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Coprophagy in Captive Brown Capuchin Monkeys (*Cebus apella*)

Helissandra Mattjie Prates
Júlio César Bicca-Marques

Introduction

Coprophagy, or the behavior of eating feces, is classified as autocoprophagy when the individual eats its own feces, or allocoprophagy when it eats the feces of others (Hirakawa, 2001; Graczyk and Cranfield, 2003). This habit is observed in lagomorphs, rodents, marsupials, and primates. Among leporids, coprophagy occurs in the form of caecotrophy (the reingestion of soft feces or caecotrophs) and serves to improve the absorption of vitamins and microbial proteins (Hirakawa, 2001). Caecotrophy has also been observed in a prosimian, the sportive lemur *Lepilemur leucopus* (Hladik, 1978). Among anthropoid primates, coprophagy has been observed in captive and wild apes (chimpanzees, gorillas,

orangutans and gibbons: Hill, 1966; Gilloux *et al.*, 1992; Warniment and Brent, 1997; Nash *et al.*, 1999; Faraldo and Taylor, 2003; Graczyk and Cranfield, 2003; Krief *et al.*, 2004), Old World monkeys (baboons and rhesus macaques: Brent *et al.*, 2002; see also Graczyk and Cranfield, 2003), and New World monkeys (marmosets, tamarins and capuchin monkeys: Anderson *et al.*, 1991; Clark, 1994; Wissman, 1999; Taylor, 2002).

Krief *et al.* (2004) discussed a number of hypotheses to explain coprophagy by captive primates: (a) food deficiency, (b) boredom, (c) social stress, and (d) medical problems. The only report of coprophagy in capuchin monkeys (Anderson *et al.*, 1991) was of an occurrence during the integration of a tame adult female into a captive group. Anderson *et al.* argued that this abnormal behavior may have been related to food deficiency and/or social stress, since the human-raised female used to eat feces before adjusting to the standard primate food pellets offered in captivity. She was also frequently involved in agonistic interactions with other group members soon after her integration.

In this paper we report cases of coprophagy by captive brown capuchin monkeys and examine whether they fit the "food deficiency" and "social stress" hypotheses cited above. We predict that if food limitation is the primary stimulus for this behavior, coprophagy will be more frequent during those periods in which the monkeys have no food available in the cage. On the other hand, if social pressure can explain this behavior, we can expect to find an inverse relationship between social rank and individual frequency of coprophagy. In addition, we would expect that a given individual will be more likely to eat feces after being harassed by other groupmates.

Methods

The social behavior of a group of 10 brown capuchin monkeys (Table 1) was studied over 219.5 observation hours, from 8 April to 24 October 2003 at the Parque Farroupilha in Porto Alegre, Rio Grande do Sul, Brazil. This urban park has many visitors and is close to busy city streets. The study group was kept in a wired hexagonal cage with a cement floor, measuring approximately 5.5 m on each side with a height of 3.5 m. For behavioral enrichment the cage was equipped with a wheel, two tires and one movable ladder. The monkeys were fed only once a day, at about 09:00 h, with fruits, vegetables and sometimes peanuts. The cage was washed with water once a week on Thursday afternoons, so the monkeys had no food available until Friday morning.

We recorded all occurrences of coprophagy following the behavior sampling rule with continuous recording (Martin and Bateson, 1993). We determined the dominance status of each individual based on the frequency and distribution of agonistic interactions within dyads (see Janson, 1985). An individual was considered to have high social rank if it was the initiator of aggression more frequently than a recipient of aggression. In contrast, low social rank was indicated by a higher frequency of aggression received than performed.

Table 1. Age-sex composition of the study group, social rank, and recorded cases of autocoprophagy and allocoprophagy by each individual.

Age-sex class	Individual	Social rank	Auto-coprophagy	Allo-coprophagy
Adult male	Roger	1st	-	-
Adult male	Chico	2nd	-	-
Adult male	Tiburcio	4th	-	-
Adult male	Barba	6th	2	9
Adult male	Assis	10th	-	-
Adult female	Amelia	3rd	3	23
Adult female	Fabi	9th	-	15
Juvenile male	Dali	5th	1	8
Juvenile male	Guri	7th	4	4
Infant male	Fiba	8th	-	4
Total			10	63

Results

We recorded a total of 73 events of coprophagy (0.33 events per hour of observation). Six individuals (Amelia, Fabi, Barba, Dali, Guri and Fiba) were observed to eat feces. The remaining four (Roger, Chico, Tiburcio and Assis) never demonstrated this behavior (Table 1), but were occasionally seen to drink urine from the floor. Coprophagy was more prevalent than expected in females than in males (41 events vs. 32 events; $\chi^2 = 59.671$, d.f. = 1, $p < 0.001$). Allocoprophagy was more frequent than autocoprophagy.

Coprophagy was more common in the afternoon than in the morning (47 events or 0.47 events per hour of observation vs. 26 events or 0.22 events per hour; $\chi^2 = 11.000$, d.f. = 1, $p < 0.001$), suggesting that food availability may play an important role in the occurrence of this behavior. However, we recorded only nine instances of coprophagy (12%) in which there was no food on the cage floor. The frequency of coprophagy on Thursdays (when the cage was cleaned and devoid of food) was 0.21 events per hour, not above the expected level based on sampling effort (14 events; $\chi^2 = 1.785$, d.f. = 1, NS).

We observed a total of 326 cases of agonistic interactions during the study (1.49 events per hour of observation). Social rank did not explain inter-individual differences in coprophagy ($r^2 = 0.002$, n = 10, F-ratio = 0.016, $p = 0.901$). For example, the two highest-ranking individuals (Roger and Chico) and the lowest-ranking individual (Assis) never ate feces, whereas Amelia and Fabi (ranked third and ninth, respectively) showed the highest frequencies of coprophagy (Table 1). In addition, only rarely had the individual observed eating feces been harassed earlier

in the day (Barba: two cases; Fabi: three cases; and Guri: two cases). Therefore, the "social stress" hypothesis was not supported.

Discussion

We observed a high frequency of coprophagy in this group of captive brown capuchin monkeys, a behavior reported only once before in this species (Anderson *et al*., 1991). In a similar study on the social behavior of a captive group of nine capuchin monkeys at the Parque Zoológico de Sapucaia do Sul, Rio Grande do Sul, Brazil, Daniel B. Montano did not observe a single case of coprophagy during 208 hours of observation over 16 months (pers. comm.).

Its prevalence in adult females and immature individuals may be related to a diet insufficient in protein, as described for marmosets by Flurer and Zucker (1988). The tendency of females and immatures to exploit diets richer in protein has been described for a number of primates, and is related to the nutritional demands of gestation, lactation, and growth (see Bicca-Marques and Calegaro-Marques, 1994). This tendency, coupled with the fact that coprophagy was more frequent in the afternoon, supports the "food deficiency" hypothesis. However, most cases of coprophagy were observed when there was still food available in the cage, and its frequency on Thursdays (when the cage is cleaned) was not greater than that expected by chance.

Although social rank may interfere with food access, and may contribute to within-group differences in food deficiency, we found no relationship between this variable and the frequency of coprophagy. Thus, if the individual's degree of social pressure (reflected here by frequency of harrassment) is inversely related to social rank, the "social stress" hypothesis may also be rejected to explain the occurrence and distribution of coprophagy in this group.

We did not test the "boredom" and "medical problem" hypotheses for coprophagy, both of which would have required detailed information on individual differences in personality and health status. Therefore, it is not possible to evaluate whether the observed distribution of coprophagy among group members was caused by a single factor or by an interplay between food deficiency, boredom, and medical problems. Finally, it is possible that this uncommon behavior has been transmitted culturally among group members, as proposed for captive chimpanzees by Nash *et al*. (1999). The observations of Roger, Chico, Tiburcio and Assis (the only four individuals not involved in coprophagy) drinking urine is compatible with Stemmler-Morath's (1937, *apud* Hill, 1966) findings that apes began coprophagy by drinking their urine. To better understand the causes and significance of coprophagy for capuchin monkeys, it is important that researchers report all observations of this behavior both in captivity and in the wild.

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Helissandra Mattjie Prates and **Júlio César Bicca-Marques,** Pontifícia Universidade Católica do Rio Grande do Sul, Faculdade de Biociências, Av. Ipiranga 6681, Pd 12A, Porto Alegre 90619-900, Rio Grande do Sul, Brazil. E-mail: <jcbicca@pucrs.br>.

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Rehabilitación y Reproducción de *Alouatta caraya* Fuera de su Área de Distribución Natural

Gabriela Bruno, Aldo M. Giudice
Mariela Nieves, Marta D. Mudry

Introducción

Alouatta caraya posee una amplia distribución en Sudamérica ocupando distintos tipos de bosques hasta los 29°56'S, en los cuales muestra una plasticidad comportamental destacada entre los primates del Neotrópico (Neville *et al.*, 1988). En condiciones de cautividad los aulladores negros no sobreviven largos períodos de tiempo, sugiriéndose la incapacidad de sustituir su dieta en estas condiciones, o bien la elevada susceptibilidad a situaciones generadoras de estrés entre las razones de esta baja viabilidad (Benton, 1976; Colillas y Coppo, 1978; Giudice *et al.*, 1995). Resulta paradójico que sólo se reproduzca excepcionalmente en cautiverio, bajo condiciones de cuidado intensivo; mientras logra reproducirse exitosamente en condiciones de libertad, en ambientes forestales exóticos con presión antrópica y más al sur de su límite austral natural de distribución. Estas condiciones no parecerían ser las más apropiadas para su supervivencia, ya sea por el rigor climático, la extrema fragmentación del hábitat en cercanía del hombre o por la pobre calidad y cantidad de la oferta de recursos alimentarios (Giudice y Ascunce, 1998). En esta oportunidad se presentan las primeras observaciones sobre hábitat, supervivencia, dieta y nacimientos, de *A. caraya* en condiciones de semilibertad, en bosques serranos, fuera del límite natural de su distribución marginal sur.

Sitio de Estudio

La población de *A. caraya* que es objeto de este reporte es parte de un estudio ecológico y comportamental en una tesis doctoral de la Universidad de Buenos Aires. Esta población habita dentro de los límites de una estancia privada de 300 ha en la que se encuentra el Centro de Reeducación del Mono Aullador Negro (CRMAN), surgido hace 10 años como una respuesta a la problemática relacionada con la rehabilitación y mantenimiento de ejemplares de aulladores negros extraídos de su entorno natural para su venta en el mercado ilegal de mascotas y que posteriormente son retenidos por diversas organizaciones de la provincia de Córdoba (Bruno *et al.*, 2004).

El CRMAN se encuentra ubicado a 1409 m.s.n.m., en el paraje Tiu Mayu (30°58'S, 64°25'O), Córdoba, Argentina. El clima templado serrano tiene temperaturas que oscilan entre -8.8°C y 32°C en invierno y 0.8°C y 38.4°C en verano, con una precipitación anual de aproximadamente 700 mm (Demaio y Medina, 1999). El área citada está inserta en la provincia fitogeográfica chaqueña, distrito serrano, caracterizado por sectores de bosque y pastizal de altura (Cabrera, 1976). Esta zona está notablemente alterada por las actividades humanas; las especies características del bosque nativo han sido paulatinamente eliminadas, siendo este bosque reemplazado casi en su totalidad por especies exóticas.

Sujetos de Estudio y Manejo

El CRMAN se caracteriza por recibir ejemplares procedentes de donaciones de particulares, así como de incautaciones/decomisos y derivados por el Departamento de Fauna Provincial (Córdoba, Argentina). Los ejemplares derivados al centro pasan un período de atención intensiva, en el cual son sujetos a los procedimientos clínicos y terapéuticos que los casos demanden. Posteriormente, se forman grupos para introducir en parches de monte exótico de aproximadamente 0.18 ha cada uno. En estos fragmentos de vegetación se han colocado travesaños para mejorar el desplazamiento en el dosel, tarimas para la colocación de los alimentos aportados por el centro y tambores metálicos de 0.60 x 1.00 m acondicionados para funcionar como refugios.

Una vez que los monos están en libertad se les aporta agua y alimentos en una razón diaria de 3 kg por grupo aproximadamente. La dieta suministrada está compuesta por verduras de hoja, frutas, pan, huevos, suplementándose además con té y leche. Todo ejemplar enfermo o que muestre signos de incompatibilidad social, es recapturado, reiniciándose la primera etapa de rehabilitación. Hasta la fecha, se han formando cuatro grupos, cuyo tamaño y composición sexo/edad se detallan en la Tabla 1.

Datos Preliminares

El CRMAN ha trabajado sobre un total de 89 aulladores desde 1994 hasta la fecha. Actualmente se mantienen 54 ejemplares, de los cuales 20 están bajo la etapa de cuidados intensivos y el resto, 34 ejemplares, están formando cuatro grupos, en distintos parches de monte exótico principalmente caducifolio (Tabla 1). Aún cuando en el área del CRMAN subsiste escasa vegetación arbórea nativa como *Fagara coco* y *Lithraea ternifolia* (representando al bosque serrano) y la presencia de gramíneas como *Stipa* sp. y *Festuca* sp. en el pastizal de altura (obs. pers., G. Bruno, 2004), hay una alteración en la composición florística por la introducción de especies de árboles exóticos, tal como *Ulmus procera, U. laevis, Robinia pseudoacacia, Populus nigra, Malus sylvestris, Thuja occidentalis, Cupressus macrocarpa* y *Salix fragilis*, entre otros. La reproducción con éxito comenzó a partir de 1998, totalizando 26 nacimientos hasta 2005, los cuales se producen a razón de cuatro ejemplares al año. El intervalo promedio entre nacimientos para las hembras multíparas