothraupis fasciata). Condor* 92:470-474.

___ and R. B. Cavalcanti (1996) Sentinel behavior, seasonality, and the structure of bird flocks in a Brazilian Savanna. *Orn. Neotrop.* 7:43-51.

Beveridge, F. M. and J. M. Deag (1987) The effects of sex, temperature and companions on looking-up and feeding in single and mixed species flocks of House Sparrows (*Passer domesticus*), Chaffinches (*Fringilla coelebs*), and Starlings (*Sturnus vulgaris*). *Behaviour* 100:303-320.

Carrascal, L. M. and E. Moreno (1992) Proximal costs and benefits of heterospecific social foraging in the Great Tit, *Parus major*. *Can. J. Zool.* 70:1947-1952.

Lindström, Å. (1989) Finch flock size and risk of hawk predation at a migratory stopover site. *Auk* 106:225-232.

Metcalfe, N. B. (1984) The effect of mixed-species floking on the vigilance of shore birds: who do they trust? *Anim. Behav.* 32:986-993.

Moynihan, M. (1962) The organization and probable evolution of some mixed species flocks of Neotropical birds. *Smithsonian Misc. Collect.* 143:1-140.

Munn, C. A. and J. W. Terborgh (1979) Multispecies territoriality in Neotropical foraging flocks. *Condor* 81:338-347.

Popp, J. W. (1988) Scanning behavior of finches in mixed-species groups. *Condor* 90:510-512.

Powell, G. V. N. (1985) Sociobiology and the adaptative significance of interspecific foraging flocks in the Neotropics. *Orn. Monogr.* 36:713-732.

Pullian, H. R. (1973) On the advantages of flocking. *J. Theoret. Biol.* 38:419-422.

Ridgely, R. S. and G. Tudor (1989) *The birds of South America*. v. I. *The Oscine Passerines*. Austin:Univ. Texas Press.

___ and _ (1994) *The birds of South Amerca*. v. II. *The Suboscine Passerines*. Austin:Univ. Texas Press.

Sick, H (1985) *Ornitologia brasileira, uma introdução*. v. I e II. Brasília:Ed. Univ. Brasília.

Sokal, R. R. and F. J. Rohlf (1981) *Biometry*, second edition. New York:W. H. Freeman.

Sullivan, K. A. (1984) The advantages of social foraging in Downy Woodpeckers. *Anim. Behav.* 32:16-22.

Ararajuba 5(2):236-237
dezembro de 1997

First report of *Xenus cinereus* (Charadriiformes: Scolopacidae) for Brazil

Juan Mazar Barnett

Av. Forest 1531 1° B, (1430) Buenos Aires, Argentina. E-mail: jmbco@ssdnet.com.ar

Recebido em 02 de julho de 1997; aceito em 04 de agosto de 1997

RESUMO. **Primeiro registro de *Xenus cinereus* (Charadriiformes: Scolopacidae) para o Brasil**. Em 16 de março de 1997, o autor observou um indivíduo do maçarico *Xenus cinereus* em plumagem invernal, na foz do rio Buranhém em Porto Seguro, (16°27' S, 39°07' W) Bahia. Este registro representa o primeiro da espécie para o Brasil, e é o terceiro para América do Sul.

PALAVRAS-CHAVE: Brasil, *Xenus cinereus*.

KEY WORDS: Brazil, *Xenus cinereus*.

During a trip to eastern Brazil, I visited the town of Porto Seguro and the Veracruz Ecological Station in the state of Bahia, Brazil, on 15-16 March 1997. Early in the morning of 16 March 1997, I was looking for birds in the mangrove swamp and mudflat shores at the mouth of the rio Buranhém (16°27' S, 39°07' W), and at c. 6:30, I found a single individual that I readily identified as a Terek Sandpiper, *Xenus cinereus*. This bird was found together with a few *Charadrius semipalmatus* and *Actitis macularia* on a small mudflat by the side of a drainage canal on the outskirts of the town of Porto Seguro.

The bird foraged actively, probing constantly on the mud surface, and walked with fast steps, holding a more or less horizontal posture. It also bobbed the rear third of its body, though less regularly. It was observed for about 20 min, and always less than 10 m from the observer. All the distinctive characters of this species were noted. It had bright orange-yellow legs with short tarsi, a long, upcurved bill c. 1.5 times the length of the head, with yellowish base of mandible and lower base of maxilla. The area above the eye was pale whitish, forming a slight eyebrow, and the upperparts were with very slight darker flammulations on back. It had a pale grey band on breast interrupted in the center, and rest of the underparts whitish. Hence the bird appeared to be in its basic, or nonbreeding plumage (Hayman *et al.* 1986).

I found the bird again at 07:15, but unfortunately the tide was rising rapidly, and the bird had moved to an island across a channel of the river some 100 m from the original place, and it could not be photographed at close range. The bird, which looked healthy, remained for some time roosting and bathing. I did nevertheless photograph the bird from that distance. At 13:30, with a fairly low tide, the bird was not found, but I saw it again at 17:40 at ebb tide. The bird was found by the side of the same drainage canal as before, but some 70 m from the edge of the mudflat. It stayed in the same area until dusk, and it probably roosted there. Other species found in the area sharing the habitat with the single *Xenus cinereus* were *Butorides striatus*, *Egretta caerulea*, *Nyctanassa violacea*, *Charadrius collaris*, and *Arenaria interpres*.

This record represents the first for Brazil, as the bird was not mentioned by Sick (1997), and apparently the third for South America. In South America, *Xenus cinereus* had previously been found only in Argentina. Pugnali *et al.* (1988) reported a bird in Punta Rasa, Buenos Aires province, which stayed from December 1987 to January 1988. Narosky and Di Giácomo (1993) mentioned an observation by B. López Lanús in Saladillo, Buenos Aires, in December 1990. The species is normally distributed from Finland and the Ukraine east through Siberia to Anadryland, wintering to tropical coasts and estuaries from southwestern Africa through the Middle East, southern Asia, and northern Australia (Hayman *et al.*, 1986, Sibley and Monroe 1990). The former authors mention vagrant records in Tasmania and Alaska.

This bird was probably a passage migrant, which had joined other waders that were moving northward. *Xenus cinereus* is obviously an occasional vagrant to South America, but it may prove to occur more regularly than thought.

ACKOWLEDGMENTS

Two anonymous reviewers made helpfull corrections to the manuscript.

REFERENCES

Hayman, P., J. Marchant and T. Prater (1986) *Shorebirds. An identification guide to the waders of the world.* London and Sydney: Croom Helm.

Narosky, T. and A. G. Di Giácomo (1993) *Las Aves de la Provincia de Buenos Aires: Distribución y Estatus.* Buenos Aires: Asoc. Ornitológica del Plata, Vázquez Mazzini Ed. y L.O.L.A.

Pugnali, G., D. Blanco and H. Rodríguez Goñi (1988) Hallazgo del Chorlo de Terek, *Xenus cinereus* (Aves, Scolopacidae) en Punta Rasa, costa atlántica de la provincia de Buenos Aires, Argentina. *Nótulas Faunísticas* 13:1-2.

Sibley, C. G. and B. L. Monroe (1990) *Distribution and taxonomy of the birds of the world.* New Haven: Yale Univ. Press.

Sick, H. (1997) *Ornitologia Brasileira.* Rio de Janeiro: Ed. Nova Fronteira.

Aspectos da nidificação do bacurauzinho, *Chordeiles pusillus* (Caprimulgiformes: Caprimulgidae) nos estados da Bahia e Minas Gerais

Lemuel Olívio Leite[1], Luciano Nicolás Naka[2], Marcelo Ferreira de Vasconcelos[3] e Marcos Maldonado Coelho[1]

[1] *Departamento de Biologia Geral, Universidade Federal de Minas Gerais, Av. Antônio Carlos 6627, 30161-970, Belo Horizonte, MG, Brasil*
[2] *Rua Irmão Joaquim 5, apartamento 1001, 88020-620, Florianópolis, SC, Brasil, E-mail: a9412819@ccb2.ccb.ufsc.br*
[3] *Departamento de Zoologia, Universidade Federal de Minas Gerais, Av. Antônio Carlos, 6627, 31270-110, Belo Horizonte, MG, Brasil*

Recebido em 11 de julho de 1997; aceito em 13 de agosto de 1997

ABSTRACT. **Nesting aspects of the Least Nighthawk, *Chordeiles pusillus* (Caprimulgiformes: Caprimulgidae) in the states of Bahia and Minas Gerais**. The Least Nighthaws is an inhabitant of open landscapes and although widespread in their distribution, very little data is available about is reproductive biology. Two nesting sites were found in November 14, 1996 and in January 31, 1997. The bredding activities were found in two different biomas: cerrado and caatinga, in the states of Minas Gerais and Bahia, respectively. Both nesting sites held only one egg each, and were found to occur in similar enviromments with sparse short trees and stony soil. The eggs were laid directly on the floor. They were eliptical, measuring 25.6 x 18.4 mm and 23.3 x 17.7 mm, being slightly bigger in Minas Gerais. They had a cream with widespread and randomly distributed dark brown spots on its surface, giving them a very criptic appearence.

KEY WORDS: caatinga, Caprimulgidae, cerrado, *Chordeiles pusillus*, egg, nesting site.

PALAVRAS-CHAVE: caatinga, Caprimulgidae, cerrado, *Chordeiles pusillus*, ovo, sítio de nidificação.

Os curiangos e bacuraus (Caprimulgidae) são representados por 24 espécies no Brasil, sendo caracterizados por hábitos noturnos, com exceção de uma espécie (Sick 1997). Estas aves nidificam em diversos tipos de locais, realizando a postura de seus ovos em sítios como: serrapilheira (Blackford 1953, Ingels 1975, Bokermann 1978, Langley 1984, Moraes e Krul 1995, Vilella 1995); areia de praias fluviais (Sick 1950, Bokermann 1978); afloramentos rochosos (Ingels *et al*. 1984, Belton 1994); locais pedregosos (Novaes 1957); sobre areia, solo ou um forro de gramíneas em áreas abertas (Alonso 1974, Brigham 1989, Marin e Schmitt 1991); lama grossa (Kiff *et al*. 1989); telhados de construções humanas (Gramza 1967) e até mesmo galhos horizontais de árvores (Seutin e Letzer 1995).

O bacurauzinho, *Chordeiles pusillus* ocorre na Colômbia, Venezuela e Brasil (Meyer de Shauensee 1982, Sick

1997), existindo um registro recente do Norte da Argentina, na Província de Misiones (E. Krauczuk, *apud* J. Mazar *in litt*). Esta espécie habita áreas de campo sujo e tem o hábito de caçar um pouco antes do pôr-do-sol (Sick 1997) através de vôos erráticos acompanhados pela sua constante vocalização (L.N.N. obs. pess.).

Apesar de se tratar de uma espécie de ampla distribuição geográfica, não se encontram informações na literatura a respeito da nidificação de *C. pusillus*. Este trabalho tem como objetivo descrever comparativamente o sítio de nidificação e o ovo de *C. pusillus* em dois biomas brasileiros: o cerrado e a caatinga, nos estados de Minas Gerais e Bahia, respectivamente.

Na região do cerrado de Minas Gerais, esta espécie é comumente encontrada em áreas com a presença de árvores e arbustos esparsos que crescem em solos com bastante cascalho superficial (M.F.V. obs. pess.). A sua presença é também muito comum em áreas de caatinga do norte do estado da Bahia, onde pode ser considerado como o bacurau mais comum da região, habitando tanto ambientes naturais, como cidades e vilarejos (L.N.N. obs. pess.).

O primeiro registro da nidificação de *C. pusillus* deu-se no estado de Minas Gerais no dia 14 de novembro de 1996, numa região de cerrado pertencente ao Centro Nacional de Pesquisa do Milho e Sorgo, CNPMS-EMBRAPA no município de Sete Lagoas (19°28'S, 44°15'W). Neste dia, um indivíduo adulto de *C. pusillus* foi espantado no chão em uma área de cerrado com solo pedregoso de cascalho superficial, com a predominância de árvores baixas de esparsas e lixeira *Curatella americana* (Dilleniaceae) e *Machaerium opacum* (Leguminosae - Papilionoideae) e de arbustos de *Policourea rigida* (Rubiaceae) (figura 1). A ave voou, indo pousar a cerca de 15 m de distância do observador. No local de onde a ave levantara vôo, foi encontrado um ovo de cor creme-clara, com muitas manchas e pintas morron-escuras (figura 2).

O ovo media 25,6 x 18,4 mm e pesava 4,5 g. Apesar da predominância de cascalho na área, no sítio de nidificação não havia nenhuma pedra, num raio circular de aproximadamente 3 cm ao redor do ovo. Numa das faces deste sítio, havia uma touceira baixa de gramínea, talvez para ajudar no sombreamento do local em certas horas do dia.

No dia 21 de novembro de 1996, retornou-se à área, encontrado-se o ovo descoberto e registrou-se a presença de um indivíduo adulto a aproximadamente 3 m deste. A ave voou do local, pousando a cerca de 15 m dos observadores em um substrato de cascalho, permanecendo críptica. No dia 24 de novembro o ovo foi encontrado abandonado pela manhã e pela tarde, não se registrando a presença de nenhum indivíduo adulto nas adjacências. O ovo foi cole-

Figura 1. Sítio de nidificação onde foi encontrado o ovo de *Chordeiles pusillus* na região do município de Sete Lagoas, MG.

Figura 2. Ovo de *Chordeiles pusillus*, encontrado numa área de cerrado, pertencente à EMBRAPA no município de Sete Lagoas, MG.

tado e depositado na Coleção de Ornitologia do Departamento de Zoologia da UFMG.

O segundo registro da nidificação desta espécie foi realizado no dia 31 de janeiro de 1997 na Fazendo Caraíbas, perto da base de campo do Projeto Ararinha-azul (9º9'S, 39º45'W), próxima à cidade de Curaça, distante a 92 km de Juazeiro, norte do estado da Bahia. O local onde o ovo foi achado encontrava-se numa área bastante alterada e degradada pela criação de gado caprino, a 50 m do riacho de Melancia. Esta área apresentava uma vegetação rala dominada por faveleira (*Cnidoscolus phyllacanthus*: Euphorbiaceae), pinhão (*Jatropha mollissima*: Euphorbiaceae) e catingueira (*Caesalpinia pyramidis*: Leguminosae - Caesalpinoideae), assim como diversas cactáceas tais como o xique-xique (*Pilosocereus gounellei*) e o mandacaru (*Cereus jamacaru*). O solo desta área era argiloso e se encontrava coberto parcialmente por cascalho, existindo pequenos lageados de rocha distribuídos no local.

De maneira semelhante ao registro de Sete Lagoas, um único ovo foi encontrado ao ser espantado do chão um indivíduo adulto de *C. pusillus* que se encontrava ao seu redor. O indivíduo realizou um curto vôo, pousando a uns 5 m de distância no chão, perto de uma árvore.

O ovo de formato elíptico, era praticamente indistinguível no ambiente e se encontrava posto diretamente no chão, consistindo o único esforço parental na construção do sítio de nidificação, a limpeza da área num diâmetro de aproximadamente 5 cm ao redor do ovo. Este media 23,3 x 17,7 mm e possuía uma coloração creme fortemente salpicada por pintas e manchas marrons distribuídas aleatoriamente ao longo de toda sua superfície.

Numa segunda visita ao local, no dia 3 de fevereiro de 1997, o ovo já tinha eclodido. O indivíduo adulto, que novamente saiu voando espantado, com o seu habitual vôo errático, desta vez dirigiu-se para uma lage de pedra a uns 30 m do sítio de nidificação. O filhote encontrava-se no mesmo local do ovo e a sua coloração também era críptica, apresentando uma penugem leonada marron-escura e rufa, tendo um formato poligonal que lembrava uma pedra.

Em ambos os casos o local escolhido pela espécie para nidificar foi bastante semelhante, isto é, ambientes abertos com árvores esparsas sobre solos pedregosos com cascalho superficial. A deposição do ovo foi diretamente no chão, com uma pequena área limpa ao redor deste, que variou de 3 a 5 cm. O número de indivíduos adultos ao redor do ovo em ambos casos foi de apenas um. Observou-se uma leve variação no tamanho dos ovos nos dois locais, sendo um pouco maior no sítio de nidificação do cerrado, no estado de Minas Gerais.

A presença de pintas e manchas na coloração do ovo de

C. pusillus mostra semelhanças com os ovos de outras espécies congêneres como *C. repestris* (Sick 1950), *C. acutipennis, C. minor* e *C. gundlachii* (Stevenson *et al.* 1983). O padrão de coloração encontrando tanto no ovo quanto no filhote de *C. pusillus* permite que estes permaneçam em condições crípticas com o substrato, confundindo-se com os pedregulhos de cascalho encontrados no sítio de nidificação.

AGRADECIMENTOS

Agradecemos à EMBRAPA por permitir nossa entrada para pesquisa dentro de sua área de cerrado. L.N.N. é muito grato ao Projeto Ararinha-azul por fornecer todo o apoio financeiro e logístico, assim como a todo o seu pessoal, que compartilhou longas horas de observação no campo. Também é grato a J. Mazar por fornecer alguns dados e a M. Rodrigues por criticar o manuscrito.

REFERÊNCIAS

Alonso, C. (1974) Nota sobre la nidification de *Hydropsalis brasiliana furcifera* (Vieillot) (Caprimulgidae, Aves). *Neotropica* 20:36-39.

Belton, W. (1994) *Aves do Rio Grande do Sul: Distribuição e biologia.* São Leopoldo: Ed. UNISINOS.

Blackford, J. L. (1953) Breeding haunts of the Stephens whip-poor-will. *Condor* 55:281-286.

Bokermann, W. C. A. (1978) Observações sobre a nidificação de dois curiangos, *Hydropsalis climacocerca* (Tschudi, 1844) e *Nyctiphurynus ocellatus* (Tschudi, 1844) (Aves, Carpimulgidae). *Rev. Brasil. Biol.* 38:871-873.

Brigham, R. M. (1989) Roost and nest sites of common nighthawks: are gravel roofs important? *Condor* 91:722-724.

Gramza, A. F. (1967) Responses of brooding nighthawks to a disturbance stimulus. *Auk* 84:72-86.

Ingels, J. (1975) Notes no the Pauraque *Nyctidromus albicollis* in French Guiana. Bull. B. O. C. 95:115-116.

___, J. H. Ribot e B. H. J. Jong (1984) Vulnerability of eggs and young of the Blackish Nightjar (*Caprimulgus nigrescens*) in Suriname. *Auk* 101:388-391.

Kiff, L. F., M. Marin A., F. C. Sibley, J. C. Matheus e N. J. Schmitt (1989) Notes on the nests and eggs of some Ecuadorian birds. *Bull.* B. O. C. 109:25-31.

Langley, C. H. (1984) Observations on two nests of the fierynecked nightjar. *Ostrich* 55:1-4.

Marin A., M. e N. J. Schmitt (1991) *A guide to the birds of South America.* Philadelphia: Academy of Natural Sciences.

Moraes, V. S. e R. Krul (1995) Ocorrência e nidificação de *Macropsalis* creagra na ilha do Mel, Paraná, Brasil (Caprimulgiformes: Caprimulgidae). *Ararajuba* 3:79-80.

Novaes, F. C. (1957) Notas sobre a ecologia do bacurau "*Hydropsalis climacocerca*" Tschudi (Caprimulgidae, Aves). Rev. Brasil. Biol. 17:275-280.

Seutin, G. e M. Letzer (1995) The Short-Tailed Nighthawk is a tree nester. *J. Field Ornithol.* 66:30-36.

Sick, H. (1950) Contribuição ao conhecimento da ecologia de *Chordeiles rupestris* (Spix) (Caprimulgidae, Aves). *Rev. Brasil. Biol.* 10:295-306.

___ (1997) *Ornitologia Brasileira.* Rio de Janeiro: Ed. Nova Fronteira.

Stevenson, H. M., E. Eisenmann, C. Winegarner e A. Karlin (1983) Notes on common antillean nighthawks of the Florida Keys. *Auk* 100:983-988.

Vilella, F. J. (1995) Reproductive ecology and behaviour of the Puerto Rican Nightjar *Caprimulgus noctitherus. Bird Conserv. Intern.* 5:349-366.

New distributional information for 25 species in eastern Paraguay

James C. Lowen[1], Juan Mazar Barnett[2], Mark Pearman[3], Rob Clay[4] and Bernabé López Lanús[2]

[1] *BirdLife International, Wellbrook Court, Girton Road, Cambridge CB3 0NA, UK.*
[2] *Asociación Ornitológica del Plata, 25 de Mayo 749 – 2º Piso, 1002 Buenos Aires, Argentina; jmbco@ssdnet.com.ar*
[3] *58 Prospect Place, London E1 9TJ, UK*
[4] *Large Animal Research Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK; rc124@hermes.cam.ac.uk*

Recebido em 17 de julho de 1997; aceito em 30 de agosto de 1997

RESUMO. **Novas informações sobre a distribuição de 25 espécies no leste do Paraguai.** Hayes (1995) dividiu o Paraguai em sete regiões geográficas e estabeleceu o status de cada uma das 645 espécies do país. Nós apresentamos novos registros para 25 espécies em uma ou mais regiões no este do Paraguai. Estes registros representam importantes extensões na distribuição dentro do país.

PALAVRAS-CHAVE: conservação, distribuição, novas informações, Paraguai.

Key words: conservation, distribution, new information, Paraguai.

Hayes (1995) divided Paraguay into seven "geographical regions", primarily based on major vegetation units and geographical features, for the purpose of analysing bird distribution. We provide the first records for 25 species in one or more of the following geographical regions of eastern Paraguay: Campos Cerrados, Ñeembucú, Central Paraguay and Alto Paraná. The majority of these species are relatively common and widespread in Paraguay (e.g., Hayes 1995), but these records present notable (if not unexpected) range extensions. This new information, with one exception, was obtained during 2,000 hours of ornithological surveys in 1995 (Lowen *et al.* 1996a, b).

Abbreviations and conventions. We use the following abbreviations throughout: *Depto. = Departmento; MN = Monument Natural; PN = Parque Nacional; RNBM = Reserva Natural del Bosque Mbaracayú, Depto. Canindeyú; RNP = Reserva Natural Privada; RVS = Reserva de Vida Silvestre.*

We follow Hayes (1995) in the allocation of sites to geographical regions for all but two localities: PN Caaguazú and PN San Rafael. We include these sites in the Alto Paraná region rather than in Central Paraguay, because both sites show avifaunal characteristics of extreme south-east Paraguay (and adjacent Misiones province, Argentina). Additionally, Hayes' border between the two regions (Hayes 1995: Figure 7, p. 14) follows the watershed between the Rio Paraguay (Central Paraguay) and Rio Paraná (Alto Paraná). Our study area at San Rafael fell within the Rio Paraná drainage system (and thus the Alto Paraná region), whereas the Cordillera de Caaguazú itself forms part of the Rio Paraná watershed (and thus forms the border to the Alto Paraná region).

Most data presented here derives from multi-observer sight or aural records, and is presented as such. The authors and other observers (see *Acknowledgments*) had extensive prior field experience with all species involved. Moreover, the identification of all but three species concerned (Gray-rumped Swift *Chaetura cinereiventris*, Mouse-coloured Tyrannulet *Phaeomyias murina*, and White-crested Elaenia *Elaenia albiceps*) is very straightforward. Brief notes on the identification of these species are provided.

We specify any documentation obtained. Tape-recordings have been deposited at the Wildlife Section, British Library National Sound Archive, UK. Photographs have been deposited in the BirdLife International slide library, UK. The single species mist-netted was measured and photographed before release. No specimens were taken. Details of region, department and co-ordinates are given for all localities mentioned (Appendix).

Species accounts. For each species, we state the region to which it is new, followed by the date(s), site(s), and, where relevant, a brief discussion. Unless otherwise specified, all dates refer to 1995.

Plumbeous Ibis *Theristicus caerulescens*

Central Paraguay: two on 12 August at PN Ypacaraí, Depto. Cordillera.

Campos Cerrados: one on 12 November at Estancia Ybu, Depto. Concepción.

Black-collared Hawk *Busarellus nigricollis*

Alto Paraná: one on 21 August 1992 in open country two km north of RNP Itabó, Depto. Canindeyú.

Black Hawk-eagle *Spizaetus tyrannus*

Alto Paraná: at RNP Itabó, Depto. Canindeyú, one on 12 August, a pair on 16 October, and one on 17 October. Additionally, two all dark hawk-eagle *Spizaetus* sp., presumably this species, were seen distantly on the latter date. These records may relate to just a single pair. Madroño N. and Esquivel (1997) provided the first records for Paraguay (from the RNBM, Depto. Canindeyú, in Central Paraguay).

Blackish Rail *Pardirallus nigricans*

Ñeembucú: single birds seen and heard daily from 3-6 November at Puerto Turi, MN Bosque de Arary, Depto. Itapúa.

Upland Sandpiper *Bartramia longicauda*

Ñeembucú: one on 29 October and eight on 30 October at RVS Yabebyry, Depto. Misiones; four on 2 November and two on 20 December at Base Aerea, MN Bosque de Arary, Depto. Itapúa.

White-rumped Sandpiper *Calidris fuscicollis*

Ñeembucú: four on 20 December at Base Aerea, MN Bosque de Arary, Depto. Itapúa.

Pileated Parrot *Pionopsitta pileata*

Campos Cerrados: observed frequently (and tape-recorded) from 10-12 October at PN Cerro Corá, Depto. Amambay, including a dawn flight of at least 50 birds on 10 October. *Pionopsitta pileata* may be seasonal at this site, having been unrecorded during previous surveys (see Hayes and Scharf 1995).

Pheasant Cuckoo *Dromococcyx phasianellus*

Ñeembucú: up to three seen and tape-recorded from 29-31 October at RVS Yabebyry, Depto. Misiones; one heard on 31 October at Base Aerea, MN Bosque de Arary, Depto. Itapúa.

Variable Screech-owl *Otus atricapillus*

Alto Paraná: single birds heard on four dates from 16-24 July at PN Caaguazú, Depto. Caazapá; two heard on 26 July at PN San Rafael, Deptos. Itapúa/Caazapá; at RNP Itabó, Depto. Canindeyú, one heard on 1 August, and up to seven birds calling (and tape-recorded) on eight dates from 14-23 October 1995. The species is evidently widespread in the Alto Paraná forests: it was presumably overlooked during surveys in the unusually cold winter of 1992 (Brooks *et al.* 1993).

Striped Owl *Asio clamator*

Ñeembucú: at Puerto Turi, MN Bosque de Arary, Depto. Itapúa, one seen on 4 November, and two seen and tape-recorded on 6 November.

Gray Potoo *Nyctibius griseus*

Ñeembucú: three calling on 30 October and one on 31 October at RVS Yabebyry, Depto. Misiones; up to three calling from 1-2 November at Base Aerea, MN Bosque de Arary, Depto. Itapúa; and up to three birds calling from 3-6 November at nearby Puerto Turi.

Gray-rumped Swift *Chaetura cinereiventris*

Campos Cerrados: two on 11 October at PN Cerro Corá, Depto. Amambay. *Chaetura cinereiventris* was easily distinguished from Ashy-tailed Swift *C. andrei* by its smaller size, more scythe-shaped wings, proportionally longer tail, and more fluttering, bat-like flight. In addition, *C. c. cinereiventris* (the nominate form occurring in Paraguay) has a restricted, neat square rump patch, contrasting markedly with the long dark tail. The underparts grade from a pale throat (demarcated from the dark 'cap') to almost black undertail coverts. Although first observed in Paraguay in 1977 (R. S. Ridgely *in litt.* 1994), but not documented until 1992 (Brooks *et al.* 1995, Hayes 1995), *C. cinereiventris* has now proved to be widespread throughout eastern Paraguay (Lowen *et al.* 1996b, Madroño N. and Esquivel 1997).

Green-and-rufous Kingfisher *Chloroceryle inda*

Alto Paraná: a male on 28 July at PN San Rafael, Deptos. Caazapá/Itapúa, appears to extend the southern limit of the species' known distribution (see Fry *et al.* 1992).

Mouse-colored Tyrannulet *Phaeomyias murina*

Ñeembucú: a pair on 31 October and one on 1 November at Base Aerea, MN Bosque de Arary, Depto. Itapúa. Its distinctive chattering call was tape-recorded. *Phaeomyias murina* is a thick-billed tyrannulet with a pale base to the lower mandible. It lacks the prominent crest of Southern Beardless-tyrannulet *Camptostoma obsoletum*, and, unlike that species, does not cock its tail.

Yellow Tyrannulet *Capsiempis flaveola*

Campos Cerrados: two on 11 October at PN Cerro Corá, Depto. Amambay.

Ñeembucú: two on 4 November at Puerto Turi, MN Bosque de Arary, Depto. Itapúa.

White-crested Elaenia *Elaenia albiceps*

Ñeembucú: one on 29 October and five on 30 October at RVS Yabebyry, Depto. Misiones; three on 2 November and two on 3 November at Base Aerea, MN Bosque de Arary, Depto. Itapúa; and two from 3-4 November at nearby Puerto Turi. Although the identification of *Elaenia* spp. is problematic (see, e.g., Ridgely and Tudor 1994), these birds all gave the typical call of *E. albiceps* (a drawn-out, emphatic "teeoo") and showed a broad white crown-patch. In addition, they lacked the strong contrast between bright upperparts and grey throat typical of Small-billed Elaenia *Elaenia parvirostris*.

Tawny-crowned Pygmy-tyrant *Euscarthmus meloryphus*

Campos Cerrados: up to six individuals were seen and tape-recorded from 10-12 October at PN Cerro Corá, Depto. Amambay. Previous studies at the park (e.g. Hayes and Scharf 1995) did not record the species.

Large-headed Flatbill *Ramphotrigon megacephala*

Campos Cerrados: two singing birds seen at PN Cerro Corá, Depto. Amambay, in riverside bamboo *Guadua* sp. on 11 October. Although Hayes (1995) listed just three or four records for the country, *Ramphotrigon megacephala* has now been found in at least six widely spaced sites in eastern Paraguay (Lowen *et al.* 1996b, Madroño N. and Esquivel 1997, A. Madroño N. *in litt.* 1997). It is easy to overlook if the song (a disyllabic *whu-hoo*) is not known (Aleixo 1997, pers. obs.).

Piratic Flycatcher *Legatus leucophaius*

Ñeembucú: one seen and tape-recorded on 3 November at Base Aerea, MN Bosque de Arary, Depto. Itapúa; and up to five from 3-6 November at nearby Puerto Turi.

Bank Swallow *Riparia riparia*

Alto Paraná: single birds on 15, 17 and 20 October at RNP Itabó, Depto. Canindeyú; and two on 6 December at RNP Ypetí, Depto. Caazapá.

Cliff Swallow *Hirundo pyrrhonota*

Alto Paraná: approximately 50 on 15 October and one on 20 October at RNP Itabó, Depto. Canindeyú; approximately 100 birds on 5 December at RNP Ypetí, Depto. Caazapá.

Blue Dacnis *Dacnis cayana*

Ñeembucú: a pair on 4 November at Puerto Turi, MN Bosque de Arary, Depto. Itapúa.

Plumbeous Seedeater *Sporophila plumbea*

Central Paraguay: up to 20 individuals daily from 14-19 September at Aguará Ñu, RNBM, Depto. Canindeyú (photographed, mist-netted, tape-recorded); two males on 27 September in an isolated area of cerrado at Estancia Jiménez, Depto. Canindeyú.

White-bellied Seedeater *Sporophila leucoptera*

Ñeembucú: at Puerto Turi, MN Bosque de Arary, Depto. Itapúa, three birds (adult male, immature male and a female) on 3 November, with the immature male still present on 4 November.

Giant Cowbird *Scaphidura oryzivora*

Ñeembucú: up to six birds daily from 28-31 October at RVS Yabebyry, Depto. Misiones; at Base Aerea, MN Bosque de Arary, Depto. Itapúa, two on 1 November and one on 2 November; and up to 12 birds daily from 3-6 November at nearby Puerto Turi.

Closing remarks. Even compared to most countries in the Neotropics, all of which are under-studied, ornithological surveys in Paraguay remain in their infancy. Almost all species detailed here are relatively common, widespread, and easy to identify. That they had not previously been recorded in their respective geographical region is most likely due to lack of fieldwork in suitable habitat, rather than vagrancy or expanding populations.

ACKNOWLEDGMENTS

For their fieldwork we thank Ignacio Avila, Roger Barnes, Lucia Bartrina, Thomas Brooks, Vanessa Doría, Estela Esquivel, Nubia Etcheverry, Rosalina Fariña, Bolivár Garcete Barrett, Richard Johnson, Durwyn Liley, Alberto Madroño N., Mirna Perrens, Jane Reid, Joe Tobias, Ramón Villalba, Sergio Villanueva, and Kristof Zyskowski. Our surveys were conducted with the help of the Dirección de Parques Nacionales y Vida Silvestre, the Facultad de Ciencas Exactas y Naturales, the Fundación Moisés Bertoni, and the Museo Nacional de Historia Natural del Paraguay. Additional logistical support was provided by the British Embassy in Asunción. Individuals from these institutions are credited in Lowen *et al.* (1996b), as are donors. Luciano Naka and Gina Pfaff provided the Portuguese abstract. Miguel Marini, Joe Tobias, David Wege, and two anonymous reviewers provided very helpful comments on an earlier version of this article.

REFERENCES

Aleixo, A. (1997) Range extension of the Large-headed Flatbill *Ramphotrigon megacephala* with comments on its distribution. *Bull. Brit. Orn. Club* 117:220-223.

Brooks, T. M., R. Barnes, L. Bartrina, S. H. M. Butchart, R. P. Clay, E. Z. Esquivel, N. I. Etcheverry, J. C. Lowen, and J. Vincent. (1993) *Bird Surveys and Conservation in the Paraguayan Atlantic Forest.* BirdLife International Study Report 57. Cambridge, UK: BirdLife International.

___, R. P. Clay, J. C. Lowen, S. H. M. Butchart, R. Barnes, E. Z. Esquivel, N. I Etcheverry, and J. P. Vincent, (1995) New information on nine birds from Paraguay. *Orn. Neotrop.* 6:129-134.

Fry, C. H., H. Fry, and A. Harris (1992) *Kingfishers, Bee-eaters and Rollers.* London: Christopher Helm Ltd.

Hayes, F. E. (1995) *Status, distribution and biogeography of the birds of Paraguay.* Monog. Field Ornith. No. 1. New York: American Birding Association.

___ and P. A. Scharf (1995) The birds of Parque Nacional Cerro Corá, Paraguay. *Cotinga* 4:20–24.

Lowen, J. C., L. Bartrina, T. M. Brooks, R. P. Clay, and J. A. Tobias (1996a) Project YACUTINGA '95: Bird surveys and conservation priorities in eastern Paraguay. *Cotinga* 5:14-19.

___, ____ , R. P. Clay, and J. A. Tobias (1996b) *Biological surveys and conservation priorities in eastern Paraguay.* Cambridge, UK: CSB Conservation Publications.

Madroño N., A. and E. Z. Esquivel (1997) Noteworthy records and range extensions of some birds found at the Mbaracayú Forest Nature Reserve (Reserva Natural del Bosque Mbaracayú), Canindeyú, Paraguay. *Bull. Brit. Orn. Club.* 117:166-176.

Ridgely, R.S. and Tudor, G. (1994) *The birds of South America: the suboscine passerines.* Vol 2, Oxford: Oxford Univ. Press.

APPENDIX

Location of sites mentioned in the text. All sites were 100-450m elevation.

Region	Site	Department	Coordinates
Ñeembucú	RVS Yabebyry	Misiones	27°10'S, 57°00'W
	MN Bosque de Arary	Itapúa	27°27'S, 56°48'W
	" at Base Aerea		27°25'S, 57°11'W
	" at Puerto Turi		27°24'S, 57°14'W
Alto Paraná	RNP Ypetí	Caazapá	25°33'S, 55°30'W
	RNP Itabó	Canindeyú	24°20'S, 54°35'W
	PN Caaguazú	Caazapá	26°04'S, 55°45'W
	PN San Rafael	Itapúa/Caazapá	26°25'S, 55°40'W
Central Paraguay	RNBM	Canindeyú	24°07'S, 55°23'W
	/Aguará Ñu		24°09'S, 55°16'W
	PN Ypacaraí	Central/Cordillera	25°15'S, 55°19'W
	Estancia Jiménez	Canindeyú	24°13'S, 55°38'W
Campos Cerrados	PN Cerro Corá	Amambay	22°39'S, 56°00'W
	Estancia Ybu	Concepcíon	22°30'S, 57°29'W

Ararajuba 5(2):244-245
dezembro de 1997

Novos registros de ninhos e ovos de três espécies de aves do Brasil Central

Miguel Ângelo Marini[1], Maria de Fátima Pereira[2], Genilda Maria de Oliveira e Celine de Melo
Departamento de Biociências, Universidade Federal de Uberlândia, Campus Umuarama, 38400-902, Uberlândia, MG

Recebido em 08 de setembro de 1997; aceito em 17 de outubro de 1997

ABSTRACT. **Further records of nests and eggs of three bird species from Central Brazil.** Further nests and eggs of three species of birds (*Herpsilochmus longirostris*, Thamnophilidae; *Antilophia galeata*, Piprinae; and *Basileuterus leucophrys*, Parulinae), quasi-endemic to Central Brazil are described.

Key WORDS: *Antilophia galeata*, *Basileuterus leucophrys*, cerrado region, *Herpsilochmus longirostris*, nests.

PALAVRAS-CHAVE: *Antilophia galeata*, *Basileuterus leucophrys*, cerrado, *Herpsilochmus longirostris*, ninhos.

Os ninhos e ovos de diversas aves brasileiras ainda são desconhecidos ou pouco conhecidos. Entre as aves endêmicas ou quase-endêmicas do Brasil central, algumas tiveram seus ninhos descritos recentemente (*Herpsilochmus longirostris*, Straube *et al.* 1992; *Basileuterus leucophrys*, Marini e Cavalcanti 1994). Relatamos aqui novos registros de ninhos e ovos de três espécies (*Herpsilochmus longirostris*, Thamnophilidae; *Antilophia galeata*, Tyrannidae: Piprinae; e *Basileuterus leucophrys*, Emberizidae: Parulinae) de aves endêmicas ou quase-endêmicas da região dos cerrados.

Os dados foram coletados em dois fragmentos de mata no município de Uberlândia, Minas Gerais, cuja vegetação predominante é o Cerrado e o clima, sazonal. O fragmento denominado A, uma mata de galeria alagada de 7,5 ha, está localizado na Granja Marileuza (48°15'W, 18°52'S); o fragmento B, uma mata mesófila de 54 ha, localiza-se na Fazenda Experimental do Glória da Universidade Federal de Uberlândia (48°13'W, 18°52'S). Foram realizadas medidas morfométricas dos ninhos e quando presentes, os ovos foram medidos e pesados e os filhotes anilhados. Para a pesagem dos ovos foi utilizada uma balança de mola tipo Pesola de 5,0 g e as medidas foram tomadas com paquímetro.

Herpsilochmus longirostris (Thamnophilidae) – Um ninho foi encontrado vazio às 7:30 no dia 6 de abril de 1994 sobre um canal de irrigação dentro da mata A. Ao ser vistoriado novamente às 8:00 do mesmo dia continha um ovo que estava sendo incubado pela fêmea. Seis dias após a postura do primeiro ovo (12 de abril), este ninho apresentava dois ovos, que estavam sendo incubados pelo casal, em revezamento. Dez dias após o início da postura (16 de abril) o ninho estava vazio, sem vestígio dos ovos, provavelmente tendo sido predado.

Este ninho possui características semelhantes ao ninho descrito por Straube *et al.* (1992), diferindo no suporte de fixação, que consistia em uma forquilha vertical naquele, e em dois ramos horizontais paralelos de uma Pteridofita, suspensos a ± 1 m de altura, no ninho aqui registrado. As medidas do ninho são: altura externa = 5,5 cm; diâmetro externo = 6,5 cm; diâmetro interno = 5 cm.

Em 27 de junho de 1994, uma ave em plumagem de fêmea colocou um inseto de 10-15 mm dentro do bico de outro indivíduo também com plumagem de fêmea, provavelmente um filhote. Este comportamento foi observado no interior de um fragmento de mata de galeria de 8 ha a 80 m do fragmento A. A fêmea envolvida neste comportamento provavelmente não é a mesma da fêmea registrada no ninho, pois vários indivíduos de *H. longirostris* foram registrados nestas duas matas.

Os dois registros (ninho em início de incubação em abril; fêmea alimentando filhote no final de junho) não são típicos para as aves da região, que concentram sua reprodução entre setembro e fevereiro (Cavalcanti e Pimentel 1988).

Antilophia galeata (Piprinae) – Foram encontrados três ninhos, todos no fragmento B. As características dos ninhos são semelhantes às descritas anteriormente (Ihering 1900, 1902, Marini 1992) e estão descritas na tabela 1 (ninhos 1 e 3).

---

[1] Endereço atual: Departamento de Biologia Geral, C. P. 486, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, 30161-970, Belo Horizonte, MG. E-mail: marini@mono.icb.ufmg.br

[2] Endereço atual: Departamento de Patologia, Universidade Federal de Uberlândia, Av. Pará 1720, Campus Umuarama, 38400-902, Uberlândia, MG

Tabela 1. Medidas (cm) e localização dos ninhos de *Antilophia galeata* encontrados na Fazenda Experimental do Glória, Uberlândia.

Medidas	Ninho 1	Ninho 3
Altura externa	7,6	5,8
Diâmetro interno	4,6	5,4
Diâmetro externo	6,4	6,6
Distância das pontas dos galhos da forquilha ao ninho	59 e 60	60 e 84
Distância do ninho ao tronco	36	40
Distância da borda do ninho ao chão	197	200
Espécie da planta suporte	*Inga* sp.	*Guatteria* sp.

O primeiro ninho foi encontrado durante o processo de construção, no dia 29 de agosto de 1994. Um indivíduo com plumagem verde-oliva, provavelmente uma fêmea, depositava folhas no interior do ninho e posteriormente as organizava com os pés. No dia 2 de setembro havia um ovo no ninho e ao ser vistoriado novamente no dia 7 de setembro, havia dois ovos. Os ovos foram medidos e pesados no dia 12 de setembro (peso = 5,0 e 5,2 g; largura = 15,6 e 15,5 mm; e comprimento = 23,9 e 23,8 mm, respectivamente). O ninho foi encontrado vazio, sem vestígio de ovos e/ou filhotes no dia 17 de setembro.

O segundo ninho foi encontrado no dia 26 de setembro de 1994, contendo dois filhotes que apresentavam penas em crescimento nas asas e cauda, e estava vazio no dia 1° de outubro. O terceiro ninho foi encontrado no dia 12 de novembro de 1994 com dois ovos. No dia 19 de novembro os ovos foram pesados e medidos (peso = 3,3 e 3,1 g; largura = 16,7 e 16,4 mm e comprimento = 24,7 e 23,8 mm, respectivamente). Este ninho não pôde ser acompanhado posteriormente.

Para *A. galeata*, ambos os ninhos acompanhados (ninhos 1 e 2) apresentaram evidências de predação. No primeiro ninho, o intervalo entre a postura do primeiro ovo e a data em que o ninho foi encontrado vazio sugere que o mesmo foi predado ainda durante o período de incubação. No segundo ninho os filhotes provavelmente também foram predados, pois quando foram encontrados estavam no início do desenvolvimento da plumagem, e um intervalo de cinco dias não parece suficiente para que o tenham completado e abandonado o ninho.

Basileuterus leucophrys (Parulinae) – Houve o registro de dois ninhos, ambos no fragmento B. O primeiro foi encontrado dia 10 de setembro de 1994 com quatro ovos e um indivíduo incubando. O ninho foi construído sob a serrapilheira, à margem do canal que intercepta o interior da mata, possuía formato globular e o material utilizado era folhas, características que são compatíveis com as descritas por Marini e Cavalcanti (1994). Dos quatro ovos, três foram pesados e medidos (peso = 2,5, 2,45 e 2,5g; largura = 15,7, 15,5 e 15,8 mm; e comprimento = 21,5, 21,3 e 20,8 mm, respectivamente), e um foi danificado durante a manipulação. No dia 14 de setembro um indivíduo estava incubando os três ovos restantes. Nos dias 17 e 19 de setembro o ninho continha três filhotes. Ao ser vistoriado 10 dias após (29 de setembro) o ninho estava vazio.

O segundo ninho foi encontrado em 1° de outubro de 1994, estava em fase de construção nas proximidades do primeiro ninho. Em visitas posteriores ao campo o ninho parecia abandonado.

AGRADECIMENTOS

Aos proprietários da 'Granja Marileuza' e aos administradores da 'Fazenda Experimental do Glória' por permitir a realização do nosso trabalho em suas propriedades. Ao Prof. Ivan Schiavini pelo uso do carro de campo. M.Â.M. possuia uma bolsa de recém doutor do CNPq. Esta é uma contribuição do Programa de Ecologia, Conservação e Manejo de Vida Silvestre da Universidade Federal de Minas Gerais.,

REFERÊNCIAS

Cavalcanti, R. B. e T. M. Pimentel (1988) Shiny cowbird parasitism in Central Brazil. *Condor* 90:40-43.

Ihering, H. v. (1900) Catálogo crítico-comparativo dos ninhos e ovos das aves do Brasil. *Rev. Mus. Paul.* 4:191-300.

___ (1902) Contribuições para o conhecimento da ornitologia de São Paulo. *Rev. Mus. Paul.* 5:261-326.

Marini, M. Â. (1992) Notes on the breeding and reproductive biology of the Helmeted Manakin. *Wilson Bull.* 104:168-173.

___ e R. B.Cavalcanti (1994) First description of the nest and eggs of the White-striped Warbler (*Basileuterus leucophrys*). *Orn. Neotrop.* 5:117-118.

Straube, F., M. R. Bornschein e D. M. Teixeira (1992) The nest of the Large-billed Antwren *Herpsilochmus longirostris*. *Bull. Brit. Orn. Club* 112:277-279.

Revisado por Edwin O. Willis, Fernando C. Novaes e Luiz A. P. Gonzaga.

REVISÃO

Ararajuba 5(1):247-250
junho de 1997

Bibliografia recente da ornitologia brasileira

José Fernando Pacheco

Departamento de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, 21944-970, Rio de Janeiro, RJ, Brasil. E-mail: jfpcbc@ax.apc.org

São relacionados nesta quarta contribuição da série 100 títulos de livros, artigos e notas relativas à bibliografia ornitológica brasileira, assim considerados sob esta chancela a partir de critérios estabelecidos na primeira compilação apresentada (Ararajuba 4: 56). Os títulos aqui listados datam principalmente de 1997, secundados de alguns outros publicados no biênio anterior que pretendem suplementar as compilações préviamente fornecidas.

Colaboraram enviando acréscimos, sugestões e comentários os seguintes colegas: Antônio C. C. de Almeida, Vânia S. Alves, Marina Anciães, Marco A. de Andrade, Marcos R. Bornschein, Luiz P. Gonzaga, M. A. Pizo, Bianca L. Reinert.

Aleixo, A. (1997) Composition of mixed-species bird flocks and abundance of flocking species in a semideciduous forest of southeastern Brazil. *Ararajuba* 5:11-18.

___ (1997) Estrutura e organização de comunidades de aves em áreas de Mata Atlântica primitiva e explorada por corte seletivo. Resumo de tese. *Atualidades Orn.* 78:2.

___ (1997) Range extension of the Large-headed Flatbill *Ramphotrigon megacephala* with comments on its distribution. *Bull. Brit. Orn. Cl.* 117:220-223.

Almeida, M. E. de C. (1997) Estrutura de comunidades de aves em dois remanescentes florestais na bacia do rio Jacaré-pepira, SP. Resumo de tese *Atualidades Orn.* 76:2.

Alvarenga, H. F. (1997) Aves fósseis: história da origem e evolução. p. 120-123. *In*: H. Sick. *Ornitologia Brasileira*. Edição revista e ampliada. Rio de Janeiro: Nova Fronteira.

Alves, V. S., A. B. A. Soares e A. B. B. Ribeiro (1997) Birds of the Jequia mangrove system, Ilha do Governador, Baía de Guanabara, Rio de Janeiro, Brazil. p. 163-170. *In*: B. Kjerfve, L. D. de Lacerda e E. H. S. Diop (eds.) *Mangrove ecosystem studies in Latin America and Africa*. Paris: United Nations Educational, Scientific and Cultural Organization.

Andrade, M. A. (1997) O Parque do Ibitipoca e suas aves. *Uiraçu* n. s. 1(1):5

___ e M. V. G. de Andrade. (1997) A cigarra-bambu (*Haplospiza unicolor*). *Atualidades Orn.* 78:11.

Anjos, L. dos e K.-L. Schuchmann (1997) Biogeographical affinities of the avifauna of the Tibagi river basin, Paraná drainage system, southern Brazil. *Ecotropica* 3(1):43-66.

Antas, P. T. Z. (1996) Analysis of Red Knot *Calidris canutus rufa* banding data in Brazil. *Intern. Wader Stud.* 8:63-70.

Azevedo Júnior, S. M. e M. E. de Larrazabal (1997) Uma proposta de legislação para a conservação das aves limícolas na Coroa do Avião, Pernambuco, Brasil. *Ararajuba* 5:63-65.

Barbieri, E., V. Gomes, P. V. Ngan e M. J. de A. C. R. Passos (1997) As aves dos gelos do sul. *Ci. Hoje* 21:34-41.

Bauer, C. e J. F. Pacheco (1997) Aves coletadas em Guarapari, litoral sul do Espírito Santo, pela expedição do Departamento de Zoologia da Secretaria de Agricultura de São Paulo em 1942. *Atualidades Orn.* 775:4.

Benez, S. M. (1997) Patologia de penas e pele das aves. *Atualidades Orn.* 75:3-4.

___ (1997) O bico das aves e a alimentação. *Atualidades Orn.* 77:3.

___ (1997) Psitacose: observações sobre palestra do Dr. Greg Harrison -USA. *Atualidades Orn.* 78:3.

___ (1997) A importância da luz na reprodução; Avaliação da granulometria na alimentação: conceito e função. *Atualidades Orn.* 79:3.

Borges, S. H. (1996) (Resenha de) Statistics for Ornithologists, 2. Edição, J. Fowler e L. Cohen. British Trust for Ornithology. *Ararajuba* 4:63.

Bornschein, M. R., B. L. Reinert e M. Pichorim (1997) Notas sobre algumas aves novas ou pouco conhecidas no sul do Brasil. *Ararajuba* 5:53-59.

Camargo, P. R. de (1997) Posturas de comportamento em canário-da-terra (*Sicalis flaveola*). *Atualidades Orn.*

75:5-6.

Christiansen, M. B. e E. Pitter (1997) Species loss in a forest bird community near Lagoa Santa in Southeastern Brazil. *Biol. Conserv.* 80:23-32.

Donatelli, R. J. (1997) Osteologia e miologia cranianas de Dendrocolaptidae (passeriformes, Tyranni) 1. Gêneros *Glyphorhynchus* (sic), *Campylorhamphus, Dendrocincla, Xiphorhynchus* e *Dendrocolaptes. Ararajuba* 5:19-37.

___ (1997) (Resenha de) *As aves de Santa Catarina: Distribuição geográfica e meio ambiente.* L. A. Rosário, 1966(sic). *Ararajuba* 5:87.

Dias, R. A. e G. N. Maurício (1997) *Certhiaxis cinnamomea* como hospedeiro de *Molothrus bonariensis* no sul do Brasil. *Atualidades Orn.* 79:9.

Duarte, J. M. B. e R. Caparroz (1995) Cytotaxonomic analysis of Brazilian species of the genus *Amazona* (Psittacidae, Aves) and confirmation of the genus *Salvatoria* (Ribeiro, 1920). *Braz. J. Genetics* 18(4):623-628.

Figueiredo, L. F. de A. (1997) O necessário pacto entre os preservacionistas e os criadores de aves silvestres. *Atualidades Orn.* 75:5.

Fortaleza, D. M. R. (1997) Análise ecológica e biogeográfica da avifauna de dois remanescentes florestais de Estado do Espírito Santo. Resumo [de monografia]. *Atualidades Orn.* 79:14.

Galetti, M., P. Martuscelli, M. A. Pizo e I. Simão (1997) Records of Harpy and Crested Eagles in the Brazilian Atlantic Forest. *Bull. Brit. Orn. Cl.* 117(1):27-31.

Goerck, J. M. (1997) Patterns of rarity in the birds of the atlantic forest of Brazil. *Conserv. Biol.* 11:112-118.

Gontijo, R. G. R. (1997) O Chopim-azeviche (*Molothrus rufoaxillares*) (sic). *Uiraçu* n. s. 1(1):3

Gonzaga, L. P., G. D. A. Castiglioni e M. A. S. Alves (1997) *Philodrias patagoniensis* (NCN). Diet. [*Coereba flaveola*, predação] *Herpetological Rev.* 28(3):154.

Griffiths, R. e B. Tiwari (1995) Sex of the last Spix's Macaw. *Nature* 375:454.

Guedes, N. M. R. (1995) Alguns aspectos sobre o comportamento reprodutivo da Arara-azul *Anodorhynchus hyacinthinus* e a necessidade de manejo para a conservação da espécie. p. 272-292. *Anais de Etologia* 13, Pirassununga.

Haffer, J. (1997) Alternative models of vertebrate speciation in Amazonia. *Biodiv. Conserv.* 6:451-476.

Hays, H., J. DiCostanzo, G. Cormons, P. T. Z. Antas, J. L. X. Nascimento, I. L. S. Nascimento e R. E. Bremer (1997) Recoveries of Roseate and Common Terns in South America. *J. Field Orn.* 68:79-90.

Hidasi, J. (1997) *Aves de Goiânia.* Goiânia: Fundação Jaime Câmara.

Hinkelmann, C. (1996) Systematics and geographic variation in Long-tailed Hermit hummingbirds, the *Phaethornis superciliosus-malaris-longirostris* species group (Trochilidae), with notes on their biogeography. *Orn. Neotrop.* 7: 119-148.

Kawall, N. M. (1997) *Amazona kawalli* visto por Kawall. *Atualidades Orn.* 78:10-11.

Keller, C. (1997) Alimentação de psitacídeos em cativeiro. *Atualidades Orn.* 77:10-11.

___ (1997) Reprodução em cativeiro de *Amazona brasiliensis. Atualidades Orn.* 79:6.

Lago-Paiva, C. (1996) Cavity nesting by great kiskadees (*Pitangus sulphuratus*): adaptation or expression of ancestral behavior? *Auk* 113:953-955.

Lima, V. S. (1997) Os sons do pitiguari. Resumo de tese. *Atualidades Orn.* 77:2.

Lins, L. V., A. B. M. Machado, C. M. R. Costa e G. Hermann (1997) *Roteiro metodológico para elaboração de listas de espécies ameaçadas de extinção.* Belo Horizonte: Fundação Biodiversitas. [Publ. Avulsas n. 1]

Lourival, R. F. F. e G. A. B. Fonseca (1997) Análise de sustentabilidade do modelo de caça tradicional no Pantanal de Nhecolândia, Corumbá, MS. p. 123-172. *In*: C. Valladares-Pádua e R. E. Bodmer (Orgs.) *Manejo e conservação de vida silvestre no Brasil.* Brasília: CNPq/ Belém: Sociedade Civil Mamirauá.

Machado, C. G. (1997) *Vireo olivaceus* (Vireonidae): uma espécie migratória nos bandos mistos de aves na Mata Atlântica do sudeste brasileiro. *Ararajuba* 5:60-62.

Machado, D. A. (1997) Estudo de populações de aves silvestres da região do Salto Piraí e uma proposta de conservação para a Estação Ecológica do Bracinho, Joinville, SC. Resumo de tese. *Atualidades Orn.* 79:2.

Melo, C. e R. H. F. Macedo (1997) Mortalidade em ninhadas de *Guira guira* (Cuculidae): competição por recursos ? *Ararajuba* 5:45-52.

Mendes, L. G. de M. (1997) Identificação segura de juritis pelo método de zoofonia. *Uiraçu* n. s. 1(1):3

Mikich, S. B. e A. I. Lara (1996) Levantamento de aves liminícolas da Praia Deserta, ilha de Superagüi, Guaraqueçaba, Brasil. *Estudos de Biologia PUC*, Curitiba 4(40):55-70.

Miller, W. J. (1997) O pombo doméstico feral, *Columba livia. Uiraçu* n. s. 1(1):7

Mourão, G. e W. Magnusson (1997) Uso de levantamentos aéreos para o manejo de populaçoes silvestres. p. 23-33. *In*: C. Valladares-Pádua e R. E. Bodmer (Orgs.) *Manejo e conservação de vida silvestre no Brasil.* Brasília: CNPq/ Belém: Sociedade Civil Mamirauá.

Myiaki, C. Y., J. M. B. Duarte, R. Caparroz, A. L. V. Nunes e A. Wajntal (1997) Sex identification of South American Parrots (Psittacidae, Aves) using the Human Minisatellite Probe 33.15. *Auk* 114:516-520.

Novelli, R. (1997) *Aves marinhas costeiras do Brasil (identificação e biologia).* Porto Alegre: Cinco Continentes.

Olmos, F. (1996) Missing species in São Sebastião island, southeastern Brazil. *Pap. Avulsos Zool.* 39(18):329-349.

___ (1997) Seabirds attending bottom long-line fishing off southeastern Brazil. *Ibis* 139:685-691.

Pacheco, J. F. (1997) Novas espécies e subespécies descritas para o Brasil nas três últimas décadas. *Atualidades Orn.* 76:4. [Notulae et Corrigenda, VII]

___ e C. Bauer (1997) Novo limite sul na distribuição do arapaçu-de-bico-branco *Xiphorhynchus picus* no leste do Brasil. *Atualidades Orn.* 78:13. [Notulae et Corrigenda, VIII]

___ e R. Parrini (1997) O limite norte de distribuição do tinguaçu-castanho (*Attila phoenicurus*) na Mata Atlântica. *Atualidades Orn.* 75:4. [Notulae et Corrigenda, VI]

___, ___, B. M. Whitney, C. Bauer e P. S. M. da Fonseca (1997) Novos registros de aves para o estado do Rio de Janeiro: Costa Verde. *Atualidades Orn.* 78:4-5.

___, ___, ___, ___ e ___ (1997) Novos registros de aves para o estado do Rio de Janeiro: região sul do vale do rio Paraíba do Sul. *Atualidades Orn.* 79:4-5.

___ e B. M. Whitney (1997) On the origin of some birds collected by George Such, and the type localities of several forms. *Auk* 114:303-305.

Pizo, M. A., I. Simão e M. Galetti (1997) Daily variation in activity and flock size of two parakeet species from southeast Brazl. *Wilson Bull.* 109:343-348.

Printes, R. C., C. G. Costa e K. B. Strier (1996) Possible predation on two infant muriquis, *Brachyteles arachnoides*, at the Estação Biológica de Caratinga, Minas Gerais, Brazil. [*Leptodon cayanensis*, possivelmente envolvido] *Neotrop. Primates* 4(3):85-86.

Raguza-Netto, J. (1997) Seasonal variation in foraging behavior of *Cypsnagra hirundinacea* in the campo-cerrado. *Ararajuba* 5:72-75.

Raposo, M. A. (1997) A new species of *Arremon* (Passeriformes: Emberizidae). *Ararajuba* 5:3-9.

Ravazzani, C. (1997) O fotógrafo da natureza: Carlos Renato Fernandes. *Atualidades Orn.* 77:8-9.

Redford, K. H. (1997) A floresta vazia. p. 1-22. *In*: C. Valladares-Pádua e R. E. Bodmer (Orgs.) *Manejo e conservação de vida silvestre no Brasil*. Brasília: CNPq/ Belém: Sociedade Civil Mamirauá.

Reinert, B. e M. Bornschein (1996) Relato de uma descoberta. *Ci. Hoje das Crianças* 64:22-23.

Ribeiro, R. C. C. (1997) Ocorrência de águia-cinzenta (*Harpyhealiatus* (sic) *coronatus*) no município de Itambé do Mato Dentro - MG. *Atualidades Orn.* 78:14.

Rodrigues, A. A. F. (1996) Cajual Island Wildlife Research and Conservation Station, Gulf of Maranhão, Brazil. *Wader Study Group Bull.* 80:79.

___ e A. T. L. Lopes (1997) Abundância sazonal e reprodução de *Charadrius collaris* no Mranhão, Brasil. *Ararajuba* 5:65-69.

___, D. C. Oren e A. T. L. Lopes (1996) New data on breeding Wilson's Plover *Charadrius wilsonia* in Brazil. *Wader Study Group Bull.* 81:80-81.

Sant'Ana, C. E. R. e J. A. F. Diniz-Filho (1997) Autocorrelação filogenética para o tamanho do corpo em corujas (Strigiformes) da América do Sul. *Ararajuba* 5:39-43.

___ e ___ (1997) Conceito energético do valor adaptativo e tamanho ótimo do corpo para avifauna brasileira. *Ararajuba* 5:69-72.

Scherer Neto, P. (1997) O Fotógrafo de natureza: Carlos Ravazzani. *Atualidades Orn.* 76:8-9.

___ e D. Kajiwara (1997) *Pipra fasciicauda* (Pipridae, Aves) no Parque Estadual de Vila Rica do Espírito Santo, Fênix, Paraná. *Atualidades Orn.* 75:7.

___, ___, E. Carrano e L. M. Abe (1997) Novos registros de gavião-pega-macaco *Spizaetus tyrannus* (Wied, 1820) para os Estados do Paraná e Santa Catarina. *Atualidades Orn.* 79:11.

Sick, H. (1997) *Ornitologia Brasileira*. Edição revista e ampliada por José Fernando Pacheco. Rio de Janeiro: Nova Fronteira.

Silva, J. M. C. (1997) Endemic bird species and conservation in the Cerrado region, South America. *Biodiv. Conserv.* 6:435-450.

___ e D. C. Oren (1996) Application of parsimony analysis of endemicity in Amazonian biogeography: an example with primates. *Biol. J. Linn. Soc.* 59:427-437.

___ e F. C. Straube (1996) Systematics and biogeography of scaled woodcreepers (Aves: Dendrocolaptidae). *Stud. Neotrop. Fauna & Environm.* 31:3-10.

Silva, M. L. da (1997) Descrição do repertório vocal do sabiá-laranjeira *Turdus rufiventris* (Aves, Passeriformes, Turdinae). Tese de mestrado - resumo. *Atualidades Orn.* 75:2.

___ (1997) O pintor de natureza: Joacilei Lemos Cardoso. *Atualidades Orn.* 79:8-9.

Silva e Silva, R. e F. Olmos (1997) *Parabuteo unicinctus* (Falconiformes: Accipitridae) na Baixada Santista, litoral de São Paulo, Brasil. *Ararajuba* 5:76-79.

Silveira, L., A. T. A. Jácomo, F. H. G. Rodrigues e P. G. Crashaw, Jr. (1997) Hunting association between the Aplomado Falcon (*Falco femoralis*) and the Maned Wolf (*Chrysocyon brachyurus*) in Emas National Park, Central Brazil. *Condor* 99:201-202.

Silveira, L. F. (1997) Que pássaro é este ? Tapaculo-de-Brasília, *Scytalopus novacapitalis* Sick, 1958. *Uiraçu* n. s. 1(1):6

Stouffer, P. C. (1997) Interspecific aggression in *Formicarius* Antthrushes? The view from Central Amazonian Brazil. *Auk* 114:780-785.

Stotz, D. F. (1997) A possible re-sighting of the Cherry-throated Tanager *Nemosia rourei* in Espírito Santo, Brazil. *Cotinga* 7:61-63.

Teixeira, D. M. (1995) A imagem do paraíso: uma iconografia do Brasil Holandês (1624-1654) sobre a fauna e flora do novo mundo. p. 89-103. *In*: C. Ferrão e J. P. Monteiro Soares (eds.) *Brasil Holandês/ Dutch Brazil*. Rio de Janeiro: Ed. Index.

___e A. C. C. de Almeida (1997) *A biologia da "Escarradeira"* Xipholena atropurpurea *(Wied, 1820) (Aves, Cotingidae).* Eunápolis, BA: Veracruz Florestal. [Estação Veracruz, Publ. Técnico-científica n. 2]

Tostes, A. P. (1997) A hora é essa. *Atualidades Orn.* 75:6.

___ (1997) Os pingos nos is. *Atualidades Orn.* 76:5.

___ (1997) Preserve-nos. *Atualidades Orn.* 78:6.

___ (1997) O nosso aprimoramento genético. *Atualidades Orn.* 79:11.

Vielliard, J. (1997) Rafael Antunes Dias - ornitólogo e pintor naturalista. *Atualidades Orn.* 75:8-9.

___ (1997) O pintor de aves: Frederico Lencioni Neto. *Atualidades Orn.* 78:8-9.

Walters, M. (1996) The correct citation of the Blue-chinned Sapphire *Chlorestes notatus. Bull. Brit. Orn. Cl.* 116:270-271.

Waugh, D. (1997) A arara mais rara do mundo adquire um amigo flexível. *Atualidades Orn.* 75:7.

___ (1997) A Fundação Loro Parque devolve arara-maracanã para repovoamento no Brasil. *Atualidades Orn.* 76:6.

Whitney, B. M. (1997) Birding the Alta Floresta region, northern Mato Grosso, Brazil. *Cotinga* 7:64-68.

ERRATA

Na Bibliografia recente da ornitologia brasileira (Ararajuba 5:80-86) onde se lê: "Donatelli, R. J. (1995) Uma metodologia para tentar minimizar o impacto de *Zenaida auriculata* (Aves: Columbiformes) sobre áreas de cultivo de grãos na região sudoeste do Estado de São Paulo. *Salusvitta* [Bauru] 14(1):21-29",

leia-se

"Donatelli, R. J., S. Andrela e R. Santos (1995) Uma metodologia para tentar minimizar o impacto de *Zenaida auriculata* (Aves: Columbiformes) sobre áreas de cultivo de grãos na região sudoeste do Estado de São Paulo. *Salusvita* [Bauru] 14(1):21-29".