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DIET AND FEEDING BEHAVIOR OF THE YELLOW-FACED PARROT (*ALIPIOPSITTA XANTHOPS*) IN BRASILIA, BRAZIL

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Resumo. – Dieta e comportamento alimentar do papagaio galego (*Alipiopsitta xanthops*) em Brasília, Brasil. – Existem poucos relatos da biologia do papagaio-galego *Alipiopsitta xanthops*, e este é o primeiro estudo sistematicamente realizado com sua dieta ao longo de um ano. O trabalho foi realizado em Brasília, durante o ano de 2006. As observações consistiram no registro das espécies consumidas pelo papagaio, além de seu comportamento alimentar. A espécie parece ser generalista em relação a dieta. Durante o estudo, o papagaio alimentou-se de 15 diferentes espécies vegetais, compreendendo um grande número de itens alimentares tais como frutos, sementes e folhas. Registramos ainda itens incomuns, tais como o solo e até mesmo a casca de árvores. Foram detectados dois métodos de obtenção de alimento: acesso direto e acesso indireto. O comportamento de obtenção de alimentos varia de acordo com a morfologia das plantas. Há plantas em que o papagaio utiliza ambos os métodos de obtenção, outras somente o acesso direto ou indireto. O papagaio utiliza os pés quando os recursos são agregados, e vários itens podem ser manipulados simultaneamente. Dessa forma, aumentam a eficiência alimentar, com a redução do tempo de procura. Os papagaios podem trocar o método de obtenção de acordo com a fase fenológica da planta. Em um fruto fechado, onde o consumo somente é possível com a manipulação, os papagaios acessam indiretamente. Uma vez que os frutos se abrem, passam a ser acessados diretamente, reduzindo o tempo de manipulação. Com o uso do pé, os papagaios garantem a utilização desses recursos por períodos maiores de tempo. O pé mais utilizado durante o acesso indireto foi o esquerdo, mas foram observados indivíduos ambidestros em campo. Existem registros do papagaio-galego comendo 35 plantas, mas podemos estar longe de uma descrição completa, uma vez que a dieta parece variar bastante entre as regiões estudadas, o que é de fato esperado para uma espécie generalista.

Abstract. – There are only few reports on the biology of the near threatened Yellow-faced Parrot *Alipiopsitta xanthops*, and this is the first systematic study on the species diet over a year. The study was carried out in 2006 in Brasilia, Brazil. Observations consisted of feeding-bouts on plant species consumed by parrots and the attainment behavior. The species seems to be a foraging generalist, feeding on fruits, seeds, and leaves of 15 different plant species. We also registered ingestion of uncommon items such as soil and bark. We observed and described two main attainment methods: direct and indirect access. Preference for food attainment method varied according to plant morphology but parrots were also observed using both methods on the same plant species. Parrots used their feet when food resources were aggregated, allowing access to several food items. That way they improved feeding efficiency through searching time reduction. The parrots switch attainment method depending on the plant phenological stage. When fruits are closed and access is only possible through handling, parrots use indirect access. When fruits are open, parrots use direct access, reducing handling time. The left foot was mostly used during indirect access, but we also observed ambidextrous individuals. A total of 35 plant species has been so far recorded as part of the diet of the Yellow-faced Parrots, with a great turn-

over on species composition as it should be expected for a foraging generalist. *Accepted 4 February 2011.*

Key words: Yellow-faced Parrot, *Alipiopsitta xanthops*, Psittacidae, diet, feeding behavior.

INTRODUCTION

About 5% of Brazilian bird species are Psittacidae (CRBO 2010), and 13 (17%) of these species are classified Endangered or Vulnerable (Red List 2010). Only a few Neotropical Psittacidae species have proper description of their basic biology. Information about breeding sites, breeding season, habits or even diet is either unavailable or incomplete for most of Brazilian parrots. This lack of information is problematic, considering that conservation of psittacid species depends on the amount of information available about their natural history (Collar 1998).

Foraging strategies in parrots vary substantially. There are generalist species that feed on seeds, pulps, flowers, leaves, as well as termites, snails, and galls (Roth 1984, Sazima 1989, Galetti & Rodrigues 1992, Galetti 1993, Collar 1997, Kristosch & Marcondes-Machado 2001; Ragusa-Netto 2004, 2006a, 2006b, 2006c; Paranhos *et al.* 2007, 2009; Bianchi 2009). Generalists may well adjust to seasonal resources; e.g., when a resource is available only a limited period/time they are able to switch to another one (Renton 2001). There are also highly specialized species that will migrate long distances according to resource availability (Roth 1984, Silva 2009). Species like the Red-bellied Macaw, for example, will fly over great distances following Mauritia Palm (*Mauritia flexuosa*) fructification (Silva 2009). There are also reports of psittacids species consuming soil (geophagy), which may be related to sodium acquisition (Brightsmith & Munoz-Najar 2004), adsorption of dietary toxins, or even mechanical enhancement of digestion (Gilardi 1999). However, no conclusive hypothesis has been so far presented regarding the function of soil ingestion by psittacids.

The Yellow-faced Parrot (*Alipiopsitta xanthops*) has a wide distribution in the Cerrado biome of South America (Sick 2001). Despite this, only a single article on its diet was published so far (Bianchi 2009); according to that author, the species feeds on fruits, flowers, and leaves of *Pouteria ramiflora*, *Mauritia flexuosa*, *Erytroxilum suberosum*, *Annona coriacea*, *Rubus* cf. *fruticosus*, *Ouratea hexasperma*, *Mangifera indica*, and *Zea mays*. Additionally, there are also a few other records in the literature, indicating consumption of fruits and seeds of Anacardiaceae and Leguminosae (Forshaw 1989, Collar 1997, Tubelis 2009). Juniper & Parr (1998) indicate the consumption of *Anacardium sp.*, *Salacia crassifolia*, and *Astronium fraxinifolium*. Lopes *et al.* (2009) report the use of *Hancornia speciosa*. Herrera & Maillard (2007) report the use of *Psidium guajava* in Bolivia. Faria *et al.* (2009) report consumption of *Ficus* sp., *Myrciaria cauliflora*, *Psidium guajava*, as well as *Mangifera indica*. In addition, Simon & Hay (2003) report that parrots predate on seeds of *Mimosa claussenii*, while Faria *et al.* (2007) state that the species may disperse *Kielmeyera coriacea* seeds.

Here we describe the diet and the feeding behavior of the Yellow-faced Parrot in a fragment of Cerrado in central Brazil during 2006.

METHODS

Study area. The study was conducted in Cerrado fragments of Cana do Reino stream (15°47'07"S, 48°02'02"W), Vicente Pires region, Brasilia, Brazil. The area consists of small Cerrado fragments, smaller than 1 km^2,

as well as small crops. The area hosts several endemic, threatened, or rare bird species (Faria 2007). At the north and west borders, there are the protected areas of Brasilia National Park and Brasília National Forest while to the south and east dense urban areas, such as Vicente Pires or Estrutural, are found. Data were collected monthly between January 2006 and January 2007.

Diet. We registered any occurrences of food consumption at any given time. When two or more individuals were found feeding on a single tree, a single bout was recorded. We collected data on plant species, plant part consumed, number of foraging parrots, feeding behavior, and date. Plant specimens were collected and identified at the University of Brasilia Herbarium.

Cerrado presents two well-defined seasons: a rainy season from October throughout April, and a dry season from May throughout September (see review in Silva *et al.* 2008). While in rainy season the average rain may reach maximum values as high as 255 mm in January, it can reach minima as low as 5 mm of average rain in June/July. In order to analyze diet seasonality, we grouped data into two rainy seasons (January–April 2006 and October 2006–January 2007, respectively), and one dry season (May–September 2006).

Parrots may or may not use their feet to feed themselves (Paranhos *et al.* 2007, 2009). Therefore we divided feeding behavior into direct (without feet) and indirect (with feet) access to any given resource. The quantitative analysis of feeding behavior was carried out taking into account only the first field observation of feeding parrots. In addition, we used photos of observations considering only one record per perch. Sequential pictures taken from one individual at the same location were considered only once (first picture taken). Differences in behavior frequency were tested using χ^2 in order to determine if there were any preferences for direct or indirect access to the food resource.

RESULTS

Diet. We recorded a total of 90 feeding bouts, including 15 different plant species and also soil (Table 1). We found a high consumption of fruit (n = 26, 29%) and seeds (n = 26, 29%), followed by flowers (n = 20, 22%) and leaves (n = 13, 14%). On a small scale, we registered soil ingestion (n = 3, 3%) and bark (n = 2, 2%). Most consumed plant species included *Caryocar brasiliense* (n = 17 pulp and flower), *Mimosa claussenii* (n = 15, seeds and flower), *Leucaena leucocephala* (n = 11, seed), *Qualea parviflora* (n = 10, fruit), *Eriotheca pubescens* (n = 10, flowers and bark), and *Pterodon emarginatus* (n = 8, leaves), representing altogether 83% of feeding bouts. We noticed differences among food items used by Yellow-faced Parrots between seasons (Fig. 1). In the first wet season (January–April 2006), diet was based on fruits (near 90%) followed by flower consumption (10%). In the second wet season (October 2006–January 2007), leaves were the most consumed item (47%) followed by fruits (32%), and flowers (21%). During the dry season, fruits were the most consumed part (60%) followed by flowers (30%).

Feeding behavior. It was very common to observe sentinels during feeding. We observed two types of feeding behavior: direct access (Fig. 2a), where the parrot fed on the food item directly, and indirect access (Fig. 2b), when the parrot grabbed the item with the beak and transferred it to its foot, from where it fed. A total of 97 visual or photographic records were used to estimate preferences in feeding behavior. Direct access was mostly used, representing 65% of all feeding events ($\chi^2 = 8.6$, $p < 0.01$) although for some plant species we registered the exclusive use of the indirect method (e.g., *Leucaena leucoce-*

TABLE 1. Diet and feeding behavior of the Yellow-faced. Parrot on Cana do Reino stream, along 2006, Brasilia, Brazil. Items: Fl – flower; Fr – fruit; Se – seed; Le – Leaf; Ba – bark; access: D – direct; I – indirect.

Family	Species	#Bouts (%)	Month	Item	Access
Araliaceae	*Schefflera macrocarpa*	2 (2.4)	Mar	Le, Fr	D
Asteraceae	*Piptocarpha rotundifolia*	1 (1.2)	Mar	Fl	D
Caryocaraceae	*Caryocar brasiliense*	17 (20)	Jan 06, Aug–Oct, Dec	Fl, Fr	D, I
Leg. Caesalpinoideae	*Peltophorum dubium*	2 (2.4)	Apr–May	Le, Se	D
Leg. Mimosoideae	*Leucaena leucocephala*	11 (12.9)	Mar–May, Jul–Aug, Oct–Jan	Se	I
	Mimosa claussenii	15 (17.6)	Aug–Sep, Dec–Jan	Fl, Se	D, I
Leg. Papilionoideae	*Pterodon emarginatus*	8 (9.4)	Sep Nov–Jan07	Le	D
Loranthaceae	*Psitacanthus robustus*	2 (2.4)	Mar	Fr	D
Malpighiaceae	*Byrsonima coccolobifolia*	1 (1.2)	May	Fr	D
Malvaceae	*Eriotheca pubescens*	10 (11.8)	Apr, May, Jul	Fl, Ba	D
Proteaceae	*Roupala montana*	1 (1.2)	Jan 07	Le	D
Sapotaceae	*Pouteria torta*	1 (1.2)	Sep	Fr	D
Vochysiacea	*Qualea gradiflora*	3 (3.5)	Jan 06, Jan 07	Le, Se	D, I
	Qualea parviflora	10 (11.8)	Jan 06, Jul–Sep	Se,	D, I
	Volchisia elliptica	1 (1.2)	Aug	Fl	D

phala) or the use of direct access (e.g., *Eriotheca pubescens)*. The use of the left foot was observed in 95% of our records, indicating strong preference over the right foot (χ^2 = 64.3, $p < 0.01$), even though we also registered ambidextrous individuals.

Fruit consumption was observed both on closed and open fruits, with parrots using indirect and direct method, respectively. After the consumption of fruits of *Qualea parviflora* and *Mimosa claussenii*, a large number of fruits and seeds were found intact below the trees, as parrots dropped fruits without inflicting any damage. Flower consumption varied according to plant species. When feeding on *Caryocar brasiliense* and *Mimosa claussenii*, parrots consumed the ovary, while in *Eriotheca pubescens* parrots fed on flower buds or the thick petals of open flowers. Overall, the consumption of flowers seems to be significant, given the large number of flowers partially eaten observed underneath the trees.

We also observed consumption of leaves, bark, and dirt. It was not possible to determine whether individuals had a preference for young leaves during leaf consumption. The parrots consumed leaves of five plant species (direct access), but mainly *Pterodon emarginatus.* We observed bark consumption in two species, *Eriotheca pubescens* and *Qualea parviflora*, always through direct access. We observed parrots on the ground only four times, and in three of those cases we observed soil consumption.

DISCUSSION

Diet. Data on the diet of the Yellow-faced Parrot indicate that the species is a foraging generalist as we recorded a total of 35 plant species (Table 2) either in field observations or literature. Moreover, none of the plant species recorded by Bianchi (2009) at Emas National Park was recorded in the present work, suggesting a high diet turnover. There

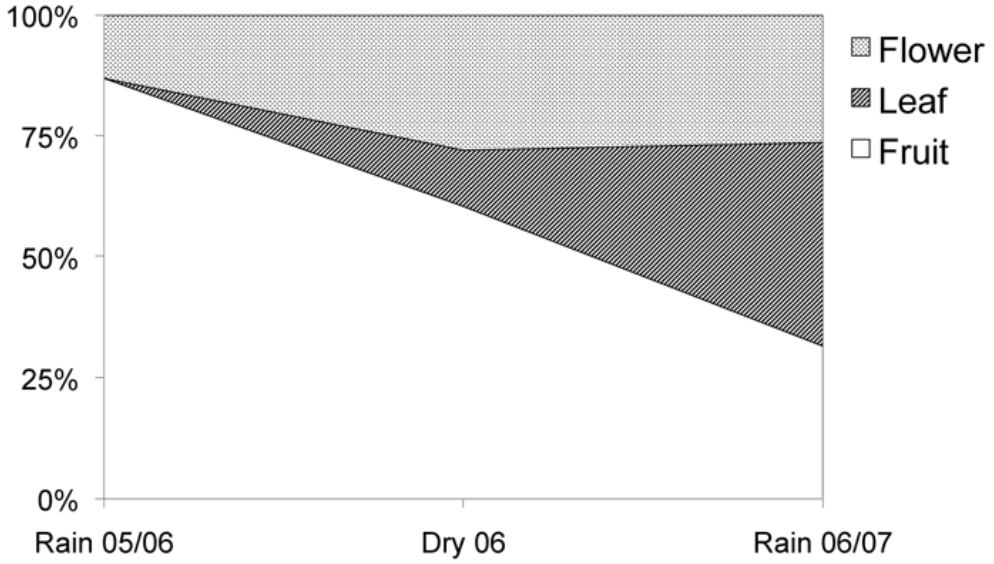

FIG. 1. Variation of Yellow-faced Parrot diet among seasons in Brasilia, Brazil.

are data on the consumption of at least four exotic species (this study, Bianchi 2009). Despite of being introduced, mango fruits (*Mangifera indica*) were the most consumed in Emas (Bianchi 2009), and it is a common food item in other localities as well (pers. observ.). Some plants may represent an important food resource for the parrots. For instance, parrots fed mainly on fruits of *Caryocar brasiliense* (79% of food records) in January 2007, and six plant species represents about 83% of all of our records. The latter (including the exotic *Leucaena leucocephala*) should be considered as a main resource for the parrot since they do not only represent a great percentage of the records but also cover the complete survey period in the study area. Seeds of some species such as *Caryocar brasiliense* were not predated during fruit consumption and actually parrots acted as seed disperser, as we observed some flying individuals carrying seeds of *C. brasiliense* and *Qualea parviflora*. Other species, such as *Mimosa claussenii* and *Leucaena leucocephala*, may have suffered severe seed predation. Flower con-sumption should also cause some impact on plant species, especially if the parrots eat the ovary.

Seasonal variation on food items has been documented for several Neotropical parrots (Galetti 1993, Ragusa-Netto 2006a; Paranhos *et al.* 2007, 2009). The data attained from Silva-Junior (2005) indicate two extreme scenarios for the 100 most common Cerrado (*sensu strictu*) plants. Between February and June, resource richness is low while around September it increases to its highest value (Fig. 3). Thus, variation in item consumption could reflect the heterogeneity of resource availability, as suggested by Renton (2001) for the Lilac-crowned Parrot (*Amazona finschi*). According to that author, dispersal abilities and diet turnover allow parrots to response to variable resource availability. Diet turnover would be indeed a good strategy for highly seasonal habitats, such as Cerrado. Additionally, flower consumption may be associated either with lack of other resources, quality of flowers as resource, or water ingestion during

FIG. 2. Food attainment methods of the Yellow-faced Parrot. A) direct access; B) indirect access.

the dry season when the relative humidity can get as low as 10% (Silva *et al.* 2008).

Most plant species were consumed in a short time span, reflecting short seasonal resource availability. *Leucaena leucocephala* was the only exception, consumed in small quantities throughout the year. Because of its toxicity (Oliveira *et al.* 2000, Nozella 2001), parrots might ingest small amounts of this seed to benefit from a high protein content despite the presence of toxic compounds, which in small amounts would not do any harm. As a matter of fact, the use of *L. leucocephala* in small amounts shows no harmful effects for chicken (*Gallus gallus*), in chicks older than 21 days (Oliveira *et al.* 2000). The toxicity of *L. leucocephala* could also explain the ingestion of soil as discussed below.

Soil consumption, also known as geophagy, is well documented for vertebrates, such as mammals, birds, and reptiles (see review in Setz *et al.* 1999). Also, according to the authors, there are several hypotheses to explain consumption of soil by animals and its function can vary among species or even within species. Some potential functions are mineral supplementation, absorption of toxins, stomach PH regulation, or even tactile sensations in the oral cavity (Setz *et al.*1999). Consumption of soil has been reported for several species of parrots (Brightsmith & Munoz-Najar 2004), and there are also several hypotheses, such as detoxification, sodium supplementation (Brightsmith & Muñoz-Najar 2004), and aid in mechanical digestion (revised by Gilardi *et al.* 1999). We performed no chemical analysis of the dirt consumed, but dirt consumption for detoxification and aid in toxin absorption seem to be suggestive, as we observed parrots feeding on leaves as well as toxic seeds of *Leucaena leucocephala* (Oliveira *et al.* 2000, Nozella 2001).

The consumption of bark had not yet been documented for the Yellow-faced Parrot or any other parrot species. Its purpose may be again associated with detoxification, chemical or mechanical aid in digestion, or absorption of nutrients. Further studies are necessary to examine both the extent and function of bark consumption among Psittacidae.

Feeding behavior. Food attainment method seems to be closely related to plant morphology, as feeding efficiency is determined by resource morphology. For instance, the fruit of *Leucaena leucocephala* is a pod, and the parrot uses its foot to access the seeds. The pod has

TABLE 2. Completementary feeding records of the Yellow-faced Parrot based on literature and other data.

Family	Species	Reference
Apocynaceae	*Hancornia speciosa*	Lopes *et al.* 2009
Sapotaceae	*Pouteria ramiflora*	Bianchi 2009
Palmae	*Mauritia flexuosa*	Bianchi 2009
Erythroxylaceae	*Erytroxilum suberosum*	Bianchi 2009
Annonaceae	*Annona coriacea*	Bianchi 2009
Rosaceae	*Rubus* cf. *fruticosus*	Bianchi 2009
Ochnaceae	*Ouratea hexasperma*	Bianchi 2009
Anacardiaceae	*Mangifera indica*	Bianchi 2009, Faria *et al.* 2009
Poaceae	*Zea mays*	Bianchi 2009
Clusiaceae	*Kielmeyera coriacea*	Faria *et al.* 2007
Fabaceae	*Mimosa clausseni*	Simon & Hay 2003
Hippocrateaceae	*Salacia crasifolia*	Juniper & Parr 1998
Myrtaceae	*Psidium guajava*	Juniper & Parr 1998, Herrera & Maillard 2007, Faria *et al.* 2009
	Myrciaria cauliflora	Faria *et al.* 2009
Anacardiaceae	*Astronium fraxinifolium*	Juniper & Parr 1998
	Anacardium humile	Tubelis 2009
	Anacardium occidentale	de Araújo, unpubl. data
Bignoniaceae	*Tabebuia aurea*	de Araújo, unpubl. data
Lauraceae	*Persea americana*	de Araújo, unpubl. data
Moeaceae	*Ficus* sp.	Faria *et al.* 2009

many seeds so that by using their feet (indirect access) parrots increase the efficiency by a decrease of search time. They eat multiple seeds from a single pod. On the other hand, the resource used in *Eriotheca pubescens* were small-sized flower buds. The buds were scattered throughout the branches, and there were no clustering among them. Thus, due to the lack of resource clusters they ate one bud at a time, using direct access. Holding the flower would only bring efficiency loss, as the handling time would increase with no improvement on search time.

We also detected a behavior shift according to the stages of fruit development in *Qualea parviflora* and *Mimosa claussenii*. In early stages, *M. claussenii* has fruits of elliptic shape of about 4 cm of size. When fruits are closed parrots use indirect access to unripe it. On advanced stages, where fruits are already opened and seeds are exposed, attainment behavior is shifted to direct access. As for *Eriotheca pubescens* flower buds, parrots seem to improve foraging efficiency by reducing handling time, when there is no need for item manipulation. Behavior shift was detected for *Qualea parviflora*. Parrots also use their feet when feeding on unripe fruits or to access fruits directly when they are open. The use of the feet seems to increase the period in which parrots are able to eat these resources, as they may eat both open and closed fruits.

Study area and conservation. The study area seems to be of relevant biological importance. Yellow-faced Parrots forage at the site throughout the year, which suggests dependence on resources found in that area. The construction of houses planned for the area (SEDUH 2006, SEMARH 2006) could criti-

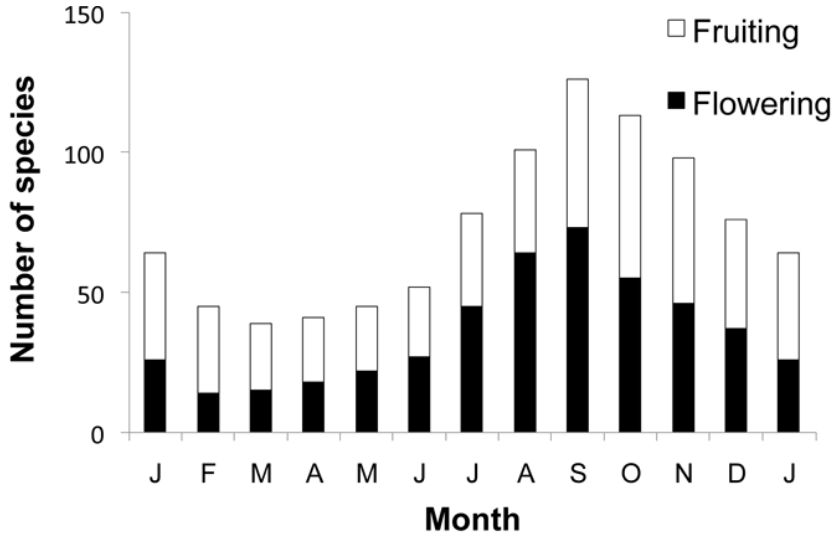

FIG. 3. Flowering and fruiting of the most common Cerrado (*sensu strictu*) species according to Silva-Junior (2005).

cally affect populations of several endemic, threatened, or rare species recorded for the Distrito Federal region (Faria 2007), and considering information about the lack of protected areas holding permanent populations of the Yellow-faced Parrot (Birdlife International 2009), a great chance would be lost. Our observations also indicate that Yellow-faced parrots use the study area as a congregation site on a daily basis. Individuals group in the area before leaving towards the Brasilia National Park. Along with Bianchi (2009), our study provides a general background on the species' diet at this locality. However, further studies are warranted to fully determine the diet composition, especially taking into account the species' wide distribution and the significant turn-over observed in species of food plants.

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