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Front cover: A bald uakari, *Cacajao calvus calvus*, from the Brazilian Amazon. Photo by Russell A. Mittermeier.

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FLORA BACTERIANA DE LA CAVIDAD ORAL DEL MONO TITÍ (*SAIMIRI OERSTEDII*) Y SU PERFIL DE SENSIBILIDAD A ANTIBIÓTICOS

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Resumen

Se estudió la flora bacteriana y su patrón de sensibilidad antimicrobiana en la cavidad oral de 33 monos *Saimiri oerstedii*: 31 silvestres y 2 en cautiverio. Con torunda estéril se rasparon los dientes y la cavidad bucal de cada mono y se resuspendió en 2 mL de solución salina estéril (0.85%); se prepararon tubos de transporte para cultivos aerobios y anaerobios y una vez en el laboratorio, se inocularon placas de agar sangre que se incubaron en aerobiosis y anaerobiosis. Los aislamientos se identificaron con sistemas miniaturizados API® (20NE, Staph y 20A); las determinaciones de la sensibilidad a los antibióticos se realizaron con galerías ATB® (G5, Staph y ANA). Se aislaron 137 cepas bacterianas: 106 aerobias (77.4%) y 31 anaerobias (22.6%). El predominio fue de bacilos Gram negativos aerobios (100 cepas), siendo *Enterobacter* el género más frecuente (42%), seguido de *Burkholderia* y *Aeromonas* (27% c/u); los anaerobios más comunes fueron *Clostridium* (36%) y *Fusobacterium* (12%). Estos resultados revelan semejanzas y diferencias con respecto a la flora oral humana y la de otros monos costarricenses; la alta frecuencia de algunos géneros sugiere que son parte de la flora oral de monos y no contaminación secundaria de bacterias del suelo. El 90% de los bacilos Gram negativos aerobios fue resistente a cefalotina y el 89% a cefoxitina; altas tasas de resistencia se presentaron también ante otras drogas; solamente ceftriaxone y pefloxacina fueron efectivos contra todas las cepas analizadas; sólo dos cepas fueron sensibles a todos los antibióticos evaluados. El mayor porcentaje de resistencia en anaerobios ocurrió ante el metronidazole (26 a 35%) seguido por cefotetán (26%) y clindamicina (23%); el 39% de los aislamientos fue sensible a todos los antibióticos evaluados. La resistencia múltiple fue menor en los anaerobios (26%) que en los aerobios (77%). Este estudio contribuye al conocimiento y a la preservación del mono tití, especie amenazada, y muestra que pocas barreras son capaces de contener los genes de resistencia y sus hospederos bacterianos, aun en animales silvestres.

Palabras Clave: *Saimiri oerstedii*, Costa Rica, flora bacteriana oral, resistencia antimicrobiana

Abstract

The bacterial microflora present in the oral cavity of 33 squirrel monkeys (*Saimiri oerstedii*, 31 wild and 2 captive) and its antimicrobial sensibility was studied. A sterile swab was used to scratch the teeth and oral cavity of every monkey; each sample was resuspended in 2 mL sterile saline solution (0.85%). Transport tubes for aerobic and anaerobic cultures inoculated with these samples were sent to the laboratory. Each sample was inoculated in blood agar plates that were incubated in aerobic and anaerobic conditions. Isolates obtained were identified with API™ galleries (20NE, Staph and 20A) and the sensibility determinations were done using ATB galleries (-G5, -Staph and -ANA). A total of 137 strains were isolated: 106 aerobes (77.4%) and 31 anaerobes (22.6%). Gram negative bacilli were predominant, with *Enterobacter* the most frequent genus (42%), followed by *Burkholderia* and *Aeromonas* (27% each). The most frequent anaerobes were *Clostridium* (36%) and *Fusobacterium* (12%). These results show similarities and differences with the bacteria of the oral cavity of humans and of other Costa Rican monkeys. The high frequency of some genera suggests that they are part of the oral flora of the monkeys and not contaminants from the soil. Ninety percent of the Gram negative aerobe bacilli were resistant to cephalotin and 89% to cefoxitine. High resistance rates were obtained with other agents; only two strains were sensitive to every antibiotic tested. In anaerobes the higher antibiotic resistance was observed with metronidazole (26–35%), cefotetan (20%) and clindamicyn (23%), 39% of the strains were sensitive to every antibiotic tested; multiple resistance was lower in the anaerobes (26%) than in the aerobes (77%). This study contributes to the knowledge and preservation of the squirrel monkey, a threatened species, and demonstrates that there are few barriers to the spread of resistant genes in bacteria, even in wild animals.

Key Words: *Saimiri oerstedii,* Costa Rica, antimicrobial resistance, oral bacterial flora

Introducción

El mono tití (*Saimiri oerstedii*) habita en los bosques de Costa Rica y Panamá (Wong, 1990), y es considerada una especie amenazada (IUCN, 2007). Otras especies del género se encuentran en América del Sur, en un área limitada por Colombia al oeste y la cuenca del Amazonas y las Guyanas al este (Wong, 1990). En Costa Rica existen dos subespecies de este género: *S. oerstedii oerstedii* y *S. oerstedii citrinellus*; ambas se consideran en peligro de extinción, principalmente por la pérdida de su hábitat, el desarrollo de infraestructura hotelera y por su captura y venta como mascotas (Carrillo *et al.*, 2000). *S. oerstedii* es el mono de menor tamaño de Costa Rica y se encuentra en bosques primarios, secundarios y en áreas cultivadas; los Parques Nacionales Manuel Antonio y Corcovado son los reservorios más importantes. Es de conducta arborícola y diurna y se alimenta durante las primeras horas de la mañana, principalmente de insectos (75–80% de la dieta) y frutas (Campbell *et al.*, 2003).

La cavidad oral de los animales, al igual que la de los humanos, es uno de los hábitats microbiológicos más complejos y heterogéneos. La flora bacteriana incluye tanto anaerobios estrictos como *Bacteroides* sp., *Fusobacterium* sp., *Actinomyces* sp. y aerobios facultativos como *Corynebacterium* sp., *Haemophilus* sp., *Moraxella* sp. y *Neisseria* sp. (Sorum y Sunde, 2001). Dicha flora indígena contiene genes de resistencia a antibióticos, incluso en individuos sin historia de exposición a antimicrobianos preparados comercialmente (Sorum y Sunde, 2001). Son necesarios nuevos estudios en la flora normal de animales para determinar si su resistencia está directamente relacionada con el dramático incremento en la resistencia de patógenos (Sorum y Sunde, 2001). Las escasas investigaciones relacionadas con la flora normal de monos se han llevado a cabo principalmente en el mono rhesus (*Macaca mulatta*) (Bowers *et al.*, 2002), mientras que en Costa Rica se efectuó un estudio relacionado con la flora oral de los monos congo (*Alouatta palliata*) y colorado (*Ateles geoffroyi*) (Gamboa-Coronado *et al.*, 2004). En el presente trabajo se describe la flora bacteriana de la cavidad oral de *S. oerstedii* así como su patrón de sensibilidad, para compararlos con los de otros monos de Costa Rica y establecer la posible influencia del hombre en la adquisición de resistencia antimicrobiana.

Métodos

Se estudiaron 33 muestras de la cavidad oral de monos de la especie *Saimiri oestedii*; 31 monos se capturaron en estado silvestre de cuatro zonas de Costa Rica: Parque Nacional Manuel Antonio (09°23'N, 84°07'O), Parque Nacional Corcovado (08°28'N, 83°35'O), Isla Damas (09°30'N, 84°15'O) y Golfito (08°36'N, 83°04'O), utilizando una cerbatana para el lanzamiento de dardos (Pneudart, Inc.) que contenían cada uno 0.3–0.4 mL de Zolazepam, conocido comercialmente como Zoletil®. Las muestras de los dos monos restantes fueron obtenidas de individuos que permanecían en cautiverio desde hace dos años en un zoológico. Con una torunda estéril se rasparon los dientes y la cavidad bucal de cada uno de los monos previamente sedados, y se resuspendió la muestra en un tubo con 2 mL de solución salina estéril (SSE). Asépticamente y con jeringa estéril se inoculó 0.5 mL de la suspensión en un tubo con medio carne cocida (CC) prerreducido. Durante el transporte hasta el laboratorio los tubos con la suspensión en SSE se mantuvieron en frío, mientras que los de CC se mantuvieron a temperatura ambiente. A cada uno de los tubos con SSE se les agregó 2 mL de caldo tripticasa soya (CTS) y se incubaron a 35°C por 24 horas; los tubos con CC prerreducidos se incubaron a 35°C por 48 horas. A partir de cada tubo con CTS se rayó una placa de agar sangre (AS) y se incubó a 35°C por 24 horas para el aislamiento de bacterias aerobias. A partir de cada tubo con CC prerreducido se rayó una placa de AS y se incubó a 35°C por 48 horas en jarra de anaerobiosis para el aislamiento de bacterias anaerobias. Se seleccionaron los diferentes morfotipos coloniales de cada placa, se les realizó tinción de Gram y se subcultivaron en placas de AS para obtener cultivos puros. Se determinó la tolerancia al oxígeno de cada cepa aislada a través de la inoculación de dos placas de AS, una incubada en atmósfera incrementada de CO_2 y otra en jarra de anaerobiosis (35°C por 48 horas). Se seleccionaron como bacterias anaerobias aquellas cuyo crecimiento fue exclusivo o mejor en condiciones de anaerobiosis.

A las cepas bacterianas aerobias se les realizaron pruebas de Gram, oxidasa y catalasa, con el objetivo de agrupar las bacterias como enterobacterias, bacilos Gram negativos no enterobacterias, estafilococos y estreptococos. Con base en los resultados se seleccionó la galería miniaturizada de pruebas bioquímicas apropiada para la identificación; se emplearon los sistemas API 20E®, API 20NE®, y API Staph®, mientras que para las bacterias anaerobias se utilizaron las galerías API 20A®. Las identificaciones se realizaron con el programa API-Plus®. Para determinar la sensibilidad a los antibióticos se emplearon galerías comerciales ATB® de acuerdo con el tipo de bacteria aerobia (ATB-G5 y ATB-Staph); en el caso de las bacterias anaerobias se utilizó el sistema ATB-ANA. Todas las galerías se incubaron y leyeron de acuerdo con las recomendaciones de la casa fabricante (bioMérieux®).

Resultados

A partir de 33 muestras de la cavidad oral de los monos tití se aislaron 137 cepas; 106 de bacterias aerobias (77.4%) y 31 de anaerobias (22.6%), lo que equivale a un promedio de 3.2 aerobios y 0.9 anaerobios por muestra. En las bacterias aerobias predominaron los bacilos Gram negativos (100 de 106 cepas aerobias), donde el género más frecuente fue *Enterobacter* (20 cepas), que se aisló del 42% de las muestras e incluyó las especies *E. aerogenes*, *E. cloacae* y *E. sakazakii*. En frecuencia le siguieron los géneros *Burkholderia* (19 cepas) y *Aeromonas* (10 cepas), los cuales se aislaron del 27% de las muestras. Se identificaron cepas de otros 20 géneros de bacilos Gram negativos (Tabla 1). Las seis cepas de bacterias aerobias Gram positivas fueron de los géneros *Staphylococcus* (tres cepas: *S. sciuri*, *S. xylosus* y *S. auricularis*) y *Bacillus* sp. (tres cepas). En las 31 bacterias anaerobias (Tabla 2) se identificaron 17 bacilos Gram positivos (géneros *Clostridium* y *Propionibacterium*), ocho bacilos Gram negativos (géneros *Fusobacterium*, *Bacteroides* y *Prevotella*), cuatro cocos Gram positivos (géneros *Gemella* y *Peptostreptococcus*) y dos cocos Gram negativos (género *Veillonella*). El género anaerobio más comúnmente aislado fue *Clostridium* (16 cepas), a partir del 36% de las muestras, con representantes de las especies *C. bifermentans*, *C. clostridioforme*, *C. perfringens*, *C. sporogenes* y *C. tyrobutyricum*.

Tabla 1. Bacilos Gram negativos aerobios aislados de la cavidad oral de 33 monos tití (*Saimiri oerstedii*) de Costa Rica.

Género	Total de cepas n = 100	Frecuencia de aislamiento(%) n = 33
Enterobacter	20	42
Burkholderia	19	27
Aeromonas	10	27
Serratia	8	18
Klebsiella	6	15
Citrobacter	6	12
Pseudomonas	4	12
Acinetobacter	3	9
Chryseomonas	3	9
Vibrio	3	9
Brevundimonas	2	6
Morganella	2	6
Pantoea	2	6
Ralstonia	2	6
Flavimonas	2	3
Agrobacter	1	3
Alcaligenes	1	3
Chromobacterium	1	3
Kluyvera	1	3
Leclercia	1	3
Ochrobacter	1	3
Pasteurella	1	3
Stenotrophomonas	1	3

Tabla 2. Bacterias anaerobias aisladas de la cavidad oral de 33 monos tití (*Saimiri oerstedii*) de Costa Rica.

Género	Total de cepas n = 31	Frecuencia de aislamiento (%) n = 33
Clostridium	16	36
Fusobacterium	4	12
Bacteroides	2	6
Gemella	2	6
Peptostreptococcus	2	6
Prevotella	2	6
Veillonella	2	6
Propionibacterium	1	3

En las pruebas de sensibilidad a los antibióticos (Fig. 1), el 90% de los bacilos Gram negativos fue resistente a la cefalotina y el 89% a la cefoxitina, cefalosporinas de primera y segunda generación respectivamente. Otras cefalosporinas presentaron menores porcentajes de resistencia microbiana: cefuroxima (69%, 2° generación), ceftazidima 1 mg·L^{-1} (61%, 3° generación), cefepima (10%, 4° generación) y cefotaxima, ceftazidima 8–16 mg·L^{-1} y ceftriaxone, todas de tercera generación, con porcentajes inferiores al 10%. Altas tasas de resistencia se presentaron también ante amoxicilina, tobramicina y amoxicilina + ácido clavulánico (Fig. 1). Ocho de los antimicrobianos demostraron porcentajes de resistencia de 10–40%, mientras que nueve estuvieron por debajo del 10%, dentro de los cuales solamente ceftriaxone y pefloxacina fueron efectivos contra todas las cepas analizadas. Por su parte, las tres cepas de *Staphylococcus* fueron resistentes a penicilina, cefalotina, ampicilina + sulbactam, eritromicina, clindamicina, nitrofurantoína, rifampicina, vancomicina y teicoplanina.

En las cepas anaerobias también se presentó resistencia a varios antibióticos (Fig. 2); el mayor porcentaje de resistencia ocurrió ante el metronidazole, 26 a 35% según su concentración, seguido por cefotetán (26%), clindamicina (23%) y penicilina (19%). Se presentó un bajo porcentaje de resistencia ante antibióticos como amoxicilina, cefoxitina, ticarcilina y amoxicilina + ácido clavulánico (4/8 mg·L^{-1}). De las 16 concentraciones de antibióticos evaluadas, seis (37.5%) fueron efectivas contra todas las cepas identificadas: amoxicilina + ácido clavulánico (16/2 mg·L^{-1}), cloranfenicol, imipenem, piperacilina, piperacilina + tazobactam y ticarcilina + ácido clavulánico.

Se presentaron casos de cepas multirresistentes tanto en bacterias aerobias como anaerobias. De los bacilos Gram negativos aerobios, el 3% fue resistente a 16–19 antibióticos, el 3% a 13–15, el 13% a 10–12, el 21% a 7–9, el 37% a 4–6, el 21% a 1–3, y sólo dos cepas fueron sensibles a todos los antibióticos evaluados. La multirresistencia del género *Staphylococcus* fue alta, ya que las tres cepas fueron resistentes a entre 10 y 12 de los 15 antibióticos evaluados; la pefloxacina, ciprofloxacina y tetraciclina fueron los únicos antibióticos efectivos contra todas las cepas. En el caso de las bacterias anaerobias, la resistencia múltiple fue menor pues el 35% fue resistente sólo a uno ó dos antimicrobianos, el 10% presentó resistencia a 3–4 y el 16% a 5–7 antibióticos, mientras que el 39% fue sensible a todos los antibióticos evaluados.

Discusión

Actualmente es escaso el conocimiento disponible sobre la flora bacteriana oral de monos y en particular de la

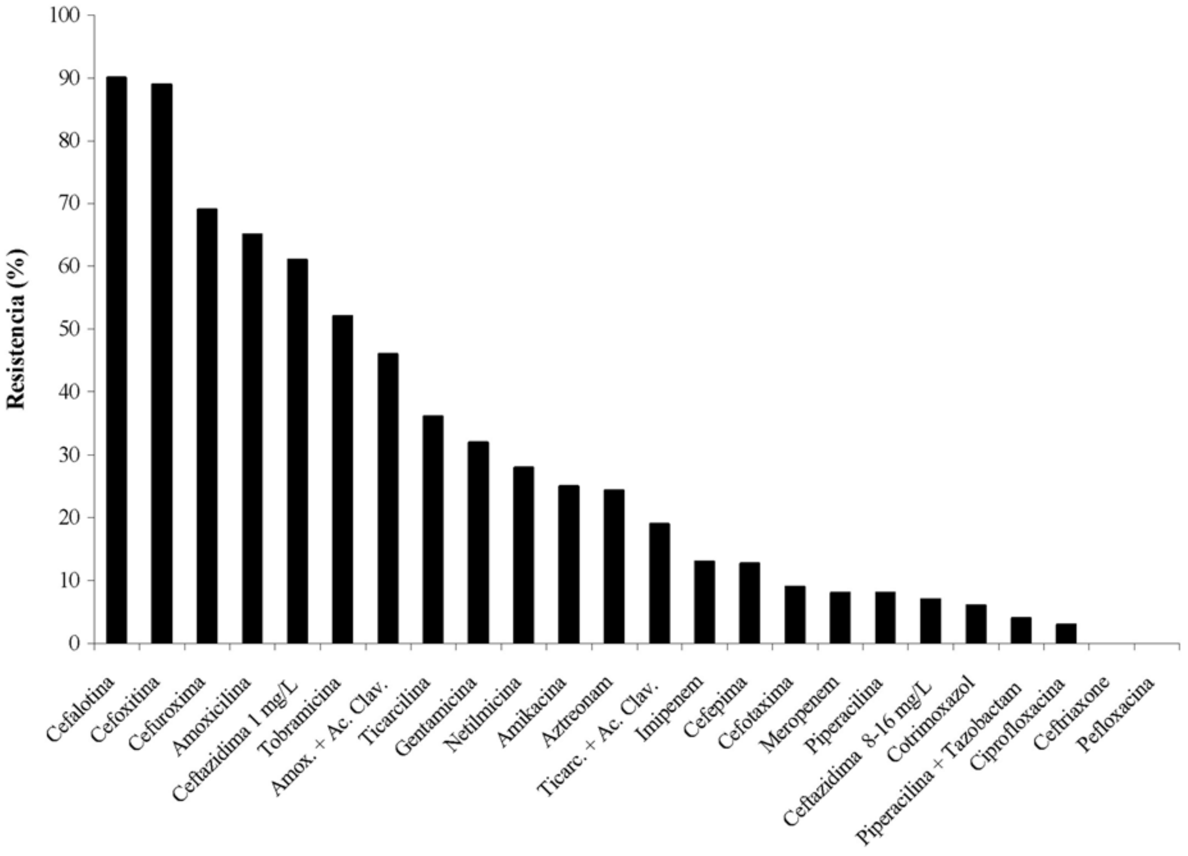

Figura 1. Resistencia antimicrobiana de 100 bacilos Gram negativos aerobios aislados de la cavidad oral de 33 monos tití (*Saimiri oerstedii*) de Costa Rica.

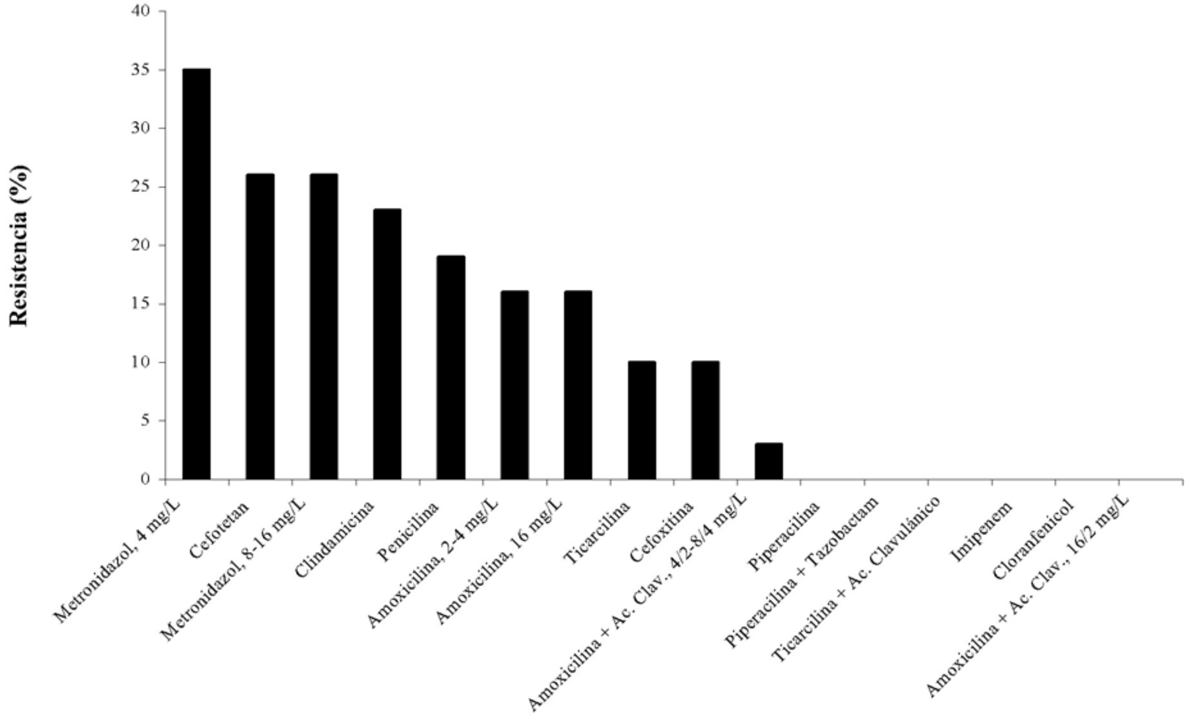

Figura 2. Resistencia antimicrobiana de 31 bacterias anaerobias aisladas de la cavidad oral de 33 monos tití (*Saimiri oerstedii*) de Costa Rica.

especie *Saimiri oerstedii*. Investigaciones previas en Costa Rica fueron realizadas en *Alouatta palliata* (mono congo) y *Ateles geoffroyi* (mono colorado) (Gamboa-Coronado *et al.*, 2004), por lo que el presente estudio permite realizar comparaciones entre la flora oral de diferentes especies de monos, así como comparaciones con la flora humana.

Se logró aislar un promedio de 4.1 cepas por muestra, sin embargo se encontró mayor cantidad de aerobios (3.2 por muestra) que de anaerobios (0.9 por muestra), a diferencia de los patrones esperados en la cavidad oral humana, donde la proporción favorece a las bacterias anaerobias. Este resultado pudo deberse a factores relacionados con las dificultades de la toma de muestras para anaerobios y el transporte de las mismas al laboratorio. Para tomar la muestra se empleó una torunda que se suspendió en solución salina y posteriormente dicha suspensión se inóculo en tubos prerreducidos, es decir con atmósfera libre de oxígeno; los anaerobios más sensibles pudieron haber perdido su viabilidad durante dicho procedimiento. Como los muestreos fueron realizados en zonas alejadas, debió transcurrir un tiempo prolongado (generalmente de 24 a 48 horas) antes de que las muestras fueran procesadas en el laboratorio. Durante el transporte los tubos en anaerobiosis debieron mantenerse a temperatura ambiente, con el objetivo de disminuir la solubilidad del oxígeno en el medio, que aumenta al bajar la temperatura; es por esto que no se transportaron en refrigeración como las muestras para aerobios. Dicha práctica pudo perjudicar la viabilidad de las especies de anaerobios con ámbitos estrechos de temperatura permisivos para el crecimiento, cercanos a las condiciones de la cavidad oral de los monos. Tales inconvenientes pudieron provocar la disminución en la recuperación de cepas de bacterias anaerobias.

Flora aerobia

El género más frecuentemente aislado fue *Enterobacter*, que está descrito como uno de los predominantes en la cavidad oral humana (Isenberg y D'Amato, 1995) y que fue también descrito como el más abundante en la cavidad bucal de los monos congo y colorado (Gamboa-Coronado *et al.*, 2004). Otras enterobacterias encontradas fueron *Serratia*, *Klebsiella* y *Citrobacter* con frecuencias de aislamiento entre el 12% y el 18%; si bien todas han sido aisladas de la cavidad bucal de los monos congo y colorado (Gamboa-Coronado *et al.*, 2004), *Serratia* no se ha descrito como habitante de la flora oral humana, sino que está asociada a superficies de plantas, suelo, semillas y agua (Grimont y Grimont, 2005), lo que podría explicar su presencia en el mono tití.

El segundo género de aerobios más frecuentemente aislado fue *Burkholderia* (todas las cepas identificadas como *B. cepacia*), no descrito como habitante común de la boca humana ni encontrado en los monos congo y colorado. Esta bacteria se ha aislado de suelo, plantas, superficie de animales, rizosfera y aguas (Coenye y Vandamme, 2003; Ramette *et al.*, 2005). *Aeromonas* fue el tercer género aerobio en abundancia y aunque no se asocia a la boca humana, sí se ha informado en bajas frecuencias en monos congo y colorado (Gamboa-Coronado *et al.*, 2004) y se ha aislado principalmente de fuentes de agua y aguas negras (Martin-Carnahan y Joseph, 2005). Los géneros *Pseudomonas* y *Acinetobacter* estuvieron presentes, respectivamente, en el 12% y 9% de las muestras y han sido aislados de otros monos (Gamboa-Coronado *et al.*, 2004), pero no se consideran flora normal de la cavidad oral humana. Ambos incluyen muchas especies ubicuas, aisladas de suelos, ríos, plantas y animales, entre otros (Juni, 2005; Palleroni, 2005).

Chryseomonas fue aislado en un 9% de las muestras y aunque su presencia en el ambiente es dudosa, este género es aparentemente saprófito o comensal de humanos y algunos animales de sangre caliente (Palleroni, 2005). Con igual frecuencia se aisló *Vibrio*, siendo todas las cepas identificadas como *V. parahaemolyticus*; esta especie se encuentra en ambientes acuáticos, pero parece estar limitada a estuarios o áreas costeras debido a su requerimiento de 1–8% de NaCl. Se asocia a animales marinos (Carnahan y Andrews, 2000), por lo que su aparición en el mono podría estar asociada a hábitos alimenticios o de consumo de agua, tomando en cuenta que los sitios de muestreo están localizados cerca de zonas marítimas. Este género ha sido descrito como parte de la microbiota subgingival de la especie *Saimiri sciureus* (Beem *et al.*, 1991).

En cuanto a los cocos Gram positivos aerobios, los géneros *Staphylococcus* y *Streptococcus* son los más frecuentes en la cavidad oral humana (Isenberg y D'Amato, 1995) y se han descrito en el 6% y el 2%, respectivamente, de la microbiota subgingival de otras especies de monos ardilla (Beem *et al.*, 1991), además de que *Staphylococcccus* se ha aislado hasta en un 67% de los monos congo y colorado (Gamboa-Coronado *et al.*, 2004). En este estudio, sin embargo, se aislaron sólo tres cepas de cocos Gram positivos, pertenecientes todas al género *Staphylococcus*; los estreptococos no pudieron ser detectados probablemente debido a que son un género nutricional y fisiológicamente más exigente. Adicionalmente, se aislaron tres cepas de *Bacillus* sp., género que constituye hasta el 12% de la flora subgingival de otros monos ardilla (Beem *et al.*, 1991).

Otros géneros menos frecuentes en estos monos y no descritos como pertenecientes a la cavidad oral humana fueron *Brevundimonas, Morganella, Pantoea, Ralstonia* y *Flavimonas* (6% cada uno) y *Agrobacterium, Alcaligenes, Chromobacterium, Kluyvera, Leclercia, Ochrobacter, Pasteurella* y *Stenotrophomonas* (3% cada uno). De éstos, sólo *Chromobacterium* fue aislado previamente de los monos congo y colorado, también con baja frecuencia (Gamboa-Coronado *et al.*, 2004). *Brevundimonas, Pantoea, Ralstonia, Flavimonas, Agrobacterium, Alcaligenes, Chromobacterium, Kluyvera, Leclercia* y *Stenotrophomonas* se encuentran ampliamente distribuidos en el ambiente, en suelos y aguas, lo que podría explicar su aparición en el mono tití, mientras que *Morganella, Flavimonas, Alcaligenes* y *Pasteurella* son considerados comensales de mamíferos, entre otros vertebrados

(Busse y Auling, 2005; Janda y Abbott, 2005; Mutters *et al.*, 2005; Palleroni, 2005).

Flora anaerobia

Las bacterias anaerobias más usuales en la cavidad oral del hombre son *Actinomyces, Bacteroides, Eubacterium, Fusobacterium, Peptostreptococcus, Prevotella* y *Veillonella* (Isenberg y D'Amato, 1995). De ellos *Fusobacterium* fue el más frecuentemente aislado en el mono tití (12% de las muestras), seguido por *Bacteroides, Peptostreptococcus, Prevotella* y *Veillonella* (6% cada uno). Estudios anteriores en monos informan de frecuencias que van desde el 4% al 50% para estos organismos (Clark *et al.*, 1988; Beem *et al.*, 1991; Gamboa-Coronado *et al.*, 2004). *B. gingivalis* y *B. intermedius* han sido encontrados como posibles patógenos de enfermedad periodontal, lo que podría correlacionar con el aislamiento de *Bacteroides* en *S. oerstedii* (Clark *et al.*, 1988). Debido a que no se encontraron *Actinomyces* ni *Eubacterium* siguiendo el mismo protocolo de muestreo, es posible que no estén presentes en *S. oerstedii*, aunque sí se han aislado de otros monos de Costa Rica. Con respecto a *Gemella*, su hábitat natural no ha sido completamente establecido, sin embargo su aparición en un 6% de las muestras, así como en la cavidad oral de otros monos (Gamboa-Coronado *et al.*, 2004), podría sugerir que constituye parte de la flora normal del tracto respiratorio superior de estos animales. Con una frecuencia menor se aisló *Propionibacterium* (3%), género encontrado principalmente en derivados lácteos y en la piel humana (Holt *et al.*, 2000).

El género de anaerobios más frecuente fue *Clostridium*, aislado del 36% de las muestras. Dicho género también se describió como el anaerobio más abundante en los monos congo y colorado (48%: Gamboa-Coronado *et al.*, 2004), aunque en otras especies de mono ardilla se señala como constituyente de sólo el 0.5% de la flora subgingival (Beem *et al.*, 1991). A pesar de que en los humanos no se consideran flora indígena oral, los clostridios son habitantes normales del suelo y todas las especies identificadas (*C. bifermentans, C. clostridiiforme, C. perfringens, C. sporogenes* y *C. tyrobutyricum*) se han logrado aislar de suelos de Costa Rica con frecuencias que van del 21% al 50% (Rodríguez *et al.*, 1993; Gamboa *et al.*, 2005), lo que explica la posibilidad de que estas bacterias se ubiquen en la cavidad bucal de los monos, a partir de la ingesta de alimentos y agua contaminados con esporas de clostridios. Sin embargo, su alta frecuencia sugiere que este género podría ser verdaderamente parte de la flora normal de la boca de los monos.

Resistencia antimicrobiana en bacterias aerobias

Gran parte de las cepas bacterianas aisladas presentaron resistencia antimicrobiana ante varios agentes quimioterapéuticos, donde sobresale la alta resistencia de los bacilos Gram negativos aerobios y de los cocos Gram positivos. Para el primer grupo, un 90% de las cepas fue resistente a cefalotina, cefalosporina de primera generación, mientras que un 89% a cefoxitina y un 69% a cefuroxima, cefalosporinas de segunda generación. Este resultado es similar al obtenido para las cepas aisladas de otros monos de Costa Rica, donde la mayor resistencia dentro de las cefalosporinas se presentó para la cefalotina, aunque en menor porcentaje (63%: Gamboa-Coronado *et al.*, 2004). La menor resistencia a la cefepima (12.7%) era de esperar, debido a que es una cefalosporina de cuarta generación, con el mayor espectro de actividad de las cefalosporinas disponibles actualmente (Gomis *et al.*, 1998). La cefepima es más estable y menos afín ante las beta lactamasas, por lo que el hallazgo de bacterias de la flora normal de los monos (particularmente cepas de *Enterobacter*, típicamente sensibles) (Gomis *et al.*, 1998) resistentes a esta droga es preocupante, dado que su uso es muy limitado al ambiente hospitalario. Por su parte, el 65% de las cepas de bacilos Gram negativos presentó resistencia a amoxicilina, similar a las cepas de los monos congo y colorado (71%: Gamboa-Coronado *et al.*, 2004). Dicho resultado correlaciona con el hecho de que la amoxicilina es uno de los antibióticos más empleados en el sistema de salud del país, debido a su bajo precio y su amplio espectro.

Los resultados muestran una importante resistencia de los bacilos Gram negativos ante los aminoglicósidos: tobramicina (52%), gentamicina (32%), netilmicina (28%) y amikacina (25%). La menor resistencia a la amikacina puede explicarse debido a que por diferencias estructurales, este antibiótico no es inactivado por las enzimas intracelulares comunes que inactivan gentamicina y tobramicina (González y Spencer, 1998). A pesar de esto, la resistencia es mayor en las cepas aisladas del mono tití, si se le compara con los patrones de otros monos de Costa Rica, donde dichos antimicrobianos fueron efectivos contra todos los bacilos Gram negativos aislados (Gamboa-Coronado *et al.*, 2004). La resistencia de bacilos Gram negativos aerobios aislados de animales ha sido descrita previamente; estudios han demostrado la presencia de cepas de *Escherichia coli* en mandriles salvajes con niveles de resistencia menores que los presentados por cepas provenientes de humanos contemporáneos, pero similares a los de cepas obtenidas en la era previa a los antibióticos (Routman *et al.*, 1985). Por otro lado, se ha encontrado que bacterias entéricas aisladas de mandriles en contacto con el ser humano presentan niveles significativamente mayores de resistencia, en comparación con las cepas de mandriles sin contacto con el hombre (Rolland *et al.*, 1985); ambos hallazgos favorecen la hipótesis de que el amplio uso de antimicrobianos por parte del ser humano ha promovido la distribución de los genes de resistencia entre las bacterias.

Los cocos Gram positivos aerobios, correspondientes todos al género *Staphylococcus*, presentaron una multirresistencia importante ante los antibióticos evaluados. Las tres cepas fueron resistentes a nueve de las 15 concentraciones de antimicrobianos probadas (60%): penicilina, cefalotina, ampicilina + sulbactam, eritromicina, clindamicina, nitrofurantoína, rifampicina, vancomicina y teicoplanina. Solamente la pefloxacina, ciprofloxacina y tetraciclina fueron efectivas contra todos los aislamientos. Estos resultados son alarmantes si se comparan con los obtenidos para los monos congo y colorado de Costa Rica, donde el 67% de los antibióticos fueron efectivos contra las 21 cepas de cocos Gram positivos aislados (Gamboa-Coronado *et al.*, 2004). La resistencia creciente a antibióticos por parte de los estafilococos se conoce desde hace varios años. La vancomicina todavía se considera como el mejor antimicrobiano disponible para el tratamiento de infecciones por estafilococos resistentes a las penicilinas que no son inhibidas por las penicilinasas; sin embargo, ya se reporta una resistencia incipiente a este fármaco por parte de los estafilococos (Nodarse, 2001), como se observa en este estudio (todas las cepas resistentes) y en caso de aumentar representaría una verdadera catástrofe en la quimioterapia.

Resistencia antimicrobiana en bacterias anaerobias
La resistencia antibacteriana que presentaron las bacterias anaerobias fue considerablemente menor con respecto a la de las otras bacterias. El mayor porcentaje de resistencia se presentó ante metronidazole (35%), al igual que ocurrió en otros monos del país (49%: Gamboa-Coronado *et al.*, 2004). Además de presentar excelente actividad ante *Bacteroides fragilis*, *Fusobacterium* sp. y *Clostridium perfringens* (Chow, 2000), este agente es utilizado también para el tratamiento de infecciones por protozoarios, por lo que su difundida aplicación ha favorecido la aparición de cepas resistentes aisladas de animales y del ser humano (Diniz *et al.*, 2000). La resistencia se presentó en el 52.4% de los anaerobios Gram positivos y abarcó todos los géneros, mientras que la droga fue efectiva contra todos los Gram negativos. Este hallazgo es similar al 3% de resistencia en Gram negativos y el 53.6% en Gram positivos encontrado por Boyanova y colaboradores (2000) en aislamientos de muestras clínicas, pero contrasta con el 44% de resistencia presentado por Gram negativos en el caso de los monos congo y colorado (Gamboa-Coronado *et al.*, 2004).

La clindamicina es un antibiótico muy útil para el tratamiento de anaerobios y su amplio uso favorece la aparición de cepas resistentes, principalmente por la alteración no enzimática del sitio de acción (Falagas y Siakavellas, 2000). Así por ejemplo, se han observado recientemente porcentajes de resistencia entre 5 y 15% para *Bacteroides fragilis* y entre 15 y 30% para otros miembros del grupo *B. fragilis*, organismos para los cuales se ha considerado típicamente este agente como una excelente opción de tratamiento (Lorber, 1995; Falagas y Siakavellas, 2000). En el presente estudio se obtuvo un 23% de resistencia a clindamicina (29% en Gram positivos y 10% en Gram negativos, incluyendo una cepa de *Bacteroides distasonis*) y es similar al 28% mostrado por los anaerobios de otros monos de Costa Rica. Estos resultados son preocupantes, si se consideraba que de los aislamientos clínicos, menos del 10% de los Gram negativos y el 19.6% de los Gram positivos son resistentes (Engelkirk *et al.*, 1992) y más aún si se compara con la ausencia de resistencia obtenida para clindamicina en cepas aisladas de saliva humana (Stark *et al.*, 1993). De las cefalosporinas, la cefoxitina es probablemente la más efectiva (Murdoch, 1998), lo que concuerda con los hallazgos en el mono tití; sin embargo, hubo una mayor resistencia que la obtenida para las cepas de los monos congo y colorado (Gamboa-Coronado *et al.*, 2004). Los informes relacionados con el incremento continuo en la resistencia ante estas cefalosporinas por parte de algunos grupos de anaerobios (Behra-Miellet *et al.*, 2003) refuerza la importancia de la búsqueda de nuevas estrategias para combatirlos.

La resistencia de los anaerobios a las penicilinas fue de 19% para la penicilina y 16% para la amoxicilina; sin embargo, como era de esperar de acuerdo con su mecanismo de acción, fue mayor en Gram negativos (30% penicilina; 20% amoxicilina) que en Gram positivos (14% para ambos antibióticos). La resistencia informada para las cepas de otros monos de Costa Rica es mayor para penicilina (31%) y menor para amoxicilina (10%) (Gamboa-Coronado *et al.*, 2004). Numerosos estudios revelan un aumento creciente en la resistencia a penicilina por parte de varios grupos de anaerobios: *Clostridium* (Engelkirk *et al.*, 1992), *Bacteroides* (Engelkirk *et al.*, 1992) y *Prevotella* (Hecht, 1999), mientras que otros como *Propionibacterium*, *Peptostreptococcus* y *Gemella* tienden a ser susceptibles (Murdoch, 1998; Hecht, 1999). En el caso de la ticarcilina se obtuvo una resistencia del 10%, mayor que la descrita para los monos congo y colorado (2%: Gamboa-Coronado *et al.*, 2004); sin embargo, la susceptibilidad aumentó hasta el 100% al probar este antibiótico conjuntamente con ácido clavulánico como inhibidor de beta lactamasas.

Multirresistencia
Dentro de todos los grupos bacterianos estudiados se presentó multirresistencia, principalmente en los bacilos Gram negativos aerobios y en los estafilococos, y en menor medida en los anaerobios. Sobresale el hecho de que un 6% de los bacilos Gram negativos aerobios fueron resistentes a 13 o más de las 24 concentraciones de antibióticos evaluadas, mientras que las tres cepas de *Staphylococcus* fueron resistentes a 10 o hasta 12 de los 16 agentes probados. En los anaerobios la resistencia múltiple es apreciablemente menor, ya que 39% de las cepas fueron sensibles a las 16 concentraciones de antimicrobianos, el 35% fue resistente a uno ó dos, mientras que sólo el 26% mostró resistencia desde tres hasta siete agentes; sin embargo, dicho hallazgo no deja de ser alarmante, pues tradicionalmente se ha creído que la resistencia múltiple no es un problema común en anaerobios (Gamboa-Coronado *et al.*, 2004). Las sustancias antimicrobianas pueden estar presentes de manera natural en suelos, ya que constituyen un mecanismo utilizado por los microorganismos en sus hábitat naturales; la resistencia contra estos agentes juega un papel importante en la dinámica poblacional de estos ambientes (Kümmerer, 2004). Por otro lado existe la resistencia intrínseca hacia ciertos agentes, debido a la fisiología natural de algunos microorganismos (Kümmerer, 2004). Estos factores permiten concluir que no es de extrañar la presencia de ciertos niveles de resistencia en los organismos aislados de la cavidad oral de *S. oerstedii*; sin embargo, estos niveles son altos y similares

a los encontrados en poblaciones humanas, lo que sugiere la influencia de una presión selectiva generada por el uso excesivo de antibióticos. Millones de kilogramos de agentes antimicrobianos son usados cada año en la profilaxis y tratamiento de personas, animales y en agricultura, favoreciendo la generación de resistencia al eliminar cepas susceptibles y seleccionar las resistentes (Levy y Marshall, 2004).

Los ambientes naturales no están libres de contaminación con antibióticos; se han encontrado en efluentes de centros médicos, aguas municipales, tanques de aireación, tanques de digestión anaerobia, aguas superficiales, sedimentos y suelo (Kümmerer, 2003, 2004). Muchos de los compuestos utilizados en medicina son sólo parcialmente metabolizados por los pacientes y son descargados en los efluentes hospitalarios o en las aguas de desecho municipales si se utilizan en casa (Kümmerer, 2004), mismo destino que tienen muchos de los antibióticos descartados por vencimiento (Hartmann *et al.*, 1999; Kümmerer, 2003). Así, estos compuestos terminan en el ambiente, principalmente en el compartimento acuoso, donde se encuentran cada vez con mayor frecuencia (Levy y Marshall, 2004) y eventualmente podrían ingresar en la cadena alimentaria. Los antimicrobianos son también utilizados para el tratamiento de enfermedades en criaderos de peces, donde son adicionados directamente al agua (Kümmerer, 2004), mientras que otros son utilizados con fines veterinarios o como promotores de crecimiento, por lo que al ser excretados terminan siendo redistribuidos como abono (Kümmerer, 2003).

En Costa Rica actualmente los hospitales no cuentan con sistemas de tratamiento de aguas residuales y el país carece de la legislación adecuada para la regulación del uso de antibióticos en agricultura y ganadería (Tzoc *et al.*, 2002). Se cree que la exposición de las bacterias a estas concentraciones antimicrobianas subterapéuticas, incrementa la velocidad de selección de cepas resistentes (Kümmerer, 2003), lo que aunado a la transferencia de determinantes genéticos de resistencia presentes en el ambiente, podría explicar en parte los patrones de resistencia encontrados en los monos tití, aunque estos tengan poco contacto directo con el ser humano. Este estudio contribuye al conocimiento y al mismo tiempo a la preservación del mono tití, animal en peligro de extinción, y muestra que pocas barreras son capaces de contener los genes de resistencia y sus hospederos bacterianos en nuestro mundo estrechamente relacionado.

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SHORT ARTICLES

BEHAVIORAL FLEXIBILITY AND TOOL SELECTION IN A TUFTED CAPUCHIN MONKEY (*CEBUS APELLA*)

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Introduction

Capuchin monkeys use a variety of tools in many different contexts in captivity (Visalberghi, 1987, 1990, 1993; Ritchie and Fragaszy, 1988; Westergaard and Suomi, 1994; Tomasello and Call, 1997; Fragaszy *et al.*, 2004b), in semi free-ranging conditions (Ottoni and Mannu, 2001) and in the wild (Fragaszy *et al.*, 2004a; Moura and Lee, 2004; Mannu and Ottoni, 2005; but see Panger, 1998). In terms of tool variety and the multiple contexts in which tools are used, capuchins are similar to great apes in tool-using behavior (Anderson, 1996). Some argue that the ability to use tools requires the cognitive ability to establish a relationship between the object and the environment in order to implement anticipated external effects (Reynolds, 1982; Ingold, 1987). Research on tool-using behavior in non-human primates has often described tool-use performance without analyses of the underlying cognitive processes (Visalberghi and Limongelli, 1996), although noteworthy exceptions are found in the classic works of Köhler (1925) and Yerkes (1927, 1943). In terms of the relationship of cognition and intelligence to tool use, there may be little similarity between capuchins and the great apes. There is growing evidence that apes understand what they are doing when using tools (e.g. Boesch, 1992; McGrew, 1992), but this has not been shown for capuchins. To compare, in a context of tool use, the cognitive abilities of chimpanzees (or other primate species) and those of capuchin monkeys, we must look for the underlying mental program that both guides and is expressed in tool-using behavior.

In this study, we do not assume *a priori* that capuchins are less, more or equally intelligent than other primate species. Capuchins, just like chimpanzees, humans, whales or any other species, possess a particular and limited suite of cognitive capacities. Here we describe the results of an experiment that evaluated the ability of a capuchin monkey to select appropriate tools in a nut-cracking task. We also speculate on the possible factors involved in tool selection.

Materials and Methods

Subjects
A group of capuchin monkeys (*Cebus apella* sp.) were housed on a small island within a zoo setting (Parque Ecológico Municipal Eng° Cid Almeida Franco, Americana, São Paulo, Brazil). The alpha male was the experimental subject. He was an adult, wild-born and raised in captivity. He monopolized almost every new object in the small home island and prevented regular access to them by the other animals, leaving us without much choice regarding experimental subjects. It was not possible to remove the alpha male from the island. As the other monkeys had only unpredictable access to the objects, it was not possible to apply the experimental protocol to them in any regular or reliable manner. However, a juvenile male and an adult female that used tools on some occasions were included for qualitative comparisons. All three monkeys had been observed to spontaneously use tools (see below) and/or took part in other tool use experiments (Jalles-Filho *et al.*, 2001), and were thus proficient in the use of tools.

Test phase
In each trial the subject was offered one of three stones (cobbles of quartzite) of similar shape but different sizes (large: 1,565 g; medium: 915 g; small: 110 g), and one nut. Twenty trials were performed per stone (17 for the small stone). A trial began when the subject held the stone in his hands to give the first blow, and ended when the nut was broken. The time and the number of blows required to complete the task were recorded. Here, "nut" actually refers to the fruits of *Terminalia* spp. (Combretaceae), a species that is found in the zoo. Monkeys were observed to crack these fruits spontaneously with the assistance of stones naturally available on the island. This fruit has a soft external layer and, underneath it, a second fibrous and hard layer, which has to be broken in order to reach the edible seed, something the monkeys could do only with the assistance of tools. We draw attention to the fact that the test phase was not designed to give the subjects experience with the different stones. Instead, it was conceived to guide us in evaluating the magnitude of the effect of stone size on the efficiency of accomplishing the task.

Experimental phase
The same three stones of different sizes were simultaneously presented to the subject, and a single nut was offered. Criteria for the starting and ending of the trials were the same as in the test phase, unless the nut was left undisturbed for three minutes, in which case the trial ended. In each trial, the order of lateral placement of the stones was altered. A total of 50 trials were performed. Both phases were videotaped for subsequent analysis.

Qualitative analysis
The two comparison subjects were videotaped in situations of tool use identical to those performed by the experimental subject.

Results

During the test phase, there was a significant effect of stone size on the number of blows required to complete the task (Kruskal-Wallis ANOVA χ^2 (17, 2) = 36.95, $p < 0.0001$,

Table 1. Summary of tool-using activities in the test phase. (Trials: LS and MS, n = 20; SS, n = 17.) LS (large stone); MS (medium stone); SS (small stone).

Type of stone	Number of blows	Mean per trial (x ± SE)	Time (s)	Mean per trial (x ± SE)
Large Stone	67	3.35 ± 0.43	135.52	6.78 ± 1.12
Medium Stone	82	4.1 ± 0.34	157.91	7.9 ± 0.9
Small Stone	381	22.41 ± 1.9	739.04	43.47 ± 6.44

Monte Carlo method; see Table 1). Post-hoc tests revealed that use of the small stones required significantly more blows than the medium or large stones (Nemenyi-Dunn multiple comparisons test, for samples of unequal size, $p < 0.0001$). However, there was no significant difference in number of blows required between the large and medium stones (Mann-Whitney Test: U = 144.0; p = 0.134 – exact test, two-tailed). Since the assumption of sphericity required for a repeated measures ANOVA was violated (Mauchly's sphericity test, w = 26.72, $p < 0.0001$), we compared the duration data across conditions with a repeated measures MANOVA, which showed a significant difference across the different stone sizes (R (2, 15) = 18.62, $p < 0.0001$). The values associated with the small stone were again responsible for the difference (Spjøtvoll-Stoline test for unequal sample sizes, $p < 0.001$). The large and medium stones did not differ significantly in time to task completion (Student's *t*-test for independent samples, $t = -1.54$, $p > 0.05$, two-tailed). In the analysis of the experimental phase, the subject excluded the small stone as an operative tool, but did not differentiate between the other two, using the large stone during 28 trials and the medium one during the other 22 trials (two-tailed binomial test, n = 50, $p > 0.5$).

Discussion

When given the choice between three different stone sizes, the experimental subject rejected the small stone as a useful tool, but did not differentiate between the other two. The subject's use of the large and medium stones did not differ with regard to the number of blows or in relation to the time necessary to complete the task, and the movements executed by the subject were exactly the same in both cases. Thus, the only differential factor, in terms of metabolic expenditure and muscular cost involved, was the magnitude of the load. Note that a weight difference of 650 g (between the medium and large stones) is probably a quite considerable one given the range of adult male weights for the species (4.0–4.5 kg: Rowe, 1996). If the subject was choosing tools in order to minimize energetic costs, a preference for the medium category should be expected, but this prediction was not confirmed by the experimental data. Please note that in our analyses, there is an assumption of a difference in energetic expenditure between the medium and large stones, and an assumption that energetic efficiency, not time efficiency, is what the monkey should maximize. These assumptions are based on the conditions of the experiment, with a large weight difference between the stones, and the captive setting, where animals are usually freed from time constraints. However, until detailed measures of energetic expenditure under different conditions are carried out, our first assumption remains speculative. If there is no significant difference in energetic expenditure and/or if time is the variable being minimized, then one should expect the observed lack of preference between the medium and large stones as tools.

Bearing the above caveat in mind, the choices made by the subject (exclusion of the small stone) could be credited to an interaction between persistence of behavioral patterns and physical features of the tool. During the test phase, the individual repeatedly picked up the small stone bimanually (like he did with the other stones), a cumbersome technique that proved very ineffective. The small stone's performance as a tool was about five to six times worse than the other tools, even though it was eight and 14 times smaller than the medium and large stones respectively. One might expect that the subject would adapt his manual behaviour to best fit the tool in question (e.g., by picking it up with only one hand), but this did not happen. We speculate that, if the subject had changed his behavior, the small stone could have been a reasonable choice in terms of energetic expenditure. It is relevant that he did not change his behaviour even once over the course of 17 test trials, nor try to explore the small stone further as a potential tool over the 50 experimental trials. The two comparative subjects were also resistant to any change of established patterns of manipulative behaviour. The juvenile male engaged in a similar sequence of movements to the alpha male and, when presented with the small stone, persisted in this behavioral pattern, incurring the same difficulties as the experimental subject. The adult female employed a different technique to break the nuts. However, like the others, she never varied her movement pattern regardless of the conditions of the task. Her behavioural pattern, which was already less efficient when compared to the one exhibited by the males, made the technique absolutely ineffective with the small stone because of the reduced magnitude of the load.

These findings suggest that the choices made by the capuchins do not spring from a more detailed means-end analysis, but seemingly from gross physical limitations or restrictions only, in a context of behavioral persistence. That is, the experimental subject only rejected the very inefficient tool, but did not choose the most energetically efficient of the other two. Furthermore, the rejection seems to result from behavioural inflexibility, which made the small stone a very inefficient implement, although it seemed to have the potential to be the opposite. This reinforces previous doubts of capuchin behavioral flexibility and other cognitive capacities, as shown in Jalles-Filho *et al.* (2001). We observed the continuous reactivation of previous manipulative action patterns, with the monkeys always applying one and the same set of movements, apparently blind to the changes in the external conditions, even when a change was needed. In terms of the concept of tool mentioned above, we suggest that the mental program used by the individual to implement the operations over the environment was lacking in complexity from the outset. A sufficiently complex program would permit new elements to be incorporated, and also the selection and combination of previous elements, producing completely new arrangements of whole motor patterns.

Previous studies of tool selection or modification (partly reviewed in Fragaszy *et al.*, 2004b) have yielded mixed results when compared the present study. In all cases, there are differences in experimental design, some of them subtle, which may explain the discrepancies. For example, Antinucci and Visalberghi (1986) have shown that a capuchin monkey was able to use three different kinds of objects (a stone, a piece of wood, and a plastic container) as hammers to crack open hazelnuts and walnuts. More importantly here, they reported that the monkey showed a strong preference for the stone, followed by the wood, with near rejection of the plastic container. The authors did not analyze the time or the number of blows required by each tool to fulfil the task. They noted qualitatively that the stone was much more effective, the piece of wood less so, and the plastic container was completely ineffective. Thus, the monkeys were selecting only for effectiveness, not effectiveness *and* energetic efficiency, as in our case. Their subject, similar to ours, showed rejection of a useless tool (although he still attempted to use it a few times). However, we believe that due to its very small weight (40 g), this tool was so ineffective that no change in behavior would make it valuable, in contrast to the small stone in our study.

Visalberghi and Trinca (1989) have shown that capuchin monkeys were able to solve three conditions of a tube task in which the tools required modification before use, but that the monkeys kept performing errors throughout the course of those experiments. Note that, in order to be effective, the monkeys had to modify the tools, not their motor patterns when using them — an approach which was not possible in our test phase, since the tool could not be modified. Behaviorally, their monkeys made various different attempts, but always by performing the same general action (trying to insert something in the tube), which was absolutely useless in some cases. Thus, there was some rigidity in behavioral patterns as well, since they kept repeating motor patterns with ineffective tools.

In another tube task experiment (Visalberghi, 1993), the same capuchins selected the correct tool out of a group of four. The other three tools in this choice experiment were completely ineffective, whereas in our experimental phase the comparison was between two equally effective tools with different energetic requirements and an inefficient one that could still be used to accomplish the task. In a different experimental set-up, Cummins-Sebrae and Fragaszy (2005) showed that capuchins chose correctly positioned canes to pull out pieces of food, but they also repositioned canes to pull the food, and improved at the task with practice, thus discovering affordances of the tool according to the authors. In the vast majority of their pairings, the tools did not differ in effectiveness, only in the ease to accomplish the task and/or the familiarity of the animals with them. Also, the required change in behavior for repositioning might be regarded as involving a simpler mental operation (comprehension of a spatial relation) than the creation of whole new motor patterns that would be necessary to make the small stone an effective choice (in our case) or to understand that splinter and tapes cannot be used to push food out of a tube (as in the case of Visalberghi and Trinca, 1989).

Although very preliminary, our results may suggest crucial differences between the tool-using behavior displayed by chimpanzees (or other great ape species) and capuchin monkeys, at least regarding behavioral flexibility involving stone tools; this agrees with a growing body of literature expressing similar doubts. The possibility that capuchins are limited in their capacity to select appropriate tools, and show much less flexibility in behavior than the great apes, should at least be regarded as a working hypothesis, testable both with similar experiments (but a larger sample size), and also with different experimental paradigms, ideally contrasting the aspects which varied between and within studies (e.g. effective vs. ineffective tool; more vs. less efficient tool; requiring tool modification vs. requiring behavioral modification). Only through more experimentation we will be able to fully comprehend capuchins' range of cognitive capacities, their physical knowledge of the world, and the relation of both to their ecology.

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DISTRIBUTION AND CONSERVATION STATUS OF THE YELLOW-TAILED WOOLLY MONKEY (*OREONAX FLAVICAUDA*, HUMBOLDT 1812) IN AMAZONAS AND SAN MARTÍN, PERU

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Noga Shanee
Angela M. Maldonado

Introduction

The yellow-tailed woolly monkey (*Oreonax flavicauda*) is one of the largest and rarest Neotropical primates. First discovered in 1802 by Alexander von Humboldt (Humboldt and Bonpland, 1812), since then only a few field studies have been conducted on this species (Leo Luna, 1980, 1982; Butchart *et al.,* 1995a; DeLuycker, 2007) and it remains one of the least known of all primate species. *O. flavicauda* is restricted to a small area of pre-montane cloud forest between 1,400 and 2,500 m a.s.l. in the departments of San Martín and Amazonas in northern Peru (Leo Luna, 1980, 1982; DeLuycker, 2007). The species probably also occurs in small areas of Cajamarca, Huanuco, Loreto and La Libertad departments (Mittermeier *et al.*, 1975; Graves and O'Neil, 1980; Leo Luna, 1980, 1982, 1989; Parker and Barkley, 1981; DeLuycker, 2007; Rolando Aquino, pers. com.). *O. flavicauda* is endemic to the tropical Andes biodiversity hotspot (Myers *et al.*, 2000), and its habitat is characterised by rugged terrain of steep mountain sides and deep river gorges, with canopy height of about 20–25 m, with a thick understory and lush vegetation cover. Low reproductive rates, long inter-birth intervals, low population densities, restricted habitat and limited geographic range all increase this species' vulnerability to extinction from human activities affecting the Peruvian Andes (Leo Luna, 1989; IUCN, 2006). Although no accurate census data exist, Nowak (1999) cites a population estimate of less than 250 individuals surviving in the wild. *O. flavicauda* is listed as Critically Endangered by the IUCN (2006) and currently featured as one of the 25 most endangered primate taxa (Mittermeier *et al.*, 2007).

The main threat to this species' survival is habitat loss from deforestation (Macedo Ruiz and Mittermeier, 1979; Leo Luna, 1980; Butchart *et al.*, 1995b; DeLuycker, 2007). Currently the species is present in several protected areas: Río Abiseo National Park, Alto Mayo Protected Forest, Cordillera Colán Reserved Zone, Cordillera Escalera Regional Conservation Area, and the Laguna de los Condores Reserved Zone. Hunting and logging are still known to occur in all of these reserves (e.g. Parks Watch Peru, 2003). Built in the 1980s, the Lima-Tarapoto highway runs through the departments of San Martín and Amazonas and brought with it many settlers from coastal and high mountain sierra departments (DeLuycker, 2007). Overpopulation and environmental degradation have caused continued immigration, giving San Martín and Amazonas some of the highest immigration levels in Peru (INEI, 2006). As a result, since the last field survey of *O. flavicauda* (Leo Luna, 1980) the area has undergone high levels of deforestation and many populations of the species now exist in isolated forest fragments. Hunting is also a major threat to the survival of the species (Macedo Ruiz and Mittermeier, 1979; Leo Luna, 1980, 1989; Butchart *et al.*, 1995a). In this study we aimed to gather up-to-date information on the status of *O. flavicauda* and to evaluate the current threat levels facing it; this also serves as a preliminary study for the implementation of a larger conservation study.

Methods

Between March and June 2007 we conducted a preliminary survey of *O. flavicauda* at 11 sites in Amazonas and San Martín departments. We also collected secondary data on a further six sites in Amazonas, Huanuco, La Libertad, Loreto and San Martín departments. Sites listed in previous studies (Mittermeier *et al.*, 1975; Graves and O'Neil, 1980; Leo Luna, 1980, 1982, 1989; Parker and Barkley, 1981; DeLuycker, 2007) as areas of this species' occurrence were surveyed for the continued presence of *O. flavicauda.* Other areas where habitat and climatic requirements could be met were also surveyed. All areas covered in this investigation were in the pre-montane cloud forest belt in the two eastern branches of the Andean Cordillera between 05°34' and 06°13'S and 77°01' and 76°31'W (Fig. 1), at altitudes ranging from 1,400 to 2,500 m a.s.l. Average temperatures for these areas are approximately 14–15°C, with average monthly rainfall between 15 mm in the dry season and 120 mm in the wet season. Primary data were collected during forest walks along existing trail systems accompanied by local residents. The location of all sites was recorded with GPS, as were points of encounter with the species. Additional data were also collected on threats to habitat in areas where this species occurs. Incidental data were collected on an *ad libitum* basis. Secondary data on species occurrence were collected from local informants and researchers. Additional data were collected on hunting practices, environmental problems and forest resource uses.

Results

Groups of *O. flavicauda* were found in three locations during this study. On 13 April 2007, near the village of Santa Rosa (05°40'13.5"S, 77°55'08.0"W), Amazonas department (Fig. 1), we encountered a group of eight *O. flavicauda*, consisting of five adults and three young, accompanied by a female white-bellied spider monkey (*Ateles belzebuth*; see Shanee *et al.*, 2007). The group was found in a fragment of forest adjoining pasture at an altitude of 1,875 m a.s.l. Throughout the encounter the group displayed aggressive behaviours such as branch shaking, "mooning" of the scrotal tuft and the short barking call characteristic of the species (Leo Luna, 1980; DeLuycker, 2007). On 2 May 2007, near the village of Shipasbamba, (05°54'35.3"S, 77°58'50.3"W), Amazonas department (Fig. 1), we encountered a group of nine *O. flavicauda*, consisting of two adult males, three adult females, one sub-adult and three juveniles. This group was found in an area of regenerating secondary forest within a larger forest fragment at an altitude of 2,305 m a.s.l., and again this group was detected aurally. We were able to approach the group and stand directly beneath them. Initial aggressive behaviours quickly gave way to more relaxed foraging.

On 27 April 2007, near the village of Paitoja (06°21'42.0"S, 77°04'52.1"W), San Martín department (Fig. 1), we heard the calls of two groups but were unable to locate them. This encounter took place in an area of contiguous primary forest at an approximate altitude of 1,787 m a.s.l. During this study we also found evidence of the presence of *O. flavicauda* in two additional sites: the private reserve of the Peruvian NGO Associación de Ecosistemas Andinas (ECOAN), Abra Patricia (05°41'52.3"S, 77°48'38.6"W), in Amazonas department on the border with San Martín, and near the Gocta waterfalls (06°01'18.4"S, 77°53'12.4"W), also in Amazonas department (Fig. 1). Abra Patricia covers an area of mixed primary and regenerating secondary forest adjoining the Alto Mayo Protected Forest, which is known to contain this species (DeLuycker, 2007). At the Gocta waterfall we found half-eaten fruit (*Ficus* spp.) showing bite marks of a large bodied primate, and the presence of *O. flavicauda* was confirmed by local residents who told us of the species' occurrence in the small patch of forest surrounding the waterfall.

We were unable to directly observe *O. flavicauda* in any of the other six sites visited in this study. However, through informal interviews with local informants, and the use of photographic depictions and verbal descriptions of *O. flavicauda*, we were able to gather additional information on these sites. Results from these interviews confirmed the presence of *O. flavicauda* at Colca (05°53'40.9"S, 77°23'15.2"W) and Nuevo Mendoza (06°27'06.7"S, 77°05'46.3"W) in San Martín department and La Perla de Limasa (05°34'20.1"S, 77°58'53.7"W) in Amazonas

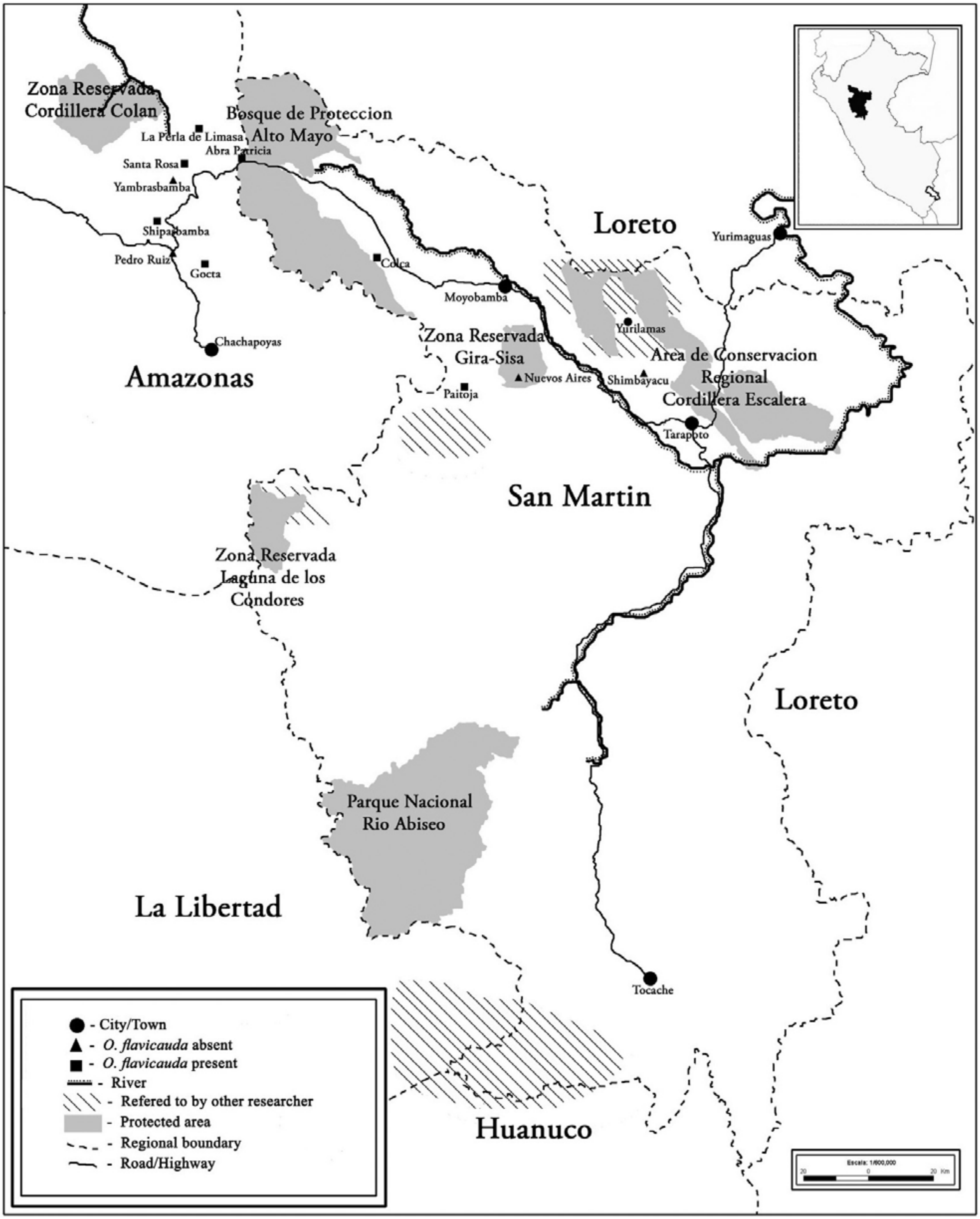

Figure 1. Map of sites visited during the study, showing the presence and absence of *Oreonax flavicauda*.

department (Fig. 1). All other areas visited during this study showed no evidence of the continued presence of *O. flavicauda*. These included the site of the "rediscovery" of the species in 1974 (Mittermeier *et al.*, 1975), Pedro Ruiz Gallo (05°56'36.3"S, 77°58'42.3"W) where the area was found to be completely deforested for several kilometres in all directions. The area around the town of Yambrasbamba (05°44'06.9"S, 77°55'30.0"W), listed by Leo Luna (1980) as *O. flavicauda* habitat, is almost completely deforested within several kilometres of the town. Reports from local informants and our own observations suggest that the species does not occur in either the Gira-Sisa Reserve (06°17'34.3"S, 76°54'24.7"W) or around the town of Shimbayacu (06°20'41.9"S, 76°31'58.4"W) in San Martín department. We were told of the confirmed presence of *O. flavicauda* in additional sites by researchers working in or involved with projects there. These site were in the Los Chilchos Valley (Hans Dignum, pers. com.), north of the Río Abiseo National Park in San Martín department and around the Río Metal river valley near Tocache in the far south of San Martín along the borders with La Libertad and Huanuco departments (Rolando Aquino, pers. com.).

Key informant questionnaires and *ad libitum* data collection showed that most people in these areas are dependent on income from timber extraction. Many people also showed concern about the level of deforestation and its implications for the future. Almost all informants said that they had noticed environmental problems affecting their lives and pointed to deforestation as the main cause of problems such as landslides, soil erosion, changes in the local climate and the disappearance of wildlife. The migrant populations in the area do not generally consume primate meat but opportunely hunt *O. flavicauda* with the intention of selling young animals as pets: in fact 8% of interviewees targeted primates whilst hunting, but only in the indigenous community of Shimbayacu did respondents say that primates were hunted for meat. Unfortunately no precise data could be collected on the percentage of primate off-take rates represented by *O. flavicauda*, as hunting was opportunistic and hunters indiscriminate in their choice of species. During the period of this study we collected incidental data on illegal trade in *O. flavicauda*. We found two recently caught *O. flavicauda* for sale and heard reports of several more. Prices ranged from 30–250 soles (about 10–70 US dollars).

Discussion

Determining population sizes and distributions for a species such as the yellow-tailed woolly monkey is made harder by its fragmented distribution, occurrence in mountainous terrain and by the fact that it has never been the subject of a full census. Nowak's (1999) estimate of less than 250 individuals was probably too low; however, we must conclude that the true population size will not now be much higher than this, with a continuing downward trend. The species' large body size, low reproductive rate and the need for large home ranges, as suggested by their low densities (Leo Luna, 1987; DeLuycker, 2007), makes it especially vulnerable to anthropogenic hunting pressures, and habitat destruction and its fragmented distribution will reduce the effective population size far below that of a single contiguous population (Purvis *et al.*, 2000). Therefore the largest, most secure, individual population should be used to determine the species' level of endangerment. We witnessed large areas within the boundaries of the Alto Mayo Protected Forest being cleared for agriculture and cattle ranching and new areas are being settled constantly. However, group sizes reported by DeLuycker (2007) within the boundaries of the Protected Forest are appreciably greater then those found during this study and in previous studies (Leo Luna, 1980; Parker and Barkley, 1981; Butchart *et al.*, 1995b), all of which were outside protected areas. This could possibly be due to relatively lower hunting pressures within the reserve.

We conclude that the main threats to this species continue to be land clearance and habitat degradation, and, contrary to recent reports (EDGE, 2007), hunting by both indigenous and immigrant communities for subsistence and trade is also a major threat to the survival of the species. Trade in *O. flavicauda* seems to be of a very local nature, but even such small levels of trade in a species as endangered as this could be disastrous. Leo Luna (1987) estimates that 600 individuals were killed by opportunistic hunters over a 10-year period, and our experience leads us to believe that similar numbers are being hunted today. During this study at least three infants were removed from the population, and presumably their mothers were killed in the process. Previous recommendations for the conservation of this species have concentrated on habitat protection and public awareness to reduce hunting pressure (Mittermeier *et al.*, 1975; Graves and O'Neil, 1980; Leo Luna, 1980, 1982; Parker and Barkley, 1981; Ríos and Ponce del Prado, 1989; DeLuycker, 2007). Much has been achieved in recent years, and currently there are several projects in place for the conservation of this and other endemic species in the area — for example, the community-based conservation project in the Los Chilchos valley, supported by Apenheul Primate Conservation Trust, IUCN Netherlands and the RABO Foundation, and also the ecosystem protection initiatives of Asociación Ecosistemas Andinos (ECOAN) and the Asociación Peruana para la Conservación de la Naturaleza (APECO). We recommend urgent conservation efforts throughout the distribution of *O. flavicauda*, concentrating on habitat protection. To best achieve this we feel that work should take place on four different levels: 1) increased protection and connectivity between protected areas, 2) better enforcement of conservation laws, 3) coordinated local and regional scale education and public awareness programs, and 4) investment in development of alternative income sources for rural populations.

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GRANDMATERNAL INFANT CARRYING IN WILD NORTHERN MURIQUIS (*BRACHYTELES HYPOXANTHUS*)

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Karen B. Strier

Introduction

Opportunities for grandmothers and other older matrilineal kin to invest in their grandchildren or younger maternal relatives are affected by whether females remain and reproduce in their natal groups. They may also be mediated by the trade-offs between investing in their own offspring versus those of their relatives. Indeed, the evolution of post-reproductive life spans in human females has been attributed to the fitness benefits that older matrilineal kin may gain by investing in their relatives' offspring instead of their own (Hrdy, 1981; Hawkes *et al.*, 1998). Some types of allomaternal investment, such as agonistic support or babysitting, can be provided irrespective of the female's own reproductive condition, while other types, such as infant carrying during travel or feeding, may be more limited if the female is already carrying an infant of her own (Paul, 2005). In Hanuman langurs (*Semnopithecus entellus*), experienced females with weaning infants or no infants accounted for roughly 10% of all allomothering attempts (Hrdy, 1977: 210), and in Japanese macaques (*Macaca fuscata*), the survivorship of infants to 12 months was significantly higher if their post-reproductive grandmothers were present than if their grandmothers were still reproducing or no longer alive (Pavelka *et al.*, 2002). In captive vervet monkeys (*Chlorocebus aethiops*), grandmothers without infants had significantly higher rates of caring for grandchildren than grandmothers with infants (Fairbanks, 1988: 437).

Northern muriquis (*Brachyteles hypoxanthus*) live in patrifocal societies in which allomaternal care of any type is rare (Odalia-Rímoli, 1998; Guimarães and Strier, 2001; Martins *et al.*, 2007). Grandmothers rarely have opportunities to interact with maternal grandchildren because daughters typically disperse from their natal groups prior to the onset of puberty (Printes and Strier, 1999; Strier and Ziegler, 2000). The only previous known muriqui grandmother of two daughters that reproduced in their natal group was caring for her own infants when her grandchildren were born, and was never observed to carry them. In this paper, we present data on infant-carrying by a second grandmother that did not have her own infant at the time.

Methods

The study was conducted at the Reserva Particular do Patrimônio Natural-Feliciano Miguel Abdala (RPPN-FMA) in Caratinga, Minas Gerais, Brazil. The 957-ha forest supports four groups of northern muriquis, and has been described in detail elsewhere (Strier *et al.*, 2006). We focus on two adult females in the Matão group, which had 81 members during this study period: DD, a grandmother who was carrying an infant when long-term monitoring on this group was initiated in 1982, and is therefore estimated to have been at least 30 years old during the present study; and her daughter, DB, who was born in 1996 and was the third of three natal females (out of 38 natal females that have survived to dispersal age) to remain and reproduce in this group (Martins and Strier, 2004; Strier *et al.*, 2006). DB's first infant, a son, DN, was born in early June 2005.

On 2 September 2005, DD was first seen traveling with her three-month-old grandson (DN) on her back. DD was observed carrying DN on subsequent occasions in 2005. From January to July 2006, instantaneous scan samples (Altmann, 1974) were conducted at 15-minute intervals on all females visible, to assess the proportion of time that DD carried her grandson relative to the proportion of time that he was carried by his mother. At the onset of each scan sample, the females' activities (e.g., resting, traveling, feeding, socializing, drinking water, and undetermined) and all individuals within a five-meter radius were recorded (Strier, 1987). DD and DB were the only females observed carrying DN (i.e., both transporting him while active and resting in contact with him). We calculated the monthly proportion of scan samples in which either DD or DB was carrying or in contact with DN, and in which DB was among her mother's nearest neighbors when DD was carrying or in contact with her grandson. We also examined whether the monthly distribution of both females' activities differed when they were carrying versus not carrying DN. We present descriptive statistics without analyses because of our small sample sizes.

Results

One or both females were observed in 332 of the 2,162 scan samples conducted during the present study period. This resulted in a total of 171 observations of DD (median = 23, range = 6–46, n = 7 months), and 184 observations of DB (median = 23, range = 7–73, n = 7 months). The percentage of monthly observations in which DD was seen carrying her grandson ranged from 0–60.8% (median = 31.1%, n = 7 months), while those in which DB was carrying her son ranged from 4.4–62.5% (median = 12.5%). From April through July, DD carried DN proportionately more often than DB (Fig. 1). DD was rarely in proximity to her daughter during the study period. On average, DB was among her mother's nearest neighbors in 14.4 ± 11.8% of the scan samples when DD was carrying her grandson (median = 18.2%, range: 0–25.0%; n = 6 months) and in 9.6 ± 7.7% of the scan samples in which DD was not carrying him (median = 11.1%, range = 0–17.6%, n = 7 months). Both females exhibited similar activity patterns whether or not they were carrying or in contact with DN. DD was twice as likely to be feeding when not carrying her grandson, and DB was seven times more likely to be feeding when not carrying her son (Fig. 2).

Discussion

We do not know why DD began carrying her grandson in the first place, or why her care of DN increased during the last four months of the study period. However, neither of the other two females (maternal sisters) that have reproduced in their natal group received any help with carrying from their mother—who, unlike DD, was caring for her own infants when her grandchildren were born. DD's interest in or ability to carry her grandson may have been possible because she was not encumbered with an infant of her own. Based on her reproductive history and the average three-year birth interval (Strier *et al.*, 2006), DD was expected to have conceived during the 2005–06 mating season. Although her last observed copulation was on 2 December 2005, she did not subsequently give birth. Muriquis do not exhibit visible signs of early pregnancy, and the cessation of cycling and mating during the mating season is usually indicative of conception (Strier and Ziegler, 1997, 2005). We do not know, however, whether DD's pregnancy failed, or whether she failed to conceive at all this year. Seven years earlier, during the 1998–1999 mating season, DD also cycled and copulated, but did not subsequently give birth. Her much lower cycling estradiol levels and higher corresponding androgen levels relative to other females that conceived that year were hypothesized to have contributed to her reproductive failure (Strier and Ziegler, 2005). Although she has reproduced in the intervening years, it is possible that during the present study, she experienced similar conception difficulties to those when she was seven years younger.

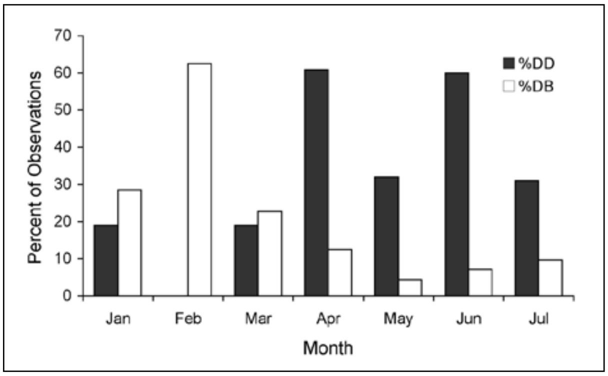

Figure 1. Grandmaternal versus maternal infant-carrying and contact. Percentages are based on scan samples in which DD and DB were carrying or in contact with DN.

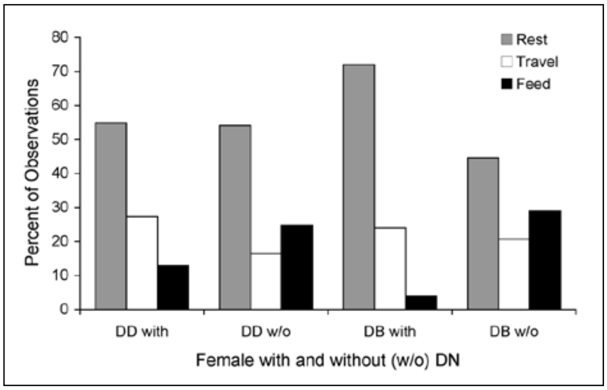

Figure 2. Distribution of DD's and DB's main activities relative to their contact with or without DN. Resting with DN involved physical contact; traveling and feeding with DN involved carrying him.

Although DD and DB were rarely in close proximity, DB was more likely to be among DD's nearest neighbors when DD was carrying her grandson than when she was not. We do not know whether DD initiated proximity with DB to gain access to her grandson, or whether DB initiated proximity with DD to solicit her help or to monitor her while she was carrying DN. Both DD and DB were less likely to feed when they were carrying DN than when they were not. It is tempting to infer that by carrying her grandson, DD liberated her daughter to feed unencumbered, but muriqui mothers often "park" their infants in the canopies of the trees in which they are feeding (Strier, 1999, p. 84). If DN was parked nearby when either his mother or grandmother were feeding, neither was scored as carrying him.

Extended allomaternal care by northern muriquis has previously been observed on only one other occasion during our long-term monitoring of this group, and curiously, the same female (DD) was also involved. On that occasion, DD carried her own and another female's similarly aged infant for 1 ½ days before relinquishing one of the infants to the other mother. In the process, however, the infants were exchanged, and both mothers successfully weaned and reared their adopted infants (Martins *et al.*, 2007). In the present case, however, DD focused her attention exclusively on her maternal grandson, despite the presence of other infants in the group at the time. Moreover, none of the other adult females, including those that were not carrying infants of their own, were observed carrying or attempting to carry DN. Although we cannot yet assess whether DD's care of her grandson will have any direct or indirect fitness benefits, our observations of persistent investment by a grandmother in her maternal grandson indicate that grandmaternal care can occur within a patrilocal society when a daughter atypically reproduces in her natal group and the grandmother is not carrying an infant of her own.

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Caracterización de la Población del Mono Aullador (*Alouatta palliata palliata*) en el Refugio Nacional de Vida Silvestre Isla San Lucas, Costa Rica

Marta Marleny Rosales-Meda

Introducción

Los estudios realizados con monos aulladores en sitos con aislamiento geográfico se han desarrollado principalmente en las islas de Barro Colorado (Milton 1990), Orquídea (Froehlich y Thorington, 1982, 1992) y Coiba (Milton y Mittermeier, 1977) en Panamá, donde predomina la vegetación de bosque tropical. Dichos estudios han sido de utilidad para conocer la ecología y comportamiento de los aulladores en estos hábitats. Hasta la fecha no existe información acerca del estado de estos primates en ambientes aislados geográficamente, estacionales y reducidos. Este es el caso del Refugio Nacional de Vida Silvestre Isla San Lucas (RNVSISL) en Costa Rica, en donde habita una población introducida de monos aulladores (*Alouatta palliata palliata*) desde hace 40 años (Costa Rica, MINAE, 2005). Se ha reportado que dicha especie juega un papel determinante en la regeneración y restauración de hábitats, principalmente en bosques secos del país (Howe, 1980; Morera, 1996), lo cual podría ser el caso del RNVSISL, donde en los últimos 30 años la cobertura del bosque caducifolio ha aumentado en un 55% (Castro y Carvajal, 2006). Por otro lado, en la actualidad, las poblaciones de monos aulladores están consideradas en peligro de extinción para Costa Rica (UICN-ORMA-WWF, 1999) y su estudio en ambientes aislados geográficamente es importante para formular e implementar acciones de manejo que puedan mejorar la viabilidad de dicha especie. La presente investigación constituye el primer aporte para conocer el estado de los monos aulladores en el RNVSISL y tuvo como objetivos: 1) caracterizar la población existente (composición por sexo-edad y características particulares) y 2) identificar algunos de los árboles utilizados como alimento y descanso en época seca.

Métodos

Área de estudio

El RNVSISL se ubica en el golfo de Nicoya, al occidente de Costa Rica, entre las coordenadas 09°57'N y 84°54'O. Su extensión es de 462 ha y la altitud varía entre los 0 y 220 m.s.n.m. Según Bolaños y Wattson (1993) la isla se encuentra dentro de la zona de vida Bosque Seco Tropical y presenta dos estaciones definidas: lluviosa (mayo–noviembre) y seca (diciembre–abril). La precipitación media anual es de 1,600 mm y la temperatura media es de 27°C. La isla se encuentra a 800 metros al oeste de la península de Nicoya y a 7 km al este de la provincia de Puntarenas (Costa Rica, MINAE, 2005). Para el año 2006, la isla contaba con 366 ha de bosque caducifolio en sucesión, 46.89 ha de bosque siempre verde, 6.9 ha de manglar y 6.8 ha de pastos arbolados (Castro y Carvajal, 2006). En 1873 el gobierno de Costa Rica declaró la creación de un centro penitencial en la Isla San Lucas, con lo cual se da la introducción de especies exóticas de fauna y flora al área, así como la degradación de la vegetación existente a causa de actividades ganadera y agrícola. En 1967 se introdujeron en la isla algunas especies de fauna silvestre, entre ellas los monos aulladores, pero se carece de información acerca de la cantidad de individuos y su origen. En 1991 se clausuró el centro penitencial y empezó un proceso de regeneración vegetal principalmente del bosque caducifolio, ya que hasta entonces predominaban las áreas de pasturas. En 2001 la isla fue declarada Refugio Nacional de Vida Silvestre por el Ministerio de Ambiente y Energía y desde entonces ha sufrido poca intervención humana. En la actualidad es visitada por pobladores de áreas aledañas con fines recreativos, principalmente en las playas, pero también se han registrado pesca y cacería furtiva (Costa Rica, MINAE, 2005; obs. pers.).

Caracterización del mono aullador

El registro de la población de monos aulladores existente en el RNVSISL se realizó mediante recorridos en la mañana (05:00–10:00 hr) y tarde (15:00–17:30 hr) durante 10 días, en época seca (18 al 27 de abril de 2006). Se visitaron al menos dos veces todos los remanentes de bosque siempre verde donde podían habitar los monos, y también se realizaron recorridos en los otros tipos de cobertura vegetal. Los monos fueron observados con binoculares por un mínimo de 40 minutos, con el fin de determinar el sexo (macho o hembra, mediante la presencia o ausencia de escroto de color blanco a partir de la etapa sub-adulta; Neville *et al.*, 1988) y edad de los integrantes de la tropa. La edad se diferenció en adulto (individuo grande e independiente), juvenil (individuo que se mueve independientemente de su madre, de tamaño medio, muy activo), infante (individuo pequeño que se agarra del pelaje dorsal de la madre, depende de ella pero se separa frecuentemente para jugar o explorar por poco tiempo) y cría (individuo pequeño que se agarra del pelaje dorsal o ventral de la madre, es totalmente dependiente de ella y se separa esporádicamente para explorar). Se identificaron características particulares de cada individuo (cicatrices y coloración del pelaje) y algunas especies de árboles utilizadas para alimento y descanso durante el tiempo de observación. La ubicación de las tropas fue registrada en un mapa con la ayuda de un GPS. Se utilizó estadística descriptiva para el análisis de la composición de tropas existentes y su organización social (machos adultos / hembras adultas y hembras-inmaduros).

Resultados

Durante 75 h de esfuerzo de búsqueda y observación se detectó un total de 112 individuos distribuidos en nueve tropas y un macho adulto solitario. Las tropas estuvieron compuestas por 31 machos adultos (28%), 38 hembras adultas (34%), 21 juveniles (19%), seis infantes (5%) y 15 crías (14%) (Tabla 1). La media del tamaño de tropas fue de 12.33 ± 6.5 y la mediana fue de 11, con un intervalo de 3 a 23 individuos. La tasa sexual promedio en adultos fue de 1.48 ± 1.03 hembras por macho, mientras que las proporciones de inmaduros (infantes + crías) por hembra y de crías por hembra fueron de 0.53 ± 0.43 y 0.36 ± 0.17 respectivamente. Todos los individuos fueron detectados en remanentes de bosque siempre verde (Fig. 1), en árboles de 20 m o más de altura. La densidad estimada de monos aulladores en el RNVSISL fue de 0.24 ind/ha y en el bosque siempre verde en época seca fue de 2.29 ind/ha. Los árboles utilizados como alimento fueron *Mangifera indica* y *Spondias purpurea* (fruto); *Cassia grandis, Bursera simarouba, Ficus benjamina, Anacardium excelsum, Pseudobombax septenatum, Albizia saman, Tamarindus indica, Acacia centralis, Desmopsis bibracteata, Melicoccus bijugatus* y *Maytenus segoviarum* (hojas). Frecuentemente se les observó descansando en árboles de *Bombacopsis quinata, Sideroxylon capiri, Enterolobium cyclocarpum, Callycophyllum candidissimun* y *Lonchocarpus* spp.

Nueve por ciento (n = 10) de los individuos observados presentaron una despigmentación (mancha blanca) en el pelaje, la cual variaba en tamaño y forma entre los diferentes individuos, pudiendo ser contínua o discontinua, y se observó principalmente en las extremidades y cola de adultos y juveniles (Tabla 1 y Fig. 2). Las observaciones

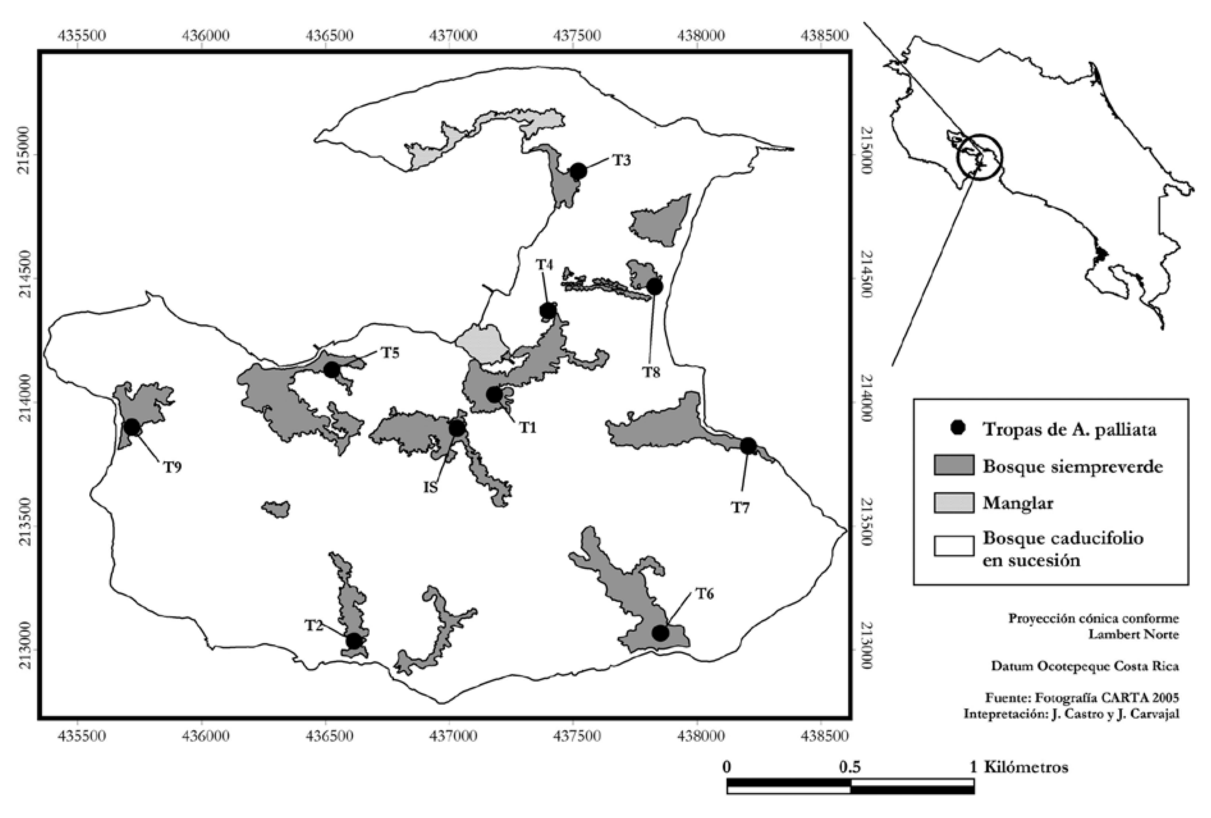

Figura 1. Distribución geográfica de las tropas (n = 9) y de un macho adulto solitario (IS) de *Alouatta palliata palliata* en el Refugio Nacional de Vida Silvestre Isla San Lucas, Costa Rica.

Tabla 1. Composición de las tropas del mono aullador, *Alouatta palliata palliata,* en el Refugio Nacional de Vida Silvestre Isla San Lucas, Costa Rica. MA = macho adulto, HA = hembra adulta, J = juvenil, I = infante, C = cría.

No. Tropa	MA	HA	J	I	C	Total	Individuos con manchas	Lugar
1	1	4	0	0	2	7	0	Administración
2	4	5	2	0	1	12	0	Hacienda Vieja
3	2	3	5	0	1	11	2	Bella Vista
4	4	3	3	0	1	11	1	Administración
5	3	6	1	1	2	13	1	El Inglés
6	7	6	5	1	3	22	0	Limoncito
7	6	8	3	2	4	23	4	Cirialito
8	3	2	1	2	1	9	0	El Coco
9	1	1	1	0	0	3	1	Tumbabote
Total tropas	31	38	21	6	15	111	9	
Mediana	3	4	2	0	1	11		
Media	3.44	4.22	2.33	0.67	1.67	12.33		
Desv.Est.	2.07	2.22	1.80	0.87	1.22	6.50		
Ind. solos	1					1	1	Central
Total general	32					112	10	

particulares de las manchas de cada individuo por tropa se especifican en la Tabla 2.

Discusión

El intervalo del tamaño de tropas detectado en el presente estudio se encuentra entre el rango reportado para la Isla de Barro Colorado (IBC, 3–45 individuos: Milton, 1990) y la isla Coiba (2–9 individuos: Milton y Mittermeier, 1977) en Panamá, así como para el bosque seco estacional del Parque Nacional Santa Rosa (PNSR, 3-40: Fedigan *et al.*, 1985) y la finca La Toboga (3-39: Heltne *et al.*, 1975) en Costa Rica. El tamaño medio de tropas observado en el RNVSISL es similar al reportado para la finca La Pacífica, en Guanacaste (11.9 individuos: Heltne *et al.*, 1975; 17 individuos: Glander, 1980) y más alto que el reportado en la isla Coiba (5 individuos: Milton y Mittermeier, 1977). Si se excluye del análisis a la tropa incipiente (No.9), el tamaño medio de tropas (13.50 ± 5.86) es un valor cercano al reportado para el bosque seco estacional (14 individuos: Fedigan, 1986), pero más bajo que el reportado para la IBC (19 individuos: Milton, 1990). Se desconoce el tiempo de formación de cada tropa en el RNVSISL. No obstante, el mismo podría afectar su tamaño, y es posible que las tropas más antiguas sean las mayores.

La cantidad media de machos, hembras e inmaduros es congruente con lo reportado para la especie (Neville *et al.*, 1988), cercana a los valores reportados para el bosque seco en el PNSR (Fedigan *et al.*, 1985), La Pacífica y La Toboga (Neville *et al.*, 1988) y relativamente menor a los reportados en el bosque tropical de la IBC en 1980 (Milton, 1990). Así, el tamaño, composición y patrón de distribución de las tropas observado en los bosques siempre verdes del RNVSISL no difiere de los valores reportados en otros hábitats y probablemente sólo depende de la abundancia, calidad y disponibilidad de recursos (Milton, 1990). Como se esperaba, se observó que las tropas más grandes (de 22 y 23 individuos) habitaban en los remanentes de bosque más grandes y antiguos (7.5 y 5.85 ha respectivamente) mientras que la tropa más pequeña (tres individuos) se observó en uno de los remanentes más pequeños y jóvenes (3.16 ha). Es posible que esto refleje una mejor adaptación de los aulladores en el RNVSISL, debido a la disponibilidad de alimento de mejor calidad y con menor cantidad de compuestos secundarios vegetales tóxicos (Milton, 1979). Durante el muestreo, se observó cualitativamente una tendencia a un mayor tamaño corporal de los monos adultos en uno de los remanentes más antiguos (tropa No. 6) y de individuos con menor tamaño corporal en remanentes de bosque más recientes (tropas No. 4 y 9), lo cual podría apoyar la hipótesis de que los aulladores alcanzan mayor tamaño y peso corporal en lugares donde tienen acceso a bosque más maduro y diverso (Froehlich y Thorington, 1990). Esto fue descrito anteriormente para la IBC y la isla aledaña Orquídea, la cual posee un área menor (16 ha) y cuenta con recursos alimenticios limitados ya que su tiempo de regeneración vegetal es menor al de la IBC (Froehlich y Thorington, 1982, 1990). No obstante, para verificar si esta tendencia se presenta en el RSVSISL, es necesario realizar estudios que proporcionen información sobre mediciones corporales de los individuos y su relación con la abundancia y diversidad de alimento.

Figura 2. Macho adulto *Alouatta palliata palliata* con despigmentación en el pelaje de la cola y de la pata derecha. (Foto por M. M. Rosales-Meda.)

Tabla 2. Descripción de las manchas de color blanco en piel o pelaje observadas en individuos de las tropas de monos aulladores que habitan en el Refugio Nacional de Vida Silvestre Isla San Lucas, Costa Rica.

No. Tropa	Observaciones
3	Un macho adulto con manchas de color blanco en el pelo de ambas patas traseras y en la parte inferior de la cola (en forma de anillo). Un juvenil con manchas de color blanco en la parte inferior de la cola (en forma de anillo).
4	Un macho adulto con parte inferior de la cola de color blanco.
5	Un macho adulto con la punta de la cola de color blanco.
7	Un macho adulto y un juvenil con manchas de color blanco en parte del pelo y piel de la pata trasera izquierda. Un macho adulto con manchas de color blanco en la piel de la pata delantera izquierda. Un juvenil con manchas de color blanco en el pelo de ambas patas traseras.
9	Una hembra adulta con pelo y piel de la pata trasera izquierda y parte inferior de la cola (sólo de un lado) de color blanco. La coloración blanca de la piel de la pata es discontinua.
Ind. solo	Macho adulto con parte del pelo y piel de la pata trasera derecha y parte de la cola (en forma de anillo) de color blanco. La coloración blanca del pelo de la pata es discontinua.

La densidad de aulladores en el RNVSISL, concentrada principalmente en la reducida cobertura de bosque siempre verde, y la proporción media de inmaduros por hembra indican que la población podría tener un crecimiento por natalidad constante. El número mayor de juveniles que de infantes y crías parece indicar que la supervivencia de los inmaduros es alta, aunque se deben realizar estudios de monitoreo de la población a lo largo del año para verificar dicha información. La baja cantidad de individuos solitarios encontrados en el RNVSISL es similar a lo reportado en otros ambientes aislados geográficamente como la isla Coiba (sólo un macho adulto solitario: Milton y Mittermeier, 1977) y la IBC (cero individuos solitarios: Froehlich *et al.*, 1981; Milton, 1990).

Con respecto a la despigmentación en el pelaje ó piel observada en algunos individuos, no existe hasta la fecha información documentada acerca de las causas de ello. Esta despigmentación ha sido también observada en individuos de *A. palliata palliata* en otras áreas no insulares del país como el Pacífico Central (Rosales-Meda, 2007), en Piro, Península de Osa (Bustamante, com. pers.) y en individuos de *A. palliata mexicana* en México (Cristóbal-Azkarate, 2003; Cortés Ortiz, com. pers.). Las posibles causas de la despigmentación pueden obedecer a alguna o el conjunto de las siguientes hipótesis: a) *Endogamia y herencia:* ya que la migración de aulladores queda restringida a la isla, es factible que exista una alta tasa de endogamia en la población y que la proporción de loci heterozigóticos sea extremadamente baja. Como consecuencia de ello, es posible que la coloración blanca se deba, a) a alelos recesivos que están siendo expresados fenotípicamente en algunos individuos y se puedan estar transmitiendo de generación en generación; en la IBC, Froehlich y Thorington (1990) reportaron que existe una proporción de loci heterocigóticos por individuo muy inferior a lo que se considera normal y dicho fenómeno es mayor en la isla Orquídea, b) carencia de algún requerimiento nutricional esencial o desnutrición: causado por cambios estacionales en y entre años que conduzca a una baja calidad de alimento disponible o a competencia inter e intra específica, lo cual puede afectar en mayor grado a los individuos más débiles (Milton, 1990; Froehlich *et al.*, 1981) ó c) carencia de algún polímero esencial que pueda afectar la producción de melanina en algunos individuos.

Se observó el uso frecuente del dosel y árboles emergentes en el RNVSISL, tal como ha sido reportado por Chapman (1988) y Neville *et al.* (1988); la mayor proporción de árboles utilizados para alimentarse o descansar tenían una altura de 20 m o más. El bosque caducifolio, el manglar y algunos cables eléctricos antiguos fueron de utilidad para el desplazamiento de individuos en la isla en la búsqueda de alimento. Los frutos de *Mangifera indica* y *Spondias purpurea* fueron consumidos por los aulladores (obs. directa o en heces), tal como ha sido reportado para la isla Coiba (Milton y Mittermeier, 1977). Es evidente que dichas especies son un recurso alimenticio importante en época seca, tanto para los aulladores como para otros mamíferos y aves que habitan en la isla (obs. pers.).

Recomendaciones para el manejo, conservación y monitoreo de los monos aulladores en el RNVSISL

A la brevedad posible, es necesario realizar estudios genéticos y de salud de los individuos que permitan entender el origen de la despigmentación en el pelaje o piel, así como evaluar la condición general actual de la población. Es también importante monitorear la proporción relativa de las categorías de sexo-edad, total de individuos, tasas de natalidad, mortalidad y sobrevivencia a largo plazo, así como métricas corporales de los individuos. Dichos aspectos deben ser estudiados en ambas épocas del año, utilizándose los mismos criterios de apreciación con respecto al sexo-edad y a las características particulares de cada individuo. Por otro lado, la evaluación de la abundancia, distribución, calidad del alimento y la capacidad de carga de la isla es esencial para entender aspectos relacionados con la salud de la población. Puesto que en RNVSISL se empieza a promover el turismo, se recomienda que esta actividad sea regulada para que tenga un impacto mínimo en los bosques de la isla; las condiciones de aislamiento y de posible estrés ambiental de la poblaciones de monos aulladores, exige que sean desarrolladas medidas para su manejo y conservación.

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Aspectos Ecológicos de *Alouatta guariba clamitans* Cabrera, 1940 na Área de Relevante Interesse Ecológico Floresta da Cicuta, Rio de Janeiro, Brasil

Sandro Leonardo Alves

André Scarambone Zaú

Introdução

O Brasil é considerado o detentor da maior diversidade de espécies de primatas do mundo. Somente na Floresta Atlântica ocorrem 24 espécies, sendo 17 endêmicas (Mendes *et al.*, 2003), entre elas *Alouatta guariba* (= *A. fusca*). A subespécie *Alouatta guariba clamitans* Cabrera, 1940 ocorre nos Estados de Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina e Rio Grande do Sul no Brasil (Coimbra-Filho, 1990) e no norte da Argentina (Di Bitteti *et al.*, 1994). Ocupando originalmente cerca de 12% do território brasileiro, atualmente a Floresta Atlântica se encontra altamente fragmentada e seus maiores remanescentes estão localizados principalmente nos Estados do Paraná, São Paulo, Minas Gerais, Rio de Janeiro, Espírito Santo e na região sul da Bahia (Zaú, 1998). Os primatas do gênero *Alouatta* Lacépède, 1799, família Atelidae, são considerados os mais folívoros entre as espécies neotropicais, porém incluem, quando disponíveis, quantidades variáveis de frutos e flores à dieta (Neville *et al.*, 1988; Queiroz, 1995). Estudos têm demonstrado que as diversas espécies do gênero ocupam áreas de vida pequenas, geralmente menores que 60 ha (Neville *et al.*, 1988; Bicca-Marques, 2003).

Alouatta guariba clamitans encontra-se enquadrada como "Quase Ameaçada" na revisão da Lista Oficial de Espécies da Fauna Brasileira Ameaçada de Extinção (Rylands e Chiarello, 2003) e "Presumivelmente Ameaçada" na Lista da Fauna Ameaçada de Extinção do Estado do Rio de Janeiro (Bergallo *et al.*, 2000). Atualmente, pouco se conhece sobre a ecologia e demografia de *A. g. clamitans* nos fragmentos de Floresta Atlântica do Rio de Janeiro. Na região do Médio Vale do Paraíba do Sul (região sul do Estado) inexistem informações acerca da situação atual desta subespécie. Este trabalho apresenta dados sobre a composição sócio-etária e a dieta de *A. g. clamitans* na Área de Relevante Interesse Ecológico Floresta da Cicuta, unidade de conservação federal no Estado do Rio de Janeiro.

Material e Métodos

Área de estudo

Abrangendo parte dos municípios de Barra Mansa e Volta Redonda, na região do Médio Vale do Paraíba do Sul, Estado do Rio de Janeiro, a "Área de Relevante Interesse Ecológico" (ARIE) Floresta da Cicuta (22°24'–22°38'S, 44°09'–44°20'W, 300–500 m a.n.m., 131 ha) é administrada pelo Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) e pela Companhia Siderúrgica Nacional (CSN). Sua vegetação é caracterizada como Floresta Estacional Semidecidual Submontana (IBGE, 1992), enquanto as áreas adjacentes são compostas por matas em estágio inicial e intermediário de sucessão, antigos plantios de *Eucalyptus* sp. e pastagens. O clima é mesotérmico (Cwa [Köppen]), apresentando duas estações bem definidas: estação seca (maio-setembro, período com pouca precipitação e temperaturas mais baixas) e estação chuvosa (outubro-abril, com elevadas temperaturas e concentração das precipitações). As temperaturas médias anuais variam entre 17° (julho) e 24°C (fevereiro) e as precipitações entre 1,000 e 1,600 mm/ano (Carauta *et al.*, 1992). As famílias com a maior riqueza de espécies na área são, em ordem decrescente, Myrtaceae, Leguminosae, Rubiaceae, Lauraceae e Euphorbiaceae (Faria, 2002; Souza, 2002). Além de *A. g. clamitans*, a ARIE Floresta da Cicuta também possui uma população introduzida de *Callithrix jacchus* Linnaeus, 1758. A coleta de dados foi realizada em uma área de 20 ha (aproximadamente 15% da área total) na parte nordeste da ARIE, cuja seleção levou em consideração características favoráveis às observações, tais como, fácil acesso, presença de uma trilha principal (2 km) e diversas "picadas", além de abranger o limite (borda) entre a área florestada e a área coberta por pastagens.

Metodologia

Entre abril e dezembro de 2002, cerca de três dias mensais foram dedicados à coleta de dados populacionais por um único observador. O método consistiu em procurar grupos de *A. g. clamitans* ao longo da trilha principal (2 km) no período das 06:00 às 18:00 h. Sempre que possível, cada grupo localizado era acompanhado até a determinação confiável de seu tamanho e composição etário-sexual. Utilizou-se a classificação etária proposta por Mendes (1989). O estudo da dieta foi realizado entre os meses de junho e novembro de 2003, à exceção de Agosto, durante três dias por mês, totalizando cerca de 165 h de esforço amostral. Cada evento individual de alimentação foi registrado, incluindo o item consumido (folha madura, folha nova, folha em estágio de maturação indeterminado, flor, fruto e broto, conforme Mendes, 1989) e o hábito (árvore, trepadeira ou indeterminada) da fonte alimentar.

Resultados e Discussão

Foram encontrados quatro grupos (Tabela 1) e um macho adulto solitário, totalizando 24 animais. Cada grupo foi denominado de acordo com alguma característica ambiental de sua área de uso. Todos os grupos apresentaram uma estrutura social uni-macho (Eisenberg *et al.*, 1972), à semelhança do observado por Mendes (1989: 84% dos grupos) em Minas Gerais, Steinmetz (2001: 83%) em São Paulo e Limeira (1996: 100%) no Rio de Janeiro. O tamanho médio dos grupos foi de 5,8 indivíduos, mesmo valor observado por Silva (1981) e Steinmetz (2001). Devido ao pequeno tamanho amostral não é prudente estimar a densidade populacional de *A. g. clamitans* na ARIE Floresta da Cicuta.

Tabela 1. Composição dos grupos de *Alouatta guariba clamitans* encontrados na ARIE Floresta da Cicuta, RJ, Brasil, entre abril e dezembro de 2002.

Grupo	N	Macho adulto	Fêmea adulta	Macho subadulto	Juvenil	Infante	Indeterminado
Bambuzal	8	1	3	1	–	1	2
Vale	8	1	3	1	1	–	2
Ponte	4	1	1	1	–	–	1
Riacho	3	1	2	–	–	–	–
Total	**23**	**4**	**9**	**3**	**1**	**1**	**5**

Um total de 60 registros de alimentação foi obtido, sendo o item folha responsável por 81% do consumo. Brotos, frutos e flores foram consumidos em menores proporções (respectivamente, 10%, 7% e 2% dos registros). Esta dieta principalmente folívora provavelmente foi observada pelo fato da coleta de dados ter sido realizada apenas durante o período de transição entre a estiagem e a estação chuvosa, época na qual há uma escassez de frutos e flores comestíveis. Folhas maduras foram consumidas em maior proporção em relação a folhas novas (respectivamente, 51% e 43% do total das folhas consumidas) e folhas provenientes de árvores compuseram 64% dos registros. As folhas de trepadeiras, plantas abundantes na área de estudo localizada na borda da floresta da ARIE, foram responsáveis por 26% dos registros de consumo de folhas. Sua abundância por todo o fragmento associada à característica produção constante de folhas novas das espécies vegetais de hábito trepador, faz das lianas e trepadeiras importantes recursos alimentares para *A. g. clamitans* (Alves, 2004).

Os dados aqui apresentados são preliminares e estudos de longa duração sobre o padrão de atividades, uso do espaço e dieta (quantidade e espécies consumidas) são necessários para o entendimento das relações entre a população de *A. g. clamitans* e o fragmento florestal em que habita. Estudos relatados por Bicca-Marques (2003) demonstram a capacidade de sobrevivência das espécies do gênero *Alouatta* em hábitats perturbados de variados tamanhos. Porém, apesar da existência de *A. g. clamitans* nos fragmentos de menor tamanho ao redor da ARIE Floresta da Cicuta, segundo informações fornecidas por guardas que executam o patrulhamento da área, não se observa nenhum tipo de conectividade entre essas "ilhas" de floresta e a unidade de conservação, o que pode reduzir ou eliminar o fluxo de indivíduos geneticamente diferentes e a possibilidade de (re) colonização de novas áreas. Devido ao processo de ocupação humana ocorrido na região do Médio Vale do Paraíba do Sul, os principais remanescentes de Floresta Atlântica se encontram em propriedades particulares, sujeitos à devastação. Com o acelerado processo de fragmentação nesta região, ações planejadas para a conservação de *A. g. clamitans* devem ser realizadas para evitar que as últimas populações fiquem aquém do limite de sustentação genética e ecológica. Sugere-se que áreas privadas que ainda preservam populações desta subespécie e outras espécies de primatas sejam mantidas e protegidas, se possível convertendo-as em unidades de conservação particulares (RPPNs).

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A PRELIMINARY STUDY OF PROXIMITY PATTERNS AMONG AGE-SEX CLASSES IN A POPULATION OF CENTRAL AMERICAN BLACK HOWLERS (*ALOUATTA PIGRA*)

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Introduction

Affiliative interactions reflect the nature of social bonds within primate social groups, which in turn can reflect the pattern of dispersal. In female resident societies, related females tend to affiliate more closely with one another, and the reverse is reported for male resident groups (Strier, 1994; Strier *et al.*, 2002). Bisexual or female dispersal may be associated with stronger bonds between adult males and females (Printes and Strier, 1999; Di Fiore and Fleischer, 2005), and weaker bonds between females (Strier, 1999).

Central American black howler monkeys (*Alouatta pigra*), recently upgraded to Endangered by the IUCN (IUCN, 2003), are folivore/frugivores (Silver *et al.*, 1998; Pavelka and Knopff, 2004) that live in small groups of 2–10 individuals. Groups are usually comprised of one or more adult males plus one or more adult females and juveniles (Horwich *et al.*, 2001; Ostro *et al.*, 2001). Preliminary reports indicate bisexual dispersal (Brockett *et al.*, 2000a; Pavelka, unpub. data), as seen in other howler monkey species (Crockett and Eisenberg, 1997; Di Fiore and Campbell, 2007), but long-term data on known individuals is not yet available. Despite the highly cohesive nature of howler monkey social groups (Bernstein, 1964; Stevenson *et al.*, 1998), overt social interactions are few. In black howler monkeys, less than 4% of time is typically spent in social interactions such as grooming and hand-holding among adults (Silver *et al.*, 1998; Brockett *et al.*, 2000b; Pavelka and Knopff, 2004; Brockett *et al.*, 2005).

Spacing patterns are important indicators of the underlying social relationships that aid in establishing affiliative contacts, and in avoiding agonistic interactions and predation (Altmann, 1980; White and Chapman, 1994). Kummer (1971: 221) argued that "social affinity and spatial proximity are so highly correlated that the distribution of animals in space can be used as a first reading of their social structure". Female social relationships in black howler monkeys appear to be, like those of other howler monkeys, undifferentiated and egalitarian (Pavelka, unpub. data). Crockett and Eisenberg (1987) have suggested that measures of inter-individual proximity may be one of the few ways to quantify affiliative social relationships within howler monkey groups. In this paper we describe the results of a preliminary study of proximity patterns to help elucidate the nature of within-group social bonds in *A. pigra*.

Methods

This study was conducted at Monkey River in the Toledo district of Belize. The 52 ha study site is located within a 100 km^2 lowland semi-evergreen riparian forest along the river. The area exhibits a distinctive dry season, generally from January to May, and a wet season from June to December. The average annual temperature in the area is 26°C, with an average annual rainfall of approximately 2,460 mm (Pavelka and Knopff, 2004). Over 160 hours of focal animal data were collected on 11 adults and juveniles (infants were not sampled) living in three groups (A, D, and Q). Each of the three groups contained one adult male and two adult females, and group Q also had two juveniles (defined as independent offspring over one year of age). Ten-minute focal animal samples were collected from each group member, with no individual sampled more than once each hour, in order to maintain independence across sample points. The first individuals were sampled opportunistically and on a rotating basis thereafter. Though individuals could not always be reliably identified, we used age-sex class and location relative to other group members to ensure individuals were as equally represented as possible. At the start of each focal animal sample, we conducted a proximity scan to record the age-sex class of each neighbor within 2 m of the focal animal (following the proximity categories established for *A. pigra* [Schneider *et al.*, 1999; Treves *et al.*, 2001], and other howler monkey species such as *A. palliata* [Zucker and Clarke, 1998] and *A. seniculus* [Stevenson *et al.*, 1998]). Each group was followed from dawn to dusk once per week over the wet season study period of July 2003 to January 2004.

From the 960 proximity scans, we calculated proximity scores for dyads using a formula adapted from Matsumura and Okamoto (1997):

$$\textbf{a)}\ \frac{f_A(B) + f_B(A)}{F(A) + F(B)} \times 100 \qquad \textbf{b)}\ \frac{f_A(A)}{F(A)} \times 100$$

Where **a)** F(A) was the total number of proximity scans for a given age-sex class A; F(B) was the total number of proximity scans for a given age-sex class B; f_A (B) was the total number of proximity scans in which B was found within 2 m of A when A was scanned; and f_B (A) was the total number of proximity scans in which A was found within 2 m of B when B was scanned. Although this formula was originally intended for individual dyad analyses, we have adapted it for age-sex classes. Given that there were different numbers of individuals and different numbers of samples for each age-sex class, for dyads with the same age-sex class, we **b)** divided the number of near proximity scans for that dyad by the total number of proximity scans for that focal age-sex class. Dyads with an unknown age-sex class were dropped from this part of the analysis. Proximity data from the three groups were pooled, with the exception of dyads involving juveniles, which were calculated by group, as juveniles were only present in one group. Chi-square tests were used due to the small sample sizes and the categorical nature of the data (Siegel and Castellan Jr., 1988).

Maintenance of proximity was calculated using Hinde's index (Hinde and Atkinson, 1970) for each of the proximity dyads using the frequency of approaches (when one individual approached and settled within one meter of another) and leaves (when one animal moved away from another with whom it had been in one meter proximity) from the focal animal data:

$$\frac{APP_a}{APP_b + APP_a} - \frac{LEA_a}{LEA_b + LEA_a} \times 100$$

Where APP_a was the number of approaches by age-sex class *a* towards age-sex class *b*; APP_b was the number of approaches by age-sex class *b* towards age-sex class *a*; LEA_a was the number of leaves by age-sex class *a* from age-sex class *b*; and LEA_b was the number of leaves by age-sex class *b* from age-sex class *a*. If the percentage was positive, then age-sex class *a* was more responsible than *b* for maintaining proximity, and vice versa if the percentage was negative. Low values of Hinde's index indicated a tendency for individuals in those dyads to be equally responsible for maintenance of proximity.

Results

Confirming the cohesive nature of Central American black howler monkeys, in 70.6% of the 960 proximity scans (divided into 347, 247, and 366 total scans for each group respectively) the focal animal had another individual within 2 m significantly more often than not (29.4%, or 284 scans with no individual within 2 m; $\chi^2 = 611.2$, *df* = 2, $p < 0.001$). Proximity scores were highest for juveniles (80%), followed by adult females (72.5%) and then males (65.8%). Fig. 1 shows the overall proximity scores within and across each age-sex class for each group. Adult females were in close proximity to other adult females as often as they were to adult males. However, analysis of the strength of the adult dyads revealed that females associated with one another more than expected given the availability of congeners in each group ($\chi^2 = 6.24$, *df* = 1, $p = 0.01$). It is possible that the percentage of time adult males spent in close proximity to adult females in each

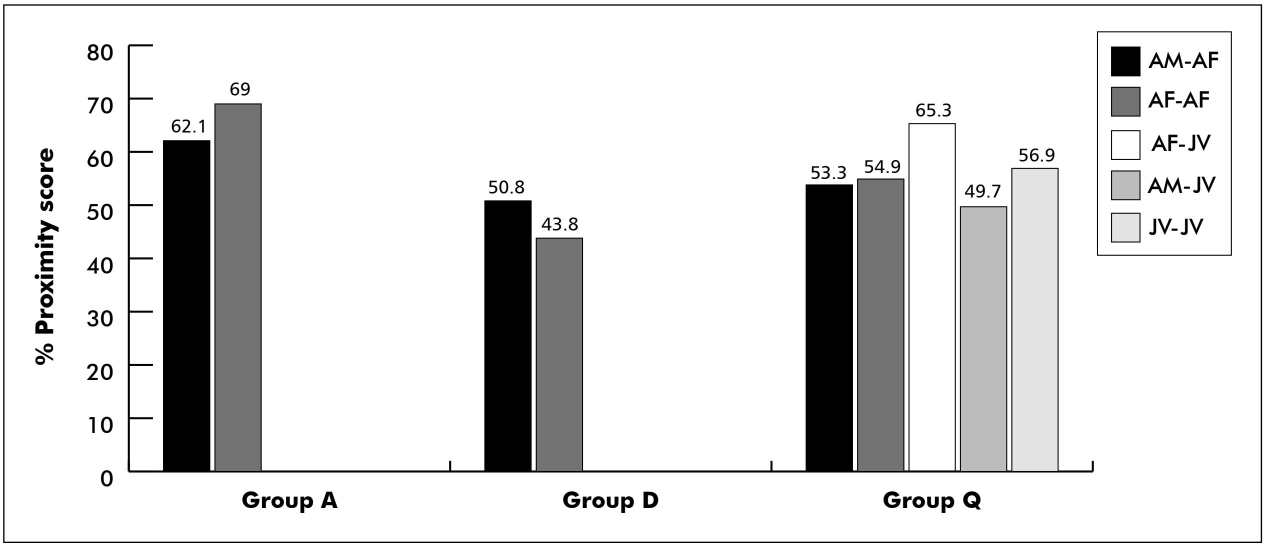

Figure 1. Proximity score by age-sex dyad for each group. AM = adult male; AF = adult female; JV = juvenile.

group was artificially low, given that males could have had both group females in close proximity at once; however, only dyadic interactions were analyzed as part of this study. In the only group with juveniles (group Q), the proximity score for adult females with juveniles was 65.3%, and juveniles were in close proximity to other juveniles in 56.9% of their proximity scans. The least commonly occurring dyad in this group was adult males and juveniles (49.7%).

Maintenance of proximity was calculated to determine which age-sex class was responsible for maintaining the "relationship" within each dyad (Table 1). Between adult females and adult males, females were slightly more responsible for maintaining proximity (5.5%), although the low score suggested fairly even responsibility. Juveniles were 15.3% more responsible for maintaining the spatial relationship with adult females; however, adult males and juveniles appeared to be equally responsible.

Discussion

Despite low levels of conspicuous social interaction and undifferentiated social relationships in *A. pigra*, the proximity data presented here support the overall impression that the groups were nonetheless very cohesive. If spatial proximity is taken as an indication of social affinity, as has been suggested (Kummer, 1971; Altmann, 1980; White and Chapman, 1994), the spacing patterns reported here further revealed variation among age-sex classes in strength of social bonds. Juveniles exhibited a higher degree of affiliation than adults, and females exhibited a higher degree of affiliation than males. Being smaller in size and less experienced than adults, young monkeys may be more vulnerable to predation and might spend more time near other individuals, particularly their mothers, as a result. Proximity patterns and vigilance rates (a measure of predation risk through scanning behavior) have been found to be related in *A. pigra*, with vigilance decreasing as the number of close neighbors increases (Treves *et al.*, 2001). Moreover, juveniles spend more time in social play than adults, increasing the amount of time in close proximity.

Individual adult female proximity scores were higher than those of adult males, as expected given the likely association between adult females and their own juvenile offspring. However, the analysis of the strength of different dyadic combinations revealed a surprising affiliation between adult females. In this study, adult females had equal opportunity to interact with another female or with the adult male. Adult males, conversely, could only associate with adult females. Thus, the finding that the male-female and female-female dyads occurred equally was surprising, with female-female dyads occurring more than would be expected given availability of congeners — and certainly given the bisexual dispersal pattern and unimale groups, which would predict weaker female-female associations than male-female associations.

Further, evidence of seasonal mating appeared to be absent as copulations were not observed. This result has been found in other howler monkey studies, suggesting that the dispersal patterns of female primates may not be a consistent predictor of social bonds, at least as measured by proximity patterns. Wang and Milton (2003) reported that adult male howlers (*A. palliata*) at Barro Colorado Island were most often in close association with adult females, as would be expected for a female-dispersing species; these findings were in contrast to those of Zucker and Clarke (1998) and Kovacovsky (2002), who found *A. palliata* females spent more time in close proximity with one another than expected. Zucker and Clarke (1998) reported that adult dyads varied in frequency and intensity across years and among individuals, and suggested that female bonds were likely influenced by female reproductive status and parity, and by changing memberships of adult males within the groups.

When comparing *A. pigra* with red-tailed monkeys (*Cercopithecus ascanius schmidtii*) and red colobus monkeys (*Procolobus badius tephrosceles*), Treves and Baguma (2002) unexpectedly found that females in the two species with female transfer — black howler monkeys and red colobus monkeys — were significantly more cohesive than the female red-tailed monkeys, who are female-resident. Though kinship was not known in our study, some individuals could have been related, thereby affecting differential proximity. Further, the data on the maintenance of proximity presented here revealed that females were not more responsible for maintaining proximity with adult males than males were with them. Females may derive more benefit from associating with males when in unimale groups, as their groups can be more vulnerable to takeovers by extragroup males (Crockett and Janson, 2000). Not surprisingly, juveniles were more responsible for maintaining

Table 1. Number of approaches and leaves attributed to each age-sex class. AM = adult male; AF = adult female; JV = juvenile; N App = number of approaches over study period; N Lea = number of leaves over study period; H Index = Hinde's index (%).

Age-sex class to which action was attributed	Received AM			Received AF			Received JV		
	N App	N Lea	H Index	N App	N Lea	H Index	N App	N Lea	H Index
AM	–	–	–	88	93	-5.5	35	36	2.6
AF	98	83	5.5	–	–	–	69	112	-15.3
JV	83	97	-2.6	196	159	15.3	–	–	–

proximity to adult females, as they may derive more benefit from close associations with females for predator protection, and to gain social, survival, and maternal skills.

Though infants were not sampled, they were present in each of the three groups at various times through the study period and could conceivably have affected proximity results, particularly among lactating and non-lactating females (see Corewyn, 2005). We caution against broad generalizations given the small sample size in the number of groups, particularly with regard to juvenile proximity, since these data were only representative of one group. We are unable to comment on male-male social relationships in *A. pigra*, and look to future research to address these limitations.

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DENSITY OF *SAGUINUS INUSTUS* (SCHWARTZ, 1951) IN THE INTERFLUVIUM OF THE CAQUETÁ–APAPORIS RIVERS, COLOMBIAN AMAZONIA

Claudia Idaly Castillo-Ayala
Erwin Palacios

Introduction

The Amazon bioregion is considered one of the highest biodiversity areas in the world. Primates are important components of this biodiversity, and with 15 genera, 81 species and 134 taxa, they are the most emblematic faunal group of Amazonia (Mittermeier *et al.*, 2002). *Saguinus* is perhaps the most diverse of Neotropical primate genera, with 13–15 species and 33 recognized forms (Hershkovitz, 1977; Rylands *et al.*, 2000). Defler (2003a) recognizes the presence of six species of *Saguinus* in Colombia (40–46% of the total species in the genus), three of them exclusively distributed in the Colombian Amazon: *S. fuscicollis* (Spix, 1823), *S. nigricollis* (Spix, 1823), and *S. inustus* (Schwartz, 1951). *Saguinus inustus*, the mottled-face tamarin, is distributed in southeastern Colombia, west of the Andes, between the Guayabero-Guaviare rivers and the Caquetá River, and between the Mesay River and the border with Brazil; however, accurate eastern and western boundaries of its geographical range within the country are still unknown (Defler, 2003a). The species is also present in western Brazil, between the Rio Negro and the Colombian border.

Saguinus inustus is one of the least-studied species of Neotropical primates; preliminary information on its ecology (ranging and diet) comes from only two short studies carried out near La Pedrera, at Comeyafú Indigenous Reserve, an interfluvial area between the Caquetá and Apaporis rivers (Palacios *et al.*, 2004; Defler, unpublished data), and from occasional observations of foraging groups in the Amanã Sustainable Development Reserve in Brazil (de Souza *et al.*, 2004). Here we present the first data on the density of *S. inustus*. We collected this information during a primate survey in the lower Caquetá River as part of a larger effort started six years ago to document and monitor the densities of primates and 15 other large vertebrate species in eastern Colombian Amazonia (Palacios *et al.*, 2003; Palacios and Peres, 2005; Peres and Palacios, 2007).

Methods

Study area

Censuses were carried out in the interfluvial area between the lower Caquetá and Apaporis Rivers, Amazonas, near Loma Linda indigenous community (01°16'S, 69°44'W, 101 m a.s.l.; Fig. 1), Córdoba Indigenous Reserve. Primary *terra firme* and várzea forests represented the majority of the forested matrix in the study site. An area of secondary *terra firme* forest (locally called *rastrojo*) located around the indigenous settlement comprised a small proportion of such matrix. There were also patches of what is locally known as savanna forest or *varillal*, which corresponds to primary forest with a mean height of 17–18 m, and a very sparse understory growing on rocky outcrops and white sands; and another savanna type known as *sabana capotuda*, with a mean canopy height of 8 m, deep soil litter and a very dense understory with intermingled vines and lianas.

Linear transects

We used the line transect method (Burnham *et al.*, 1980) to estimate *S. inustus* densities. From a zero point located ca. 100 m away from the community secondary forest area, two transects (4.6 and 4.9 km long, oriented 40° NW and 40° NE respectively) were cut; they were

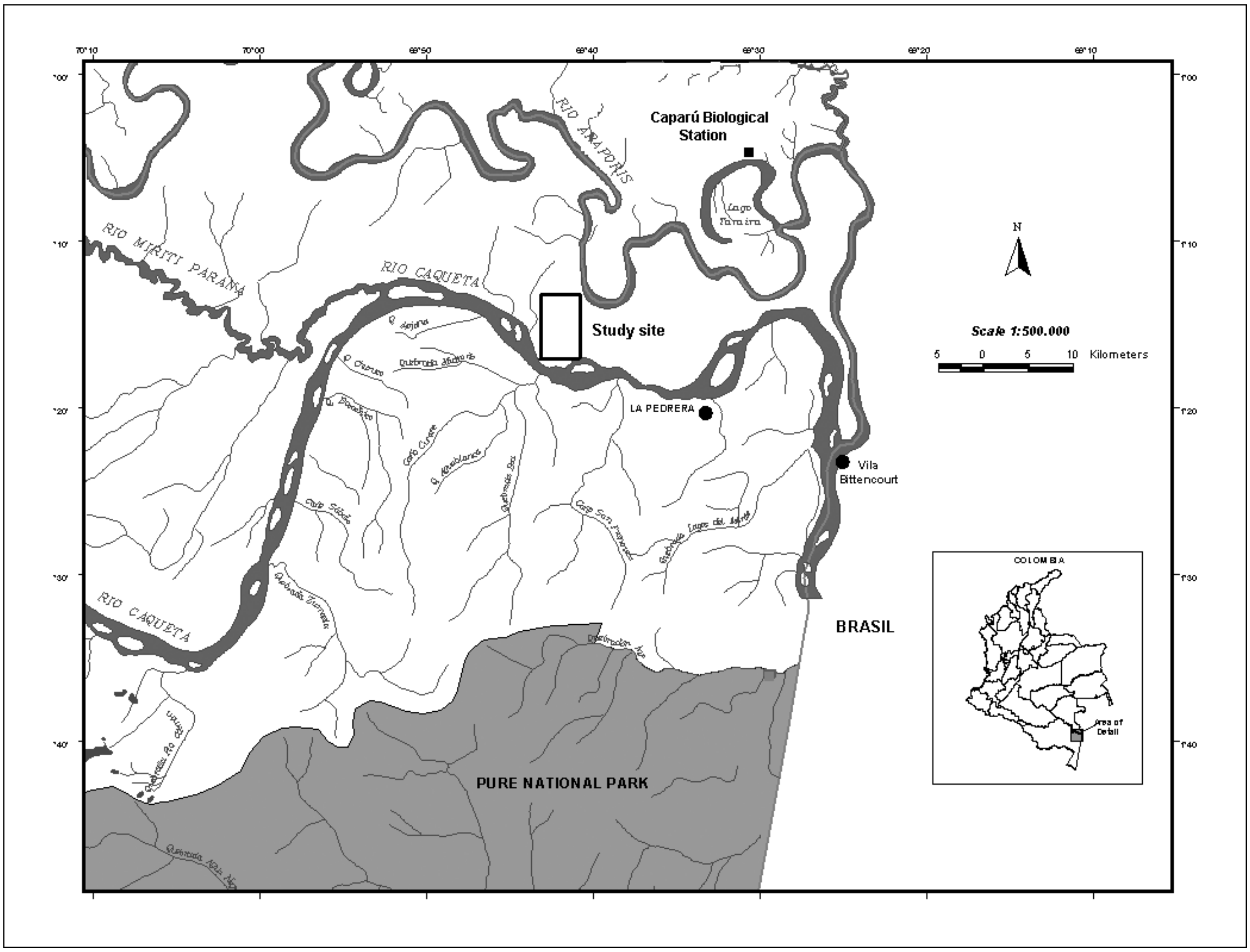

Figure 1. The lower Caquetá region in Eastern Colombian Amazonia. Black square shows the area where censuses were carried out.

marked with flagging tape every 50 m to facilitate accurate location of sightings. Transects were cut a month before we started the censuses, so at the time of the study, local fauna were already habituated to the transect paths. The shortest transect crossed nearly 2 km of *rastrojo*, 1.1 km of *varillal*, and 1.5 km of primary *terra firme* terrace forest. The second transect crossed hilly primary *terra firme* forest with sandy soils in the first half of its length and clay soils in the second, as well as patches of *sabana capotuda*.

Censuses were carried out during 10 days each month between October 2005 and February 2006. Independent observers walked the transects during days without rain at a mean speed of 1.2 km/h, between 0630 and 1130 hrs. Community members previously trained and able to accurately detect and identify local primate species participated in the surveys. Every time we encountered groups of *S. inustus*, we recorded the date, time, number of individuals, perpendicular distance from the transect, distance walked, height and type of forest. After each encounter, a maximum of 15 minutes were spent to obtain accurate counts of groups. Data were analyzed using DISTANCE 5.0 Beta 5 software (Thomas *et al.,* 2005).

Results and Discussion

A total census effort of 380 km was achieved, during which groups of *S. inustus* were sighted 33 times. Six additional primate species are sympatric with *S. inustus* in the lower Caquetá and Apaporis interfluvial area: *Alouatta seniculus*, *Aotus* cf. *vociferans*, *Callicebus torquatus, Cebus albifrons*, *Cebus apella*, and *Saimiri sciureus.* Although the study site is included in the distribution range of *Lagothrix lagothricha*, this species was not recorded during the survey period. People from Loma Linda said they have never seen woolly monkeys in that area, and this is likely to be a consequence of a long history of human settlement and subsistence hunting in the region. *L. lagothricha* has not been recorded recently in the lower interfluvium of the Caquetá and Apaporis Rivers, east of the mouth of the Mirití River (Palacios, pers. obs.), and the species is likely to be locally extinct.

We estimated a *S. inustus* density of 3.8 groups/km^2 and 19.6 individuals/km^2. Mean group size was 5.2 individuals (sd = 1.87). The mottled-face tamarin was one of the primate species most frequently encountered after *C. torquatus* and *S. sciureus* (Castillo-Ayala, in prep.).

Mottled-faced tamarin density at Loma Linda is in the range of that reported for other *Saguinus* species in nine different localities in western Amazonia (Soini, 1981; Freese *et al.*, 1982; Pook and Pook, 1982; Terborgh, 1983; Peres, 1997), but high compared with those reported for *S. fuscicollis* at some sites in eastern Colombian Amazonia (3.4–16.9 individuals/km^2: Palacios *et al.*, 2003; Palacios y Peres, 2005; Palacios, unpublished data). In contrast, *S. fuscicollis* densities in three other sites in eastern Colombian Amazonia (Caño Arapa and Caño Esperanza, Puré National Park, and Caño Curare) were much higher (21.5, 26.5, and 30.3 individuals/km^2 respectively; Palacios, unpubl. data) than those found for *S. inustus* at Loma Linda. Mean group size is in the range recorded for other species of Amazonian *Saguinus*; for example, *S. fuscicollis* showed a group size range of two to eight individuals (Freese, 1975; Soini, 1981; Janson and Terborgh, 1985).

During the first month of censuses, 75% of the *S. inustus* sightings were in secondary forest, while in the second and third months the situation reversed, with 70% and 62.5% of the sightings in primary *terra firme* forest. During the last month of surveys the proportion of sightings of the species was similar for both types of forest (53.8% primary vs. 46.2% secondary). The preference for secondary forest during the first month of surveys may be a result of higher fruit availability of various species of *Inga* in the *rastrojos*. The sweet arils of *Inga* have been noted as one of the most consumed resources by the mottled-face tamarin (Palacios *et al.*, 2004). *S. inustus* may show resource use patterns similar to other species of *Saguinus*; for example, *S. fuscicollis* usually forages on one or a few species of plants during consecutive days until no more fruits are available (Defler, 2003a). This may be the case with *Inga* fruits; other primates such as red howlers also concentrate their foraging efforts in particular *Inga* fruit patches until crops are depleted (Palacios, unpublished data).

Based on occasional observations, Defler (2003a) suggested the possibility that *S. inustus* could be more abundant in secondary forests near indigenous settlements than in primary forests. Snowdon and Soini (1988) reported that some species of *Saguinus*, among them *S. nigricollis*, attain higher densities in secondary forests. Palacios *et al.* (2004) observed the presence of *S. inustus* in both types of forests; Defler (2003a) believes that *S. geoffroyi* may have the same habitat preferences, and that *S. fuscicollis* seems to be the species of *Saguinus* with the more diverse habitat use, as this species uses primary forests as well as highly disturbed ones. *S. inustus* at the Caquetá–Apaporis interfluvium used an approximately equal proportion of primary and secondary forest (51.16% and 48.8% respectively). Fourteen percent of the sightings of *S. inustus* in primary forest corresponded to *sabana capotuda* habitat with characteristics that this species usually prefers; in a different study related to the ecology of the species, *S. inustus* regularly used portions of forest with dense understory (Castillo-Ayala, unpublished data). Furthermore, 85.7% of the encounters with groups of *S. inustus* in secondary forest corresponded to *rastrojo alto* with a very dense understory. These preferences have been reported for other species of *Saguinus*; for example, Emmons and Feer (1999) mention that *S. fuscicollis, S. nigricollis* and *S. bicolor* often can be seen in habitats with high densities of lianas.

This first density estimate of *S. inustus* provides important data, but supplemental information from other areas of the Caquetá–Apaporis interfluvium will be necessary in order to assess the conservation status of the species in this region. The forests around the community of Loma Linda still offer appropriate habitats for the conservation of the species, including secondary forests at different successional stages, and a large proportion of primary forest. The forest matrix in the lower Caquetá and Apaporis interfluvium corresponds mainly to indigenous reserves (Palacios *et al.*, 2004), which support a large indigenous population that is increasing due to high birth and immigration rates. As a consequence, the need for new housing and croplands will continue to increase, transforming significant areas of primary forest. New surveys and ongoing studies on the ecology of the mottled-face tamarin will contribute to a better knowledge of its density in the Caquetá–Apaporis interfluvium, and will provide more data to help determine their forest type preferences, how they cope with habitat transformation, and the conservation strategies that need to be implemented with local communities to preserve this interesting primate.

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NEW OCCURRENCE RECORDS AND EASTERN EXTENSION TO THE RANGE OF *CALLICEBUS CINERASCENS* (PRIMATES, PITHECIIDAE)

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Wilson Roberto Spironello
Dayse Campista Ferreira

Introduction

Spix (1823) first described the ashy black titi monkey (*Callicebus cinerascens*) from a male specimen assumed to have been collected along the Rio Içа near the border with Peru, in the state of Amazonas, Brazil. Van Roosmalen and colleagues (2002) questioned the origin of this specimen, maintaining that as all subsequent records were for the right bank of the Rio Madeira (Rylands, 1982; Hershkovitz, 1990; van Roosmalen *et al.*, 2002), the type locality must be incorrect. During his taxonomic revision of the genus *Callicebus*, Hershkovitz (1990) added three valid localities for *C. cinerascens,* one on the right bank of the Rio Aripuanã, and two on the right bank of the Rio Roosevelt. Rylands (1982) observed the species along the right bank of the Rio Aripuanã, and van Roosmalen *et al.* (2002) included new records from the right banks of the Rios Aripuanã and Madeira and the left banks of the Rios Arara and Canumã.

In their taxonomic revision of the genus *Callicebus*, van Roosmalen *et al.* (2002) predicted that *C. cinerascens* would only extend as far east as the left bank of the Rio Sucundurí. They indicated that possibly *C. hoffmannsi*, or another yet-to-be-described species of titi monkey, would occupy the Rio Canumã interfluve delineated by its tributaries, the Rios Sucundurí and Abacaxis. Hershkovitz (1963, 1988, 1990; in Silva Jr. and Noronha, 2000) suggested that *C. hoffmannsi* extends south of the Rio Paraná do Urariá and along the right bank of the Rio Canumã. These range predictions have yet to be tested, and the exact range of this genus in the interfluve between the Rios Madeira and Tapajós remains unknown (Silva Jr. and Noronha, 2000). The objective of this study is to refine the range map for the ashy black titi monkey, based on the literature and new occurrence records from field surveys.

Materials and Methods

Occurrence data in the present study are based on a literature review and two field excursions. During the first expedition, between January and May of 2001, we surveyed the interfluve between the Rios Madeira and Tapajós, specifically the region of the Rios Maués, Abacaxis and Sucundurí. In the second, in June and July of 2006, we surveyed the interfluve between the Rios Aripuanã and Juruena. This second excursion formed part of the Juruena–Apuí Expedition. During

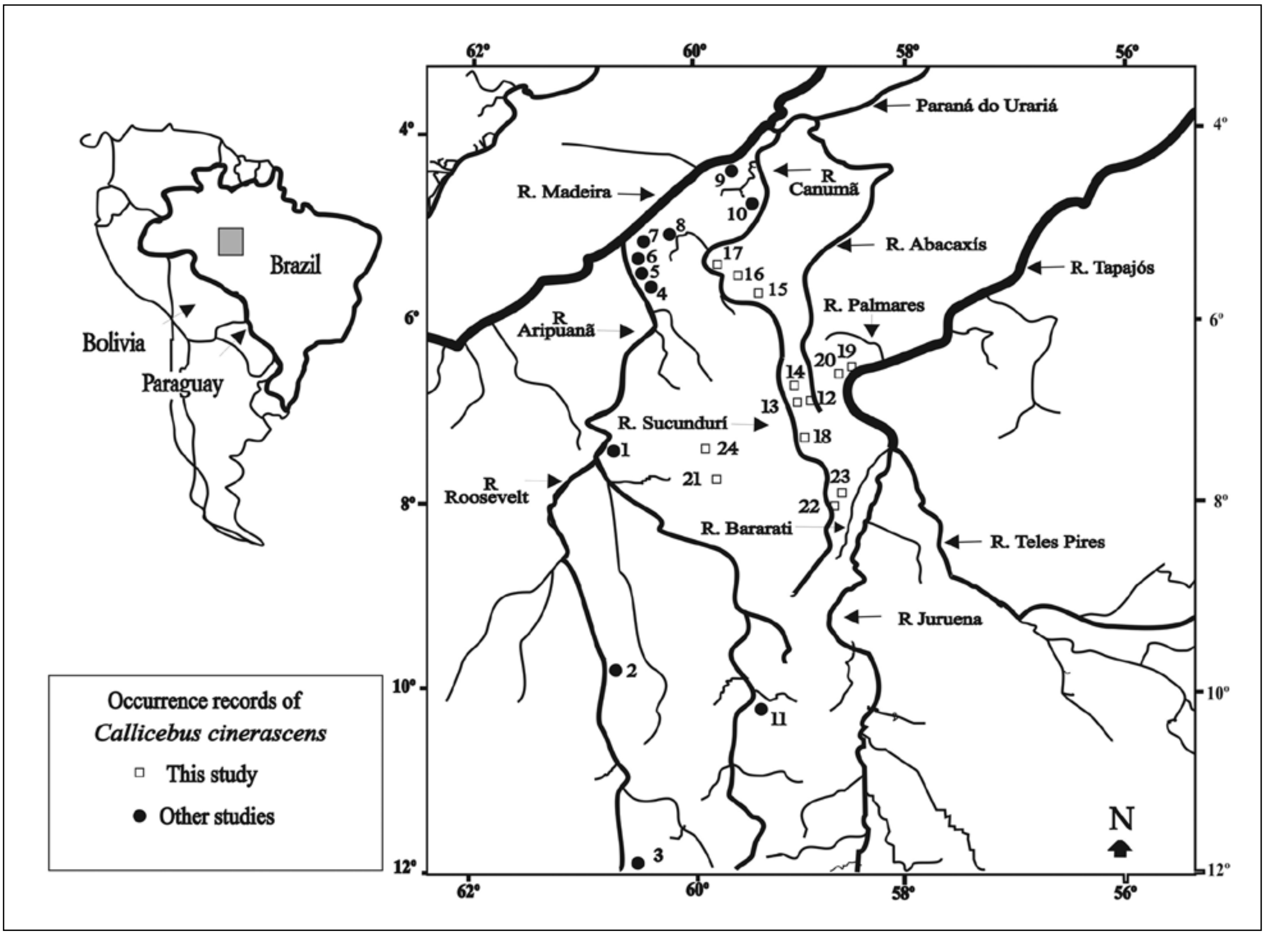

Figure 1. Geographic range of *Callicebus cinerascens,* based on Hershkovitz (1990), Rylands (1982), van Roosmalen *et al.* (2002) and this study: (**1**) Prainha, right bank of the Rio Aripuanã, Amazonas; (**2**) São João and (**3**) Otoho, right bank of the Rio Roosevelt, Mato Grosso; records for the species from the following locations on the right bank of the Rio Aripuanã, Amazonas: (**4**) Cipotuba (05°48'23"S, 60°12'76"W), east bank of Lago Cipotuba; (**5**) Prainha (05°45'S, 60°12'W), Igarapé Prainha; (**6**) São João (05°28'S, 60°22'W), Igarapé Terra Preta; and along the right bank of the Rio Madeira, Amazonas; (**7**) around the town of Novo Aripuanã (05°07'08"S, 60°22'45"W); (**8**) left bank of the Rio Arara (05°12'S, 60°04'W), 40 km east of Novo Aripuanã; (**9**) around the town of Borba (04°22'S, 59°35'W); (**10**) left bank of the Rio Canumã; (**11**) Humboldt Pioneer Nucleus (10°10'S, 59°27'W), on the right bank of the Rio Aripuanã, Mato Grosso; right bank of the Rio Sucundurí, Amazonas; (**12**) BR230 (06°46'S, 59°00'W); (**13**) Vila de Sucundurí (06°48'S, 59°04'W); (**14**) 06°42'S, 59°03'W; (**15**) 05°44'S 59°22'W; (**16**) 05°30'S, 59°28'W; (**17**) 05°25'S, 59°41'W; (**18**) source of Igarapé Surubim (06°53'S, 59°03'W); left bank of the Rio Sucundurí, Amazonas; (**19**) left bank of the Rio Tapajós (06°34'S, 58°24'W); (**20**) left bank of the Rio Tapajós (06°34'S, 58°35'W); (**21**) Vicinal do Coruja (07°38'S, 59°49'W), Floresta Nacional do Jatuarana; (**22**) Serra do Sucundurí (08°50'S, 59°08'W), Floresta Estadual do Sucundurí; (**23**) right bank of the Rio Bararati (08°21'S, 58°37'W), Parque Estadual do Sucundurí; and (**24**) right bank of the Rio Juma (06°42'S, 59°35'W).

these surveys, we identified the ashy black titi monkey using both the diagnostic characters defined by Hershkovitz (1990) and material from the collection at the National Institute of Amazonian Research (INPA 4085).

Results and Discussion

During both trips we observed *C. cinerascens* repeatedly along the banks of the Rios Sucundurí and Abacaxis, close to the left bank of the Rio Tapajós and the right bank of the Rio Bararatí (Fig. 1). All observations were in made in *terra firme*, *campinarana* or secondary forests. Individuals were frequently observed in relatively open areas of young secondary growth, which may indicate a degree of flexibility in habitat use by this species. These new occurrence records extend the eastern limit of *C. cinerascens*' range beyond that proposed by van Roosmalen and colleagues (2002). We now predict that this species' range should extend north to the Rio Paraná do Urariá, east to the left bank of the Rio Abacaxis and the left bank of the upper Rio Tapajós, west as far as the right bank of the Rio Madeira, and south to the corridor formed between the Rios Aripuanã-Roosevelt and Tapajós-Juruena, in the states of Amazonas and Mato Grosso. The most southerly record is Otoho on the right bank of the Rio Roosevelt in Mato Grosso (Fig. 1).

During this study we found no overlap between the range of *C. cinerascens* range and that of any other species of *Callicebus*, suggesting that this species is parapatric with its sister taxa, *C. hoffmannsi*, *C. baptista* and *C. bernhardi*. While interviewing a resident of a community on the left bank of the Rio Tapajós (06°34'S, 58°28'W), near the Rio Palmares in the municipality of Maués, Amazonas State, we discovered that a gray titi monkey with light spots on its throat occurs in the area. It is possible that this is *C. hoffmannsi* (van Roosmalen *et al.*, 2002) and that the Rio Palmares represents the eastern limit for *C. cinerascens* and serves as a point of contact between the two species. In addition to improving the precision of *C. cinerascens*' range, this study also enabled us to determine in which protected areas it occurs. In the state of Amazonas, *C. cinerascens* is present in the Floresta Nacional do Jatuarana (837,100 ha), the Parque Nacional do Juruena (2,002,565 ha), the Floresta Estadual do Sucundurí (492,905 ha), and the Parque Estadual do Sucundurí (808,312 ha). Its range also encompasses the Floresta Estadual de Apuí (185,946 ha), the Reserva de Desenvolvimento Sustentável Bararatí (113,606 ha), the Parque Estadual do Guariba (72,296 ha), the Reserva Extrativista do Guariba (150,465 ha), the Floresta Estadual do Aripuanã (336,040 ha), the Reserva de Desenvolvimento Sustentável do Juma (589,611 ha), the Parque dos Campos Amazônicos (873,570 ha), the Floresta Estadual de Manicoré (83,381 ha) and the Reserva de Desenvolvimento Sustentável Aripuanã (224,291 ha). In Mato Grosso, it is expected to occur in the Reserva Extrativista Guariba Roosevelt (57,630 ha), the Estação Ecológica do Rio Roosevelt (27,860 ha), and the Parque Estadual Igarapés do Juruena (227,800 ha).

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NEW OCCURRENCE RECORDS OF *MICO ACARIENSIS* (PRIMATES, CALLITRICHIDAE)

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The Rio Acari marmoset (*Mico acariensis*) was described by van Roosmalen *et al.* (2000). The holotype was originally being kept as a pet by inhabitants of a small settlement near the Rio Acari, in Central Amazonia, Brazil. A specimen was collected and deposited in the vertebrate collection of the National Institute of Amazonian Research (INPA 3931) (van Roosmalen *et al.,* 2000). The new species was classified in the *Callithrix argentata* group *sensu* Hershkovitz (1977) and Vivo (1988, 1991), and was associated with the bare-eared marmosets *Mico saterei* and *M. melanurus*. Diagnostic characters include bright orange coloration of the lower back, body underparts, legs and tail base (the rest of the tail is black); upper parts are almost all white; the white chest contrasts with a partly black muzzle; the narrow triangular nose patch and ocular rings are black and dark pigmented ears partially covered with white hairs (van Roosmalen *et al.*, 2000). According to van Roosmalen *et al.* (2000), the type locality is a small settlement on the right bank of the lower Rio Acari (05°07'08"S, 60°01'14"W), close to the confluence of the Rios Canumã and Sucundurí in the state of Amazonas, Brazil. Based on distribution patterns of marmosets in the Amazon region, these authors predicted that the species would occupy the entire Acari-Sucundurí interfluvium, probably extending to somewhere between the Rios Aripuanã and Juruena, forming a contact zone with *Mico melanurus*.

During a recent field expedition (Noronha, 2004) to the lower Madeira-Tapajós interfluvium, marmosets with the same diagnostic characters were observed at three locations along the left bank of the Rio Sucundurí. Four groups were observed at the Vila de Sucundurí (06°48'S, 59°04'W), and three specimens were obtained from local inhabitants and deposited in the collection of Museu Paraense Emílio Goeldi (MPEG 36085, 36086, 36087). Other troops were also recorded close to the Igarapé Surubim (06°54'S, 59°03'W) and the Igarapé do Liso (07°17'S, 58°50'W). These new records partially confirm the range proposed by van Roosmalen and colleagues (Fig. 1). Information

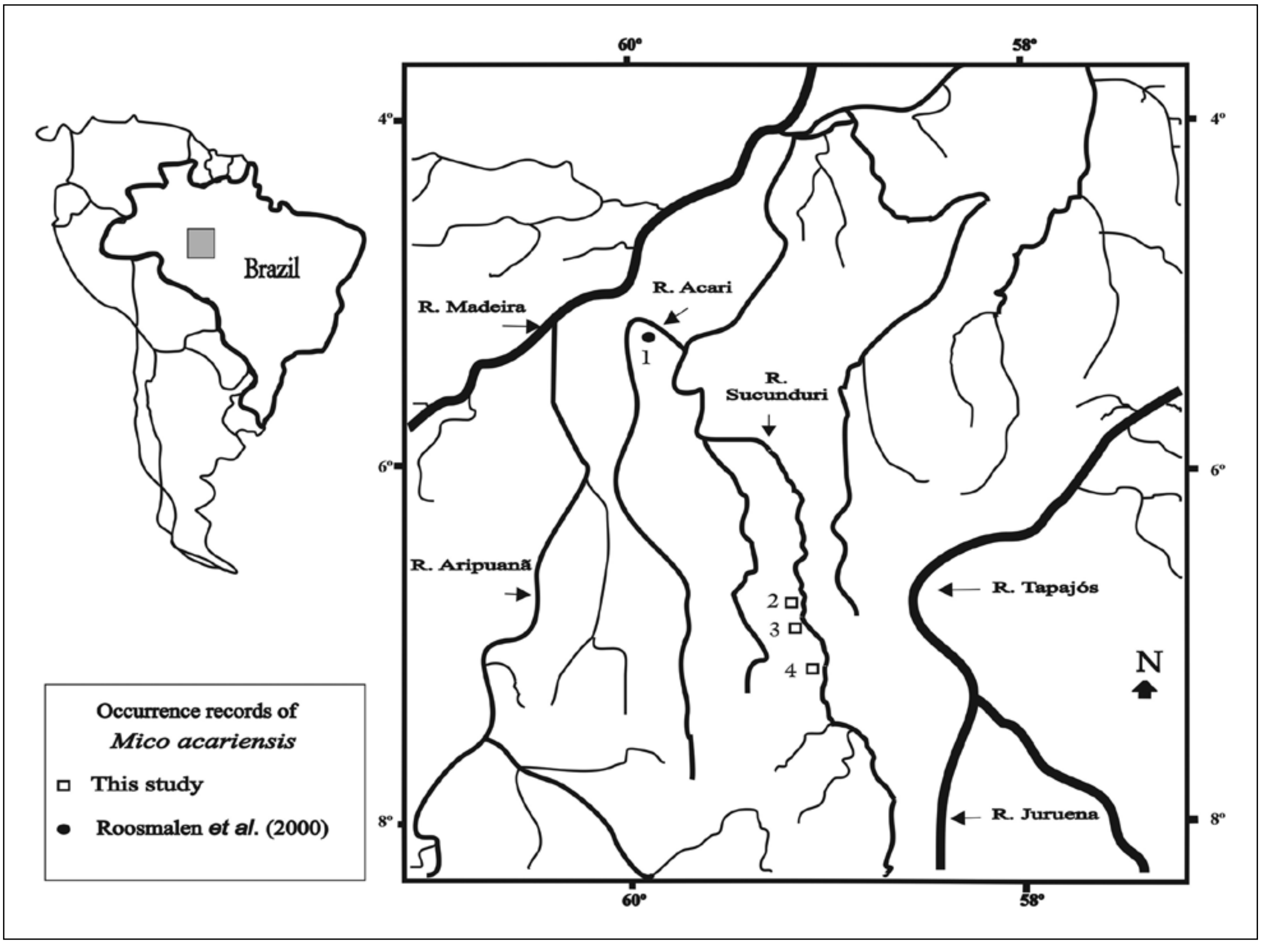

Figure 1. The range of *Mico acariensis* based on van Roosmalen *et al.* (2000) and records from this study: **1.** Type locality; **2.** Vila de Sucundurí; **3.** Rio Sucundurí, at the mouth of the Igarapé Surubim and **4.** Igarapé do Liso.

obtained during interviews with the ex-inhabitants of an abandoned village near the Igarapé do Urucú (a left affluent of the Rio Sucundurí, along the Serra do Sucundurí) indicates that *M. acariensis* and another species of marmoset with blackish hairs occur in the area. As *M. melanurus* has been confirmed as occurring in the Sucundurí Mountains (Noronha, unpubl. data), it is possible that these species are sympatric in this region.

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SLEEP PARAMETERS IN CAPTIVE FEMALE OWL MONKEY (*AOTUS*) HYBRIDS

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Introduction

In the 1970s and 1980s, captive breeding of owl monkeys began in countries such as the United States of America (Cicmanec and Campbell, 1977; Weller *et al.*, 1991; Malaga *et al.*, 1997), Peru (Gozalo and Montoya, 1990) and Germany (Rappold and Erkert, 1994). In 1977, a comparatively smaller owl monkey colony was established in Japan, at the Primate Research Institute facility of Kyoto University, with founding members originating from Bolivia. Unfortunately, at that time, the production of hybrids occurred due to inadvertent pairing of different owl monkey species before the existence of multiple *Aotus* species had been determined (Hershkovitz, 1983; Ford, 1994; Groves, 2001). Extreme chromosomal diversity with diploid counts ranging from 46 to 56 is one distinguishing feature of owl monkeys, apart from their nocturnality (Ma *et al.*, 1977; Yunis *et al.*, 1977; Reumer and de Boer, 1980; Simpson and Jones, 1982). Previous studies on owl monkey hybrids suggest that while the adult female hybrid monkeys may sometimes conceive — although at lower rates compared to normal individuals — adult male hybrid owl monkeys are most probably sterile (Ma *et al.*, 1977; Yunis *et al.*, 1977; Reumer and de Boer, 1980; Simpson and Jones, 1982).

Rigorous sleep quantification data exist for less than 10% of extant primate species (Campbell and Tobler, 1984). Since owl monkeys (1) are unique among platyrrhines for their nocturnal behavior, (2) are notable for their strictly arboreal habitat, and (3) use holes and platforms in lodge trees as their sleep sites, sleep quantification in the wild has remained a virtually impossible challenge. Under captive conditions owl monkey sleep has been recorded previously for *A. trivirgatus* (Perachio, 1971) and *A. azarae* (Sri Kantha and Suzuki, 2006; Suzuki and Sri Kantha, 2006). The objective of this study was to quantify the parameters for sleeping behavior activity among captive-born owl monkey hybrids.

Methods

Four female owl monkey hybrid siblings (age range 11–16 yrs; weight range 1.016–1.163 kg) and three female owl monkey purebreds, including a mother and two of her progeny (age range 6–16 years; weight range 1.050–1.079 kg) reared at Kyoto University's Primate Research Institute (PRI), were the subjects of this study. The founding members of the owl monkey colony, born in the mid-1970s, originated from Bolivia. These seven monkeys were housed in individual stainless steel cages (100 × 70 × 60 cm). The *Aotus* colony room was maintained on a shifted, alternating 12 hr light (2300–1100 hrs: 200 lux): 12 hr dark (1100–2300 hrs: 0.01– 0.5 lux) cycle. Lighting conditions of the room were routinely checked by an illuminance meter (TopCon IM-5, Tokyo). Food and water were available to the monkeys *ad libitum*, and the commercial pellet diet for New World monkeys (25.1 g protein and 10.6 g lipid/100 g diet) was supplemented daily with fresh fruits and twice-weekly with mealworms. All experiments were carried out with approval from the Research Committee of the Institute, and according to the Primate Research Institute's Guidelines for the Care and Use of Laboratory Primates.

Quantification of the monkeys' sleep behavior activity was carried out by actigraphy (Actiwatch AW-64, Mini Mitter Co., Bend, Oregon, USA) for 12 consecutive days, as described previously (Sri Kantha and Suzuki, 2006; Suzuki and Sri Kantha, 2006). In brief, the following definitions were applied as per the Actiwatch manufacturer's instructions: (1) Activity count: an instrument-specific arbitrary unit (AU) quantifying primate activity, computed from any omni-directional motion made by the caged monkey. Though this count is not suitable for determining the absolute activity of the monkey in concrete terms, it is helpful in evaluating comparative activity patterns among the monkeys wearing the Actiwatches from the same commercial supplier. (2) Total sleep time (TST): the cumulative count of time, as measured in minutes in a continuous 24-hour circadian cycle, that was recorded as sleep. As per the algorithm used in the instrument, based on a one-minute sampling epoch, activity counts of 0.40 were recorded as a wake epoch, and activity counts below this threshold were recorded as a sleep epoch. (3) Sleep episode length (SEL): the mean length of blocks of continuous sleep, measured in minutes, falling between two waking bouts, in a 12 h light phase of the 24 h circadian cycle.

The weight of the Actiwatch was only 17 g (approximately one-sixtieth of an owl monkey's body weight) and there were few if any signs of discomfort due to its presence around the monkey's neck. Karyotype analysis was performed as previously reported by Hirai and colleagues (1998). Data were analyzed by a two-tailed Student's *t*-test for independent means for any significant differences. Statistical computations were performed using STATISTICA software (StatSoft, Inc., Oklahoma, USA).

Results

The female parent of these sibling monkeys belonged to *A. azarae* type (2n = 50), and the male parent was of unknown lineage (2n = 53). The karyotype maps of the now-deceased male parent A14 (2n = 53) have already been published (Nagao *et al.*, 2005). Based on the varying karyotype profiles (with diploid numbers 51, 52 and 53) in four of the monkeys in our study and the affiliated taxon data available for owl monkeys (Ford, 1994), these first-generation captive-bred females were confirmed as *Aotus* hybrids. Among these four hybrid females, A40 was an outlier, since karyotype analysis demonstrated that this monkey carried a trisomic condition for its X-chromosomes (data not shown). Though this monkey remains healthy, certain behavioral and physiological differences from the other group members were observed, such as excessive tear formation in the eyes and agitated vocalizations.

Quantified sleep behavior activity data for each of the four *Aotus* hybrids, for 12 consecutive days, are presented in Table 1. Due to its trisomic condition for X-chromosomes, the *Aotus* hybrid 40 monkey's activity-behavioral sleep parameters are of some interest. We recorded the lowest daily activity amount in this trisomic monkey (103 ± 34 AU) and the shortest SEL/12 h light phase (13 ± 5 min) compared to the other three non-trisomic hybrid monkeys, indicating that it may be partially suffering from lethargy and discontinuous sleep phases. The mean SEL of the trisomic hybrid monkey significantly differs from the mean SEL (27 ± 13 min) of non-trisomic hybrid monkeys ($p < 0.01$). Table 2 provides a statistical comparison of group mean variation in behavioral sleep parameters for non-trisomic hybrid and purebred monkeys. Both the TST/24 h and SEL/12 h light phase differed significantly ($p < 0.01$)

Table 1. Measured behavioral sleep-activity parameters in the hybrid owl monkey subjects[1].

Owl Monkey	Behavioral Sleep		Activity
ID number[1] and sex	TST/24 h[2] (min)	SEL/12 h light phase[3] (min)	Mean Activity Counts (arbitrary units)
Non-trisomic			
37 ♀	618 ± 187	23 ± 8	159 ± 108
39 ♀	829 ± 92	40 ± 12	133 ± 49
41 ♀	734 ± 64	18 ± 5	121 ± 49
Trisomic			
40 ♀	730 ± 196	13 ± 5	103 ± 34

[1] Owl monkeys 37, 39, 40 and 41 are siblings, born to wild-born parents of the founder colony.

[2] Total Sleep Time; based on 12 consecutive days of data acquisition.

[3] Sleep Episode Length, determined during the monkey's quiescent (light) phase.

Table 2. Comparison of group mean variation in behavioral sleep parameters for owl monkey non-trisomic hybrids and purebreds.

Parameter	Owl Monkeys[b]		*t*-test (p)
	Non-trisomic Hybrids	Purebreds	
n	3	3	
age range (yr)	11–16	6–16	
TST/24 h (min)[a]	727 ± 150	591 ± 82	< 0.01, df = 70
SEL/12 h light phase (min)[a]	27 ± 13	51 ± 36	< 0.01, df = 70

[a] Mean ± SD.
[b] All monkeys are females.

between the two groups, with the hybrid individuals registering a higher TST/24 h and a shorter SEL compared to the pure breds.

Discussion

One of the females in our study (ID number 40) carries an X chromosome trisomy, detected from karyotype analysis. In the absence of published information on the sleep profiles of *Aotus* hybrids, or trisomic *Aotus*, the marked variation in SEL obtained for the trisomic *Aotus* hybrid monkey is a novel finding. Studies on trisomy among nonhuman primates have been understandably meager, partly due to a very low survival rate of individuals with chromosomal anomalies (Ruppenthal *et al.*, 2004). Nevertheless, the prevalence of significant sleep disturbances among humans suffering from autosomal trisomic conditions (Ellingson and Peters, 1980; Shaffer *et al.*, 1996; Ruppenthal *et al.*, 2004; Segel *et al.*, 2006) provide some clue to the unusually varied behavioral sleep profile recorded for this trisomic *Aotus* hybrid monkey. To conclude, we report significant differences in the TST and SEL parameters between the purebred owl monkeys and the non-trisomic hybrid owl monkeys. In addition, similar to trisomic humans who suffer from sleep irregularities, the SEL and activity data obtained in a trisomic hybrid owl monkey provide indirect evidence to its behavioral irregularity in comparison to non-trisomic hybrid owl monkeys.

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Further Information on Neotropical Monkeys Reported in the XVI$^{\text{TH}}$ Century: Part 2

Bernardo Urbani

This article presents new evidence on the manner in which Neotropical primates were perceived in the 16th century (after Urbani, 1999, 2004). It includes several aesthetic and artistic views of New World primates from the early Contact period. The *Florentine Codex* contains the first illustration of human / non-human primate interactions from the New World. Between 1540 and 1585, Friar Bernardino de Sahagún wrote a compendium of 12 books in Nahuatl, Latin and Spanish and illustrated these volumes with the cooperation of local assistants of Aztec descent. This work was the result of interviews with people of Tlatecolco, Tenochtitlán and Texcoco (today, the greater Mexico City metropolitan area). This text is considered one of the major illustrated treatises of the contact period in the New World. A drawing in Book 11 depicts a scene entitled *Captura de monos* ("capturing monkeys"; see Fig. 1). It is a representation of monkeys being lured and captured (Sahagún, 1963). The physical appearance of the primates illustrated suggests they might be spider monkeys (*Ateles geoffroyi*). As described in a previous report (Urbani, 1999), Sahagún indicated in 1555 that the Mexican Amerindians would use monkeys' hands as omens for deciding when to sell their merchandise.

The other representations include early European paintings in which monkeys occupy a principal position posing with nobles. These suggest that Neotropical primates played an interesting role as preferred and "exotic" pets even during the early Contact period. The earliest painting is of Prince Edward of Wales with a marmoset, possibly *Callithrix jacchus* (Fig. 2a; Zuckerman, 1998). It was painted by the German Renaissance artist Hans Holbein (1497–1543), living at that time in Basel, Switzerland. The monkey might have been obtained by some of the English travelers that visited the northeastern part of South America during the 16th century (see Ribeiro and Araujo Moreira Neto, 1992). In Fig. 2b, the painting depicts the *Infanta* Isabela Clara Eugenia (1566–1633), daughter of Felipe II and Isabel de Valois, with a common marmoset (*Callithrix jacchus*) (Zuckerman, 1998). This painting by the Spanish Renaissance painter Alonso Sánchez Coello (1531–1588) is the most realistic pictorial representation of any Neotropical primate during the 16th century (see other figures in Urbani 1999, 2004, this study). These early European paintings (Figs. 2a and 2b) suggest the existence of an early international network of primate trade; the geographical distribution of these marmosets was a Portuguese territory in the New World (today northeastern Brazil), out of the colonial range of Spain and England.

Finally, Lucas Hombolte (1494–1544) painted a portrait of Catarina de Aragón y Castilla (1509–1533) of Spain with a capuchin monkey (Fig. 2c; Zuckerman, 1998; Fragaszy *et al.*, 2004). It is neither a tufted capuchin nor a white-faced capuchin, but may be either *Cebus albifrons* or *Cebus olivaceus*. Venezuela was the first Spanish territory to be

Figure 1. Obtaining monkeys by the Mexican Amerindians.

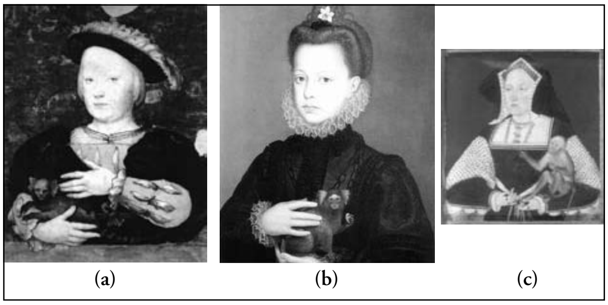
(a) (b) (c)

Figure 2. **(a)** Prince Edward of Wales with a marmoset; **(b)** The *Infanta* Isabela Clara Eugenia and a common marmoset; **(c)** Catalina de Aragón y Castilla with a capuchin monkey.

explored, between 1500 and 1535, and so this brown untufted capuchin monkey species is most likely *C. olivaceus*. Finally, it is interesting to note that Catalina de Aragón y Castilla was married to Prince Arthur of Wales; therefore it is feasible to suggest that among the members of the Tudor dynasty of England there was particular interest in primates as pets.

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NEWS

CONSERVATION EFFORTS FOR PERUVIAN PRIMATES

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Peru is amongst the countries with the highest biodiversity of primates in the world (Cowlishaw and Dumbar, 2001). While the exact number of species is still uncertain, at least 36 species are recognized now, with at least three endemic species (V. Pacheco, pers. comm.). The number of primate species is likely to increase further as new species are recognized and described or with changes in taxonomic arrangements. However, the exact geographic distribution and aspects of the biology of most Peruvian primates remains poorly known or even unknown (Aquino and Encarnación, 1994). This lack of knowledge within scientific circles is matched by a low degree of public awareness of local primates, even when they inhabit forests surrounding human settlements. Surveys conducted in towns within the distribution of Peru's endemic primates showed that if local people are aware of the presence of primates, they usually know them as "chimpanzees," "gorillas" or just "monkeys" (Shanee, unpubl. data).

There is an urgent need to save the endemic primates of Peru and their habitats due to the great extinction risk they face. Cities and communities within the habitat of many of Peru's endemic and endangered species are also the areas where poverty, deforestation, unsustainable land use and immigration are highest (Elgegren, 2005) which is the main reasons for the rapid decline of primate populations in these areas (Leo Luna, 1984). At present, the main cause of the present conservation problem is the lack of education for creating conservation awareness (Pacheco, 2002).

As a response to this problem, the Peruvian-based NGO Yunkawasi, together with the support of Neotropical Primate Conservation, the Peruvian National Institute of Natural Resources (INRENA) and the Ministry of Education of Peru, has started the program "Environmental Education for the Conservation of Peruvian Primates," using the Critically Endangered yellow-tailed woolly monkey (*Oreonax flavicauda*) as the flagship species. *O. flavicauda* is endemic to the northeastern Peruvian tropical Andes (Mittermeier *et al.*, 1975; Macedo *et al.*, 1979; Groves, 2001) and is recognized as one of the World's 25 Most Endangered Primates (Mittermeier *et al.*, 2007). This program aims to increase people's awareness of conservation issues, to promote knowledge and understanding of the primates of Peru, with emphasis on the endemic primate species and the threats they face. It has already been launched in Lima, Peru's capital, and in the next months it will be implemented in cities within the ranges of many Peruvian primates. Since education campaigns are fundamental in any conservation effort (Defler *et al.*, 2003), this environmental education program is also complementary to the ongoing project "La Esperanza — Community Conservation and Research for the Yellow-Tailed Woolly Monkey *Oreonax flavicauda*," carried out by Neotropical Primate Conservation and the Museo de Historia Natural of the Universidad Nacional Mayor de San Marcos. This program aims at establishing a community-run reserve connecting two existing protected areas to create a biological corridor for both *O. flavicauda* and another endemic, the night monkey *Aotus miconax*. Even though both of these conservation efforts are necessary and timely for helping to change the situation faced by many Peruvian primates, they are not enough and many more programs like this are needed. For more information visit <http://www.neoprimate.org>.

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NEOTROPICAL PRIMATE CONSERVATION

We are pleased to announce the creation of a new charitable organisation dedicated to the conservation of primates from the neotropics. Neotropical Primate Conservation (NPC) aims to work through a combination of scientific research, sustainable development, habitat protection and restoration, creation of public awareness, environmental education, and facilitation of the commercialisation of sustainable, ecological products on behalf of local people. NPC's first project is an integrated conservation project for the yellow tailed woolly monkey in Peru. We are also working to end the bush meat and illegal wildlife trade through local and international ad campaigns. To find out more, please visit us at <http://www.neoprimate.org>.

WILDLIFE BIOLOGY IN PRACTICE

José Vítor Vingada, Editor in Chief

"Wildlife Biology in Practice" is an Open-Access International Journal edited by the Portuguese Wildlife Society, and it is dedicated to wildlife research. The journal publishes research papers, review papers, discussion papers, methodological papers, technical notes, clinical case reports and short communications, with topics ranging from all aspects of wildlife care to administration, fundraising, education programs, case studies, environmental issues, legalities, ethics and more. The journal seeks papers that are novel, integrative and written in a way that is accessible to a wide audience that includes an array of disciplines from the natural sciences, social sciences and the humanities concerned with Wildlife Biology.

REGIONAL ENVIRONMENTAL ENRICHMENT CONFERENCES: IPS 2008 PRE-TRAINING WORKSHOP

The topic of the workshop is *improving captive primates welfare through good husbandry.* This workshop aims to proactively promote the welfare of captive primates by providing employees from habitat country zoos and/or sanctuaries with the knowledge, skills, motivation and management skills to implement BH in their home institutions. It wil be held from July 30th to August 3rd at Edinburg Zoo. For more details go to: <http://www.reec.info/IPS2008.htm>.

PRIMATOLOGY FILM COMPETITION

A Primatology Film Competition is to be held to judge the best films/videos made in the area of primatology produced from 1997 up to present. The winning productions will be screened at the Congress of the International Primatological Society in Edinburgh, Scotland, August 3–8, 2008. There will be two categories: (1) professionally made, with budget above $30,000, and (2) independent productions that cost less than $30,000. There will be preliminary screenings and judging and the five best entries in each category will be screened in Edinburgh. Monetary prizes will be awarded to the top entries in the non-professional category, and appropriate certificates from the IPS will be awarded the winners in the professional category. The deadline for receiving entries is January 31, 2008. For further information see the Congress website: <http://www.ips2008.co.uk/FilmCompetition.html> or contact Charles Weisbard at: <cw2359@columbia.edu>.

HORWICH EARNS FIRST WNPRC JACOBSEN CONSERVATION AWARD

Jordana Lenon

Robert Horwich, Director of Community Conservation, a nonprofit primate conservation organization, is the first recipient of the Lawrence Jacobsen Conservation Research Award. This award from the Wisconsin National Primate Research Center supports studies in applied conservation biology that protect non-human primate species and their habitats. The award will benefit Dr. Horwich's ongoing work to conserve the golden langur (*Trachypithecus geei*) in India. The Golden Langur Conservation Project is a holistic project that blends conservation, research, education, economic development and community development. Horwich will use the award to step up conservation and evaluation efforts at one focal area, the Kakoijana Reserve Forest. He and project participants, including national forest members and villagers from adjacent communities, plan to measure changes in reforestation, the increase in golden langurs, and changes in economic development within 10 communities surrounding Kakoijana. "Thus, through this project, we will use Kakoijana as a model to determine the effectiveness of the conservation effort," Horwich said.

THE WORLD'S 25 MOST ENDANGERED PRIMATES

Humankind's closest living relatives — the world's apes, monkeys, lemurs and other primates — are under unprecedented threat, with 29 percent of all species in danger of going extinct, according to a new report by the Primate Specialist Group of IUCN and the International Primatological Society (IPS), in collaboration with Conservation International. The World's 25 Most Endangered Primates list, compiled at the 21st Congress of the International Primatological Society in Entebbe, Uganda, shows that eight of the primates on the latest list, including the Sumatran orangutan of Indonesia and the Cross River gorilla of Cameroon and Nigeria, also appeared on the previous three lists (2000, 2002, 2004). Six other species are on the list for the first time, including a recently discovered Indonesian tarsier that has yet to be formally named.By region, the list includes 11 species from Asia, seven from Africa, four from Madagascar, and three from South America, showing that non-human primates are threatened wherever they live. The full report is published in *Primate Conservation* 22, available at <http://www.primate-sg.org/pc.htm>.

NEW CACAJAO SPECIES

A uakari monkey living in north-western Amazonia, it belongs to a species unknown to science until recently but is now named *Cacajao ayresii* in honour of Brazilian biologist Marcio Ayres, who pioneered field studies on uakaris. Uakaris are traditionally associated with flooded forests on the margins of lowland rivers, but *Cacajao ayresii* turned up in a mountainous area of the Pico de Neblina region on the border between Brazil and Venezuela, a long way from its relatives of the *Cacajao* genre. The new species has a very restricted distribution, and since it lives outside any protected area and is hunted by local people, it should immediately be considered endangered. The complete article has been published in the National Geographic News at <http://news.nationalgeographic.com/news/2008/02/080204-new-monkey.html>.

CONSERVATION ENDOWMENT FUND — REQUEST FOR PROPOSALS

The Conservation Endowment Fund (CEF) supports the cooperative conservation-related scientific and educational initiatives of AZA and its member institutions. Every major type of conservation and animal care initiative is represented — research, field conservation, education, animal welfare, animal health and captive breeding. The 2008 application is now available on the AZA website at <http://www.aza.org/ConScience/WhatIsCEF/>. Proposals are due on 4 April 2008.

RECENT PUBLICATIONS

BOOKS

The Evolution of Mind: Fundamental Questions and Controversies, by Steven W. Gangestad. 2007. The Guilford Press. 448 pp. ISBN: 978-1593854089. In the past two decades, an explosion of research has generated many compelling insights, as well as hotly debated controversies, about the evolutionary bases of human nature. This volume brings together leading proponents of different theoretical and methodological perspectives to provide a balanced look at 12 key questions at the core of the field today. In 43 concise, accessible chapters, followed by an integrative conclusion, the contributors present viewpoints informed by human behavioral ecology, evolutionary psychology, and gene-culture coevolutionary approaches. Topics include the strengths and limitations of different methodologies; metatheoretical issues; and debates concerning the evolution of the human brain, intellectual abilities, culture, and sexual behavior. *Content sample:* 9. What nonhuman primates can and can't teach us about the evolution of mind – C. B. Standford; 10. Who lived in the environment of evolutionary adaptedness? – J. B. Silk; 11. Chimpanzee and human intelligence: life history, diet and the mind – J. B. Lancaster and H. S. Kaplan; 12. Optimality approaches and evolutionary psychology: a call for synthesis – H. S. Kaplan and S. W. Gangestad; 13. The games people play – P. DeScioli and R. Kurzban; 17. The developmental dynamics of adaptation – H. Honeycutt and R. Lickliter; 18. An alternative evolutionary Psychology? – K. Sterelny; 22. The role of group selection in human psychological evolution – D. S. Wilson; 24. On detecting the footprints of multilevel selection in humans – R. Kurzban and C. A. Aktipis; 25. The hominid entry into the cognitive niche – H. C. Barrett, L. Cosmides and J. Tooby; 41. The evolutions of human mating strategies: consequences for conflict and cooperation – D. M. Buss; 42. Social structural origins of sex differences in human mating – W. Wood and A. H. Eagly; 43. The evolutions of women's estrus, extended sexuality, and concealed ovulation, and their implications for human sexuality research – R. Thornhill.

The Future of the Wild: Radical Conservation for a Crowded World, by Jonathan S. Adams. 2007. Beacon Press. 267 pp. ISBN: 978-0807085370. With appropriate urgency and a thorough understanding of history and the issues, Jonathan Adams offers a sound conservation strategy in The Future of the Wild, using the latest in conservation science as well as the desires of local communities to protect the places where people live and work. With modern examples, Adams shows how each small success moves conservationists closer to creating protected landscapes large enough to support animals like bison and wolves. Only with freedom to roam through and between these huge lands, using wilderness corridors, can such large animals flourish. *Content:* Part I. Thinking Big: 1. A Parliament of owls; 2. Do big things run the world?; 3. Save some of everything; Part II. Science and Community: 4. Conservation in exurbia: Florida and California; 5. Appointment in Sonora; 6. The native home of hope; 7. Save enough to last: Florida and everglades; Part III. Yellowstone and the best hope of Earth: 8. Blind men and elephants; 9. Guarding the golden goose.

Why Conservation is Failing and How It Can Regain Ground, by Eric T.Freyfogle. 2006. Yale University Press. 320 pp. ISBN: 978-0300110401.Critics of environmental laws complain that such rules often burden people unequally, restrict individual liberty, and undercut private property rights. In formulating responses to these criticisms, the conservation effort has stumbled badly. Freyfogle explores why the conservation movement has responded ineffectually to the many cultural and economic criticisms leveled against it. He addresses the meaning of good land use, describes the many shortcomings of "sustainability," and outlines six key tasks that the cause must address. Among these is the crafting of an overall goal and a vision of responsible private ownership. The book concludes with a stirring message that situates conservation within America's story of itself and with an extensive annotated bibliography of conservation's most valuable voices and texts — important information for readers prepared to take conservation more seriously. *Content:* 1. The Four Faces of Resistance; 2. Five Paths and Their Values; 3. The Lure of the Garden; 4. Back to Sustainability; 5. What is Good Land Use?; 6. Conservation's Core Tasks, A conservation message to the American people, Conservation's central Readings: A bibliographic essay.

Protected Areas and International Environmental Law, by Alexander Gillespie. 2007. Brill. 318 pp. ISBN: 978-9004161580. This volume seeks to provide the reader with a clear understanding to the way that protected areas are created, listed and managed in international law. In doing so, it provides a complete overview of the primary international and regional conventions in this area, and the decisions and resolutions that have come from them. In doing so, it provides a comprehensive examination of, inter alia, the World Heritage Convention, the Man and the Biosphere regime, the Ramsar (Wetlands) Treaty, and the Convention on Migratory Species. It also deals extensively with the important regional conventions in this area, covering Europe, Africa and the Americas. The regimes governing international maritime protected areas, and Antarctica, are also dealt with. In each area, the values, selection considerations, management, and compliance considerations are examined in detail and linked into recognizable examples from well known protected sites of international significance. *Content:* 1. The History and Scope of Protected Areas; 2. Definitions; 3. Values; 4. Obligations and Gaps; 5. Management; 6. Local Populations; 7. Threats; 8. Compliance; 9. Financial Assistance, Communication, Constituents and Final Issues; 10. Conclusion.

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Book Reviews

Amazonia Through the Eyes, Haral Sioli — A Pioneer of Tropical Ecology Research

Review of: Gelebtes, geliebtes Amazonien – Forschungsreisen im brasilianischen Regenwald zwischen 1940 und 1962, by Harald Sioli (edited by Gerd Kohlhepp), 2007. München, Verlag Dr. Friedrich Pfeil. ISBN: 978-3-89937-071-3. 228 pages, 2 colour figures, 61 b/w-figures, 1 expedition map. Price: 38.00 EURO <http://www.pfeil-verlag.de/df1.html>.

Eckhard W. Heymann

Ecological research in Amazonia is inseparably linked to the name of Harald Sioli. He is one of the pioneers, if not *the* pioneer of the systematic study of Amazonian ecosystems in the 20th century. Trained as a zoologist, botanist and limnologist at the University of Kiel in Germany, he first participated in an expedition to Brazil in 1934–35. When he returned to Brazil in 1938, he became stuck there by the outbreak of World War II and could not return to Germany. Starting in 1940, he spent the next 16 years with ecological research in Amazonia. Sioli returned to Germany in 1957 to become a director of the Hydrobiologische Anstalt in Plön, which was later renamed as Max-Planck Institute for Limnological Research, one of the mayor nuclei for tropical ecology research in Germany. Sioli continued to do research in Amazonia as a director of this institute, and much of today's research in Brazilian Amazonia is based on his pioneering work. Apart from numerous scientific publications, Sioli also has written lifetime memories in a total of eight volumes. This book summarizes the essentials of Sioli's years in Amazonia. Its main title does note easily translate into English; the literal translation is "Lived, beloved Amazonia", with "lived" having the sense of "having intensively experienced".

This is a wonderful and fascinating book. Each page transpires the commitment of the author to scientific research in Amazonia, and his strong affection for this part of the world and to the people living there. A sentence in the second chapter of the book nicely illustrates this: "I have not only performed scientific research in Amazonia, I also have lived this country as it was by that time" (p. 20). The book describes both the research and personal experiences Sioli made during his expeditions into the Brazilian rainforest between 1940 and 1962. He was fortunate to live and work in Amazonia by a time when rainforest destruction was not yet a major issue, but it must also have been a terrible experience for him to see destruction gaining pace and changing Amazonia in a way that makes it barely recognizable to those who knew it in earlier times. As Sioli writes: "My Amazonia that I have lived with does no longer exist. Another Amazonia has replaced it..." (p. 104).

Sioli took an integral approach to Amazonian ecology. He clearly recognized the intimate link between water, soils, vegetation, and the animals living there. Nowadays, with an ever increasing specialization, scientists with such broad perspective have become as rare as many of the organisms of tropical rainforests. Although there is little reference to primates in this book, Neotropical primatologists with an interested in the ecology of the forests where their study subjects are living will find it a highly informative, exciting, entertaining, but also emotional reading. At many places, I felt strongly reminded to my personal feelings and experiences when first coming to Peruvian Amazonia in the early 80s. I also learned many things about the fascinating Amazonian ecosystem which I had not known before. For primatologists, there is an interesting statement concerning the hunting of primates: according to Sioli, Parintintin Indians occasionally hunt woolly monkeys, but never spider monkeys, because consumption of the latter may transmit diseases (p. 90). Is it possible that there are diseases around in Amazonia that have not yet been recognized or diagnosed by scientists, but that some day might have similar impacts as diseases spread from hunted and butchered monkeys and apes to humans in Africa?

I recommend this book to everybody interested in Amazonian ecology and in the history of research in Amazonia who is capable of reading and understanding at least a bit of German. Hopefully, this book will be translated into English (or into Brazilian Portuguese), to make it accessible for a wider audience.

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MEETINGS

2007

Animal Training & Behavior Through Positive Reinforcement — Further Challenging and Advanced Issues. December 7–9, 2007, Munich, Germany. This seminar will be imparted by Ken Ramirez, vice president for animal collections and animal training; he develops and supervises animal-care programs, staff training and development as well as public presentation programs for the animal collection at Shedd Aquarium. The Seminar will include themes related to operant conditioning, training situations and problem solving with positive reinforcement. For more information visit: <http://www.clickerreiter.de/KenRamirez1.htm>.

6. Göttinger Freilandtage. Primate Behavior and Human Universals. December 11–14, Göttingen, Germany. This conference aims to bring together primatologists, evolutionary anthropologists and psychologists to summarise our current state of knowledge concerning behavioural variation and its determinants within the order Primates, including humans. Specifically, it will focus on three aspects: (1) comparative studies of behavioural adaptations across (human and non-human) primates that examine evolutionary principles, (2) the ability and failures of evolutionary theory to explain human behavioural traits that affect survival and reproduction, and (3) to identify and explain human behavioural universals. For additional details contac Prof. Dr. Peter Kappeler, e-mail: <gft@gwdg.de> or visit the weg page: <http://www.soziobio.uni-goettingen.de/welcome.html>.

2008

III Conferência Nacional do Meio Ambiente. Em maio de 2008 será realizada a "III Conferência Nacional do Meio Ambiente", cujo objetivo será construir um espaço de convergência social para a formulação de uma agenda nacional do meio ambiente, por intermédio da mobilização, educação e ampliação da participação popular, com vistas ao estabelecimento de uma política de desenvolvimento sustentável para o País. Afinal, a definição de políticas públicas para um Brasil sustentável depende de mudanças na forma de atuação das esferas governamentais, do setor produtivo, das organizações da sociedade, chegando ao cotidiano de cada cidadão. Em suas edições, a conferência coloca para a sociedade temas estratégicos para o País, que visam a conservação da biodiversidade, da água, do clima e dos recursos energéticos, com vistas ao desenvolvimento sustentável, levando em consideração que é possível sim crescer sem degradar a natureza. Quem quiser enviar textos para compor a Comissão Nacional, pode enviá-los até dia 15 de dezembro para <arletegenrich@yahoo.com.br>. Informações sobre a Conferência Nacional em <www.mma.gov.br/conferencianacional> ou pelo e-mail <cnma@mma.gov.br>.

5th Annual Assesment and Treatment of the Pain and Distress in Animals (ATOP V). February 8, 2008. Will be held at the Massachussetts Medical Society Conference Center at Waltham Woods Corporate Center. What are the consequences for your science if human endpoints are not taken into consideration in the experimental design? The conference will examine this question in detail. For more information go to <www.theawengroup.com/ATOPV_info.html>.

Behaviour and Individuality in Primates and other Mammals. March 17–18, 2008, Lisbon, Portugal. The conference Behaviour and Individuality in Primates and other Mammals is held as part of the celebrations of the 6th anniversary of BioCEL, and will take place at the Auditorium Agostinho da Silva at Lusófona University. The conference aims to launch a creative debate and brainstorm for future research on a rather new topic of research: the study of inter-individual variation in animal behaviour. As we get to know more about each animal species the evidence of individuality also grows. For more information visit the web site: <http://behavior-individuality.blogspot.com/>.

9th Student Conference on Conservation Science. March 25–27, 2008. Department of Zoology, University of Cambridge, United Kingdom. The SCCS is aimed at young researchers working in universities departments, conservation organisations, or resource managment agencies. Approximately 170 postgraduate students attend the conference each year, from a broad range of disciplines in conservation, including ecology, geography, sociology and economics. The most important part of the three-day programme will be poster sessions and 33 fifteen minute talks by students on any aspect of conservation science. There will also be workshops, presentations by conservation NGOs and agencies and social events designed to give participants the opportunity to make new contacts in their own and related disciplines. Prizes are awarded to posters and talks of outstanding quality and relevance to conservation. For more information and applications go to: <www.sccs-cam.org>.

American Association of Physical Anthropologists Annual Meeting. April 7–13, 2008, Columbus, Ohio. For more information visit the web site: <http://www.physanth.org/annmeet/>.

3rd International Conference on Primate Genomics: Primate Genomics and Human Disease. April 13–16, 2008, University of Washington, Seattle. The conference includes a focus on genomic and proteomic resource development, advances in computational biology and bioinformatics, and new developments in comparative genomics and evolutionary biology. The 2008 conference also highlights research activities in which genomics and nonhuman primate models are being used to better understand human disease. Recent advances in the field, including the sequencing of the rhesus macaque genome, the development of macaque-specific DNA microarrays, and new opportunities for nonhuman primate proteomics make this conference particularly timely, significant, and exciting. For more information go to: <www.seattleprimategenomics.com>.

IV Simpósio de Áreas Protegidas. 19–23 de maio, 2008. O SAP é uma oportunidade de colocar juntas as pessoas que viabilizam a conservação no campo, com aqueles pensam seus conceitos, com aqueles que lutam nas frentes de batalha jurídica e política, com aqueles que estão dando os primeiros passos na proteção de áreas dentro das universidades. Nesta ocasião, o SAP será realizado na atraente cidade de Canela, localizada na Serra Gaúcha. Para mais informações contatar <sap@officemarketing.com.br>, ou visite o site <http://sap.ucpel.tche.br/news/>.

31st Meeting of The American Society of Primatologists. June 18–21, 2008, West Palm Beach, Florida. For more information visit the web site: http://www.asp.org/asp2008/index.htm or contact Matthew Novak, e-mail: <novakm@mail.nih.gov>.

II Congreso Colombiano de Primatologia. Junio 26–28 de 2008, Bogotá, D.C. Organizado por la Asociación Colombiana de Primatología (ACP). Se realizarán presentaciones a manera de conferencias magistrales, ponencias, presentación de carteles, mesas de discusión, talleres y cursos, en torno a dos grandes temáticas: conservación in situ y ex situ. Para mayor información contactar <congreso2008@primatologiacolombia.org>/<presidencia@primatologiacolombia.org>, o visite el sitio <http://www.primatologia.org>.

22nd Annual Meeting of The Society of Conservation Biology. July 13–17, 2008, Chattanooga, Tennessee, USA. The chair of the meeting will be Dr. David A. Aborn, from the Department of Biological and Environmental Sciences, University of Tennessee at Chattanooga. As evidenced by several previous meeting themes, there are connections among many aspects of the environment and its conservation, and recognizing those connections is critical for achieving the goals of conservation biology. To that end, the theme for the 2008 SCB annual meeting *"From the mountains to the sea"* will examine several major ecosystems, both as separate components and as a connected entity. For more information and submission dates, go to: <www.conbio.org/2008/>.

XXIInd IPS Congress. August 3–8, 2008, Edinburg International Conference Center, Edinburg, Scotland. Sponsored by the Primate Society of Great Britain. Abstracts for oral and poster presentations must be submitted by 30th November 2007. For information consult the web page: <http://www.ips2008.co.uk/index.html>.

XXth International Congress of Zoology. August 26–29, Jussieu Grand campus, Paris, France. Held every four years, the International Congress of Zoology gives zoologists and professionals from all fields related to zoology the chance to come together to discuss the current status of zoology and to share ideas about future development of all its disciplines. The International Society of Zoological Sciences (ISZS) and the Societe Zoologique de France invite you to the XX International Congress of Zoology. It will be co-hosted by the Universities Pierre et Marie Curie (PVI), Paris-Sud (PXI) and the Museum National d'Histoire Naturelle. Registration will open on 1st December 2007. For information about the Congress, please visit: <http://icz2008.snv.jussieu.fr> or <http://www.globalzoology.org/index-new/20icz.htm>.

6th International Conference on Methods and Techniques In Behavioral Research. August 26–29, 2008, Maastricht, The Netherlands. The theme of the 6th international conference on methods and techniques in behavioral research will be *Measuring Behavior.* This conference is the premier interdisciplinary event for scientists and practitioners concerned with the study of human or animal behavior. This unique conference focuses on methods, techniques and tools in behavioral research in the widest sense, from behavioral ecology to neuroscience and from physiology to ergonomics. In doing so, *Measuring Behavior* responds to a growing need to cross disciplines and create bridges between them. For more details go to <www.noldus.webaxxs.net/mb2008/>.

2009

Neotropical Primate Husbandry, Research, and Conservation Conference. October 13–15, 2009. Brookfield Zoo is pleased to announce that it will host a Neotropical Primate Husbandry, Research, and Conservation Conference. This conference will focus on a variety of topics pertaining to neotropical primates like husbandry, conservation, and emergent issues pertaining to captive and wild populations. The workshop will include three days of presentations, a poster session, as well an icebreaker, silent auction, and banquet. Additional information regarding registration fees, travel information, and submission of abstracts will be made available in late 2008. For questions please contact <vince.sodaro@czs.org>.

Notes to Contributors

Scope

The journal/newsletter aims to provide a basis for conservation information relating to the primates of the Neotropics. We welcome texts on any aspect of primate conservation, including articles, thesis abstracts, news items, recent events, recent publications, primatological society information and suchlike.

Submissions

Please send all English and Spanish contributions to: Erwin Palacios, Conservación Internacional – Colombia, Carrera 13 # 71-41 Bogotá D.C., Colombia, Tel: (571) 345-2852/54, Fax: (571) 345-2852/54, e-mail: <epalacios@conservation.org>, and all Portuguese contributions to: Júlio César Bicca-Marques, Departamento de Biodiversidade e Ecologia, Pontifícia Universidade Católica do Rio Grande do Sul, Av. Ipiranga, 6681 Prédio 12A, Porto Alegre, RS 90619-900, Brasil, Tel: (55) (51) 3320-3545 ext. 4742, Fax: (55) (51) 3320-3612, e-mail: <jcbicca@pucrs.br>.

Contributions

Manuscripts may be in English, Spanish or Portuguese, and should be double-spaced and accompanied by the text on CD for PC compatible text-editors (MS-Word, WordPerfect, Excel, and Access), and/or e-mailed to <epalacios@conservation.org> (English, Spanish) or <jcbicca@pucrs.br> (Portuguese). Hard copies should be supplied for all figures (illustrations and maps) and tables. The full name and address for each author should be included. Please avoid abbreviations and acronyms without the name in full. Authors whose first language is not English should please have their English manuscripts carefully reviewed by a native English speaker.

Articles. Each issue of *Neotropical Primates* will include up to three full articles, limited to the following topics: Taxonomy, Systematics, Genetics (when relevant for systematics and conservation), Biogeography, Ecology and Conservation. Text for full articles should be typewritten, double-spaced with no less than 12 cpi font (preferably Times New Roman) and 3-cm margins throughout, and should not exceed 25 pages in length (including references). Please include an abstract in the same language as the rest of the text (English, Spanish or Portuguese) and (optional) one in Portuguese or Spanish (if the text is written in English) or English (if the text is written in Spanish or Portuguese). Tables and illustrations should be limited to six, except in cases where they are fundamental for the text (as in species descriptions, for example). Full articles will be sent out for peer-review. For articles that include protein or nucleic acid sequences, authors must deposit data in a publicly available database such as GenBank/EMBL/DNA Data Bank of Japan, Brookhaven, or Swiss-Prot, and provide an accession number for inclusion in the published paper.

Short articles. These manuscripts are usually reviewed only by the editors. A broader range of topics is encouraged, including such as behavioral research, in the interests of informing on general research activities that contribute to our understanding of platyrrhines. We encourage reports on projects and conservation and research programs (who, what, where, when, why, etc.) and most particularly information on geographical distributions, locality records, and protected areas and the primates that occur in them. Text should be typewritten, double-spaced with no less than 12 cpi (preferably Times New Roman) font and 3-cm margins throughout, and should not exceed 12 pages in length (including references).

Figures and maps. Articles may include small black-and-white photographs, high-quality figures, and high-quality maps. (Resolution: 300 dpi. Column widths: one-column = 8-cm wide; two-columns = 17-cm wide). Please keep these to a minimum. We stress the importance of providing maps that are publishable.

Tables. Tables should be double-spaced, using font size 10, and prepared with MS Word. Each table should have a brief title.

News items. Please send us information on projects, field sites, courses, Thesis or Dissertations recently defended, recent publications, awards, events, activities of Primate Societies, etc.

References. Examples of house style may be found throughout this journal. In-text citations should be first ordered chronologically and then in alphabetical order. For example, "…(Fritz, 1970; Albert, 1980, 2004; Oates, 1981; Roberts, 2000; Smith, 2000; Albert *et al.*, 2001)…"

In the list of references, the title of the article, name of the journal, and editorial should be written in the same language as they were published. All conjunctions and prepositions (i.e., "and", "In") should be written in the same language as rest of the manuscript (i.e., "y" or "e", "En" or "Em"). This also applies for other text in references (such as "PhD thesis", "accessed" – see below). Please refer to these examples when listing references:

Journal article

Stallings, J. D. and Mittermeier, R. A. 1983. The black-tailed marmoset (*Callithrix argentata melanura*) recorded from Paraguay. *Am. J. Primatol.* 4: 159–163.

Chapter in book

Brockelman, W. Y. and Ali, R. 1987. Methods of surveying and sampling forest primate populations. In: *Primate Conservation in the Tropical Rain Forest,* C. W. Marsh and R. A. Mittermeier (eds.), pp.23–62. Alan R. Liss, New York.

Book

Napier, P. H. 1976. *Catalogue of Primates in the British Museum (Natural History). Part 1: Families Callitrichidae and Cebidae.* British Museum (Natural History), London.

Thesis/Dissertation

Wallace, R. B. 1998. The behavioural ecology of black spider monkeys in north-eastern Bolivia. Doctoral thesis, University of Liverpool, Liverpool, UK.

Report

Muckenhirn, N. A., Mortensen, B. K., Vessey, S., Fraser, C. E. O. and Singh, B. 1975. Report on a primate survey in Guyana. Unpublished report, Pan American Health Organization, Washington, DC.

Website

UNESCO. 2005. UNESCO Man and the Biosphere Programme. United Nations Educational, Scientific, and Cultural Organisation (UNESCO), Paris. Website: http://www.unesco.org/mab/index.htm. Accessed 25 April 2005. ("Acessada em 25 de abril de 2005" and "Consultado el 25 de abril de 2005" for articles in Portuguese and Spanish respectively).

For references in Portuguese and Spanish:

"and" changes to "e" and "y" for articles in Portuguese and Spanish respectively.

"In" changes to "Em" and "En" for articles in Portuguese and Spanish respectively.

"Doctoral thesis" changes to "Tese de Doutoramento" and "Tesis de Doctorado" for articles in Portuguese and Spanish respectively.

"MSc Thesis" changes to "Dissertação de Mestrado" and "Tesis de Maestría" for articles in Portuguese and Spanish respectively.

"Unpublished report" changes to "Relatório Técnico" and "Reporte no publicado" for articles in Portuguese and Spanish respectively.

Neotropical Primates
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Short Articles

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