NEOTROPICAL PRIMATES

A Journal of the Neotropical Section of the
IUCN SSC Primate Specialist Group

Volume 28
Number 1-2
December 2022

SSC Species Survival Commission

re:wild®

Neotropical Primates
A Journal of the Neotropical Section of the IUCN SSC Primate Specialist Group

Re:wild, Austin, Texas, USA

ISSN 2995-2174 Abbreviation: *Neotrop. Primates*

Printed By: Linemark, Upper Marlboro, MD, USA

IUCN SSC Primate Specialist Group logo courtesy of Stephen D. Nash, 2002

Front Cover: A subadult, albino wild black-faced black spider monkey (*Ateles chamek*), Las Piedras River, Madre de Dios, Peru. Photograph by Liselot Lange (see article this issue by Lange & Glenn).

This issue of *Neotropical Primates* was kindly sponsored by the Margot Marsh Biodiversity Foundation, VA, and Los Angeles Zoo, CA

Articles

DOI: https://doi.org/10.62015/np.2022.v28.222

THE CHALLENGES OF PRIMATE RESEARCH AND CONSERVATION IN PARAGUAY

Rebecca L. Smith[1], Jorge Damián Ayala Santacruz[1], and Paul Smith[1, 2]

[1] Fundación Para La Tierra, Centro IDEAL, 321, Mariscal José Félix Estigarribia, c/ Teniente Capurro, Pilar, Ñeembucú, Paraguay. E-mail: <rebecca@paralatierra.org>.
[2] FAUNA Paraguay, Encarnación, Paraguay.

Abstract

The primate fauna of Paraguay consists of just five species (*Sapajus cay*, *Alouatta caraya*, *Aotus azarae*, *Plecturocebus pallescens* and *Mico melanurus*) and has been largely overlooked by the international primatological community. Notwithstanding, Paraguay currently has the second highest deforestation rate in Latin America and the threats facing Paraguayan primates are as severe as anywhere else on the continent. Primate conservation in Paraguay is complicated by the complete absence of a homegrown primatological research community and the country lacks the solid biological research foundation required for the development of robust management strategies. Only one university degree in biology is available in the country (with the Universidad Nacional de Asunción), and opportunities for postgraduate education in biological sciences require studying abroad, whilst the limited number of career opportunities upon graduation mean that those receiving such training frequently prefer to pursue their career elsewhere rather than return to the country to practice. No higher education courses in primatology are currently available in Paraguay. Fundación Para La Tierra (PLT) is a Paraguayan conservation and education NGO (80086144-2), founded in 2010. PLT focuses on conservation of Paraguay's natural habitats through scientific research, community engagement and education, and implements Paraguay's only long-term primatology research projects: the "Hooded Capuchin Project" conserving *Sapajus cay* in what little remains of the Upper Paraná Atlantic Forest and the "Urban Howler Monkey Project" researching the behavioural ecology of *Alouatta caraya* inhabiting the city of Pilar. The PLT primate projects adopt a multi-faceted approach: long-term scientific research, training and supporting local people with an interest in primates, supervision of international students and environmental education in schools. In this article we will discuss the challenges of developing such a project, and a vision for the future of primatology in Paraguay.

Keywords: Challenges, community development, Latin America, primatology, scientific development

Ñemombyky

Ka'ikuera Paraguai pegua oī po laja (*Sapajus cay, Alouatta caraya, Aotus azarae, Plecturocebus pallescens* ha *Mico melanurus*) ha tetã okaragua oheja tapy kuepe tekombo'e ka'ikuera Paraguai pegua. Ha Paraguai ejetopa mokoī haguape la ombyai veva ika'aguykuera Latino America apytepe ha pe amenaza orekova umi ka'ikuera paraguai pegua peteichaitente umi ambue hendape tetãnguera Latino America pe guaicha. Ka'aguyre ñeñangareko ndoguerekoī peteī tekombo'e umi ka'i kuera rehegua ko tetãme ha upevare ndorekoi peteī mberete añete ojegueraha hagua tendonde gotyo pe ñeñangareko hesekuera. Ko tetãme oī peteī mbo'ehao herava Universidad Nacional de Asunción, ha eñembo'aranduseveramo katu eho va'era ambue tetãrehe, ha avei sa'i oī la juruja ha umi ohova oñemo'arandu tetã ambuere katu ndouseveima pe hetame ogueraha hagua tenonde pe iñarandu. Ko'arape ndaipori peteī ñemo'aranduha tekovekuaaty rehegua paraguipe. Fundación Para La Tierra (PLT) ha'e peteī ONG ombo'eva la conservacion rehe Paraguaigua (80086144-2) eñepyru va'ekue 2010 pe. PLT eñenfoca la conservacion umi jeikoha natural Paraguai pegua rehe ojapo rupi hikuai la estudio cientifico, ha avei omba'apo hikuai yvypora aguiguandive ha ombo'apova avei hikuai ñemo'aranupe, ha ha'ekuera añonde omba'apova o oñemo'aranduva umi ka'i rehegua ko tetãme: el Proyecto Ka'i oheka oñangareko hagua pe *Sapajus cay* sa'ima oiva ka'aguy pe Alto Parana ha pe mba'apo ''Mono Aullador Urbano" ostudiava pe caraja oikoha ha teko kuera rehegua *Alouatta caraya* oikova tava Pilarpe. Tembiapo de primates PLT ogueroko petei enfoque heta mba'ere: investigacion cientifica ipukuva, ñemo'arandu yvypora aguiguape ka'ikuera rehegua, ombo'e avei ambue tetã guape ikatu haguaicha ijapo studio Paraguaipe ha avei tekombo'e mbo'e haope. Ko articulope ñeñe'ẽta mba'epa la hasy veva la jajapo hagua tembiapo peichagua paraguaipe ha jahecha peteī ñepytyvomby pe primatologia Paraguaipe guara.

Ñe'e okendavoka: Mbyteamérika ha Ñembyamérikagua, cientifico ñemogenda, tavaygua ñemogenda, emoranandu ka'ikuera rehegua, pa'akuera

Resumen

La fauna de primates de Paraguay consta de solo cinco especies (*Sapajus cay, Alouatta caraya, Aotus azarae, Plecturocebus pallescens* y *Mico melanurus*) y su estudio ha sido ignorada en gran medida por la comunidad primatológica internacional. No obstante, Paraguay tiene actualmente la segunda tasa de deforestación más alta de América Latina y las amenazas que enfrentan los primates paraguayos son tan graves como en cualquier otro lugar del continente. La conservación de primates en Paraguay se complica por la ausencia total de una comunidad de investigación primatológica local y el país carece de la base sólida de investigación biológica requerida para el desarrollo de estrategias de gestión efectivos. En el país existe solo un título de grado universitario en biología (con la Universidad Nacional de Asunción), y las oportunidades de educación de posgrado en ciencias biológicas requieren estudiar en el extranjero, mientras que el número limitado de oportunidades de carrera al graduarse significa que quienes reciben dicha formación con frecuencia prefieren seguir sus carreras en otros lugares en lugar de regresar al país para ejercer. Actualmente no hay cursos de educación superior en primatología disponibles en Paraguay. Fundación Para La Tierra (PLT) es una ONG de educación y conservación paraguaya (80086144-2), fundada en 2010. PLT se enfoca en la conservación de los hábitats naturales de Paraguay a través de la investigación científica, la participación comunitaria y la educación, e implementa los únicos trabajos de investigación de campo en primatología a largo plazo en el país: el "Proyecto Capuchino Encapuchado" que busca conservar el *Sapajus cay* en lo poco que queda del Bosque Atlántico del Alto Paraná y el "Proyecto Mono Aullador Urbano" que investiga la ecología del comportamiento de las poblaciones de *Alouatta caraya* que habitan en la ciudad de Pilar. Los proyectos de primates de PLT adoptan un enfoque multifacético: investigación científica a largo plazo, capacitación y apoyo a la población local interesada en los primates, supervisión de estudiantes internacionales y educación ambiental en las escuelas. En este artículo discutiremos los desafíos enfrentados en desarrollar un proyecto de esta clase en Paraguay y una visión para el futuro de la primatología en el país.

Palabras clave: América Latina; Desarrollo científico; Desarrollo comunitario; primatología; retos

Introduction

Primatological research in Paraguay is limited to a small number of studies punctuated by large periods of publishing inactivity (Azara 1801; Rengger 1830; Stallings and Mittermeier 1983; Stallings 1983, 1984, 1985; Stallings et al. 1989; Wright 1994; Smith and Briggs 2015; Cartes et al. 2017; Smith 2017a, b; Smith and Payne 2017; Cartes et al. 2018; Smith et al. 2018; Smith and Kane 2020; Smith et al. 2020; Smith et al. 2021a; Smith et al. 2021b; Wellian and Smith 2021; Smith 2021; Duffy et al. 2022; Smith et al. 2022; Smith and Lusseau 2022a). The country is home to five species of non-human primates (hereafter primates), one each from the five platyrrhine primate families: Cebidae – the hooded capuchin (*Sapajus cay*), Atelidae – the black and gold howler monkey (*Alouatta caraya*), Aotidae – Azara's night monkey (*Aotus azarae*), Pitheciidae – Chacoan titi monkey (*Plecturocebus pallescens*) and Callitrichidae – the black-tailed marmoset (*Mico melanurus*). While this is a lower number of species compared to other South American countries such as Brazil, Peru and Bolivia, Paraguay has comparable or higher diversity of species than some other countries with a thriving primatological research (both national and international) community including Argentina (five species: two *Alouatta*, two *Sapajus* and one *Aotus*) and Mexico (two *Alouatta* and one *Ateles*). It is probable that a lack of infrastructure for research is the principal factor that has contributed to the country being overlooked by foreign researchers, but this does not adequately explain the absence of a local primatological research community, or the near total absence of data-generating primatological publications produced by Paraguayan researchers – a country with one of the longest histories of natural history publication on the continent (Azara 1801; Rengger 1830).

In recent years Paraguay has had one of the highest deforestation rates in the world (Da Ponte et al. 2017a, b, 2018; Smith 2021; Smith and Lusseau 2022b) but popular opinions as to the importance of conservation of natural habitats are rarely reflected in the legislature. The Upper Paraná Atlantic Forest (BAAPA) that once spread across almost the entire eastern side of the country has been decimated by industrial agriculture, principally soybean plantations (Da Ponte et al. 2017a). Between 2000 and 2019 more than 58% of BAAPA considered highly suitable for capuchin monkeys was lost in Paraguay (Smith 2021). Annually from 2019-2021, the little that remains of the Paraguayan Atlantic Forest was ravaged by fires, with Área para Parque Nacional San Rafael (one of only two areas of BAAPA with an area of more than 50,000 ha) losing over 45% of its cover in 2020 alone (MADEs 2020). Theoretically a zero deforestation law (Ley 2524/2004) exists for the BAAPA region, but in many areas charcoal production and other clandestine and destructive forestry practices continue unabated. The Occidental region of Paraguay, the Gran Chaco, is a vast xeric forest, originally around 240,000 km^2 (Soto et al. 2015), that is now one of the world's fastest disappearing terrestrial habitats, with hundreds of thousands of hectares being lost every year to make way for cattle ranches. Only around 197 km^2 of

this region has any sort of formal protection (Cartes et al. 2015). In 2010, 281,210 ha (2812.1 km^2) were destroyed with this increasing by 21% by 2014 (Soto et al. 2015). At the current rate of deforestation, the Chaco Forest is predicted to be completely gone before 2035 (Muller et al. 2020). Paraguay clearly faces serious ecological and social challenges that require urgent action if they are to be addressed.

In recent years it has become popular amongst some sections of "western" academia to view the presence of foreign scientists (including primatologists) working in developing countries as a negative influence, taking opportunities that might otherwise be taken advantage of by local primatologists (Blair 2019; de Vos 2020; Gokken 2018; Mecca 2020; Nkomo 2020; Waters et al. 2021; Rodrigues et al. 2021, 2022). This is not the case in Paraguay, where while the limited primatological research of note has been carried out by foreign scientists, there have been long latent periods where no foreign primatologists have been active at all and the field still failed to flourish. More than 30 years of primatological research inactivity passed between the last primatological research that was carried out in Paraguay in the 1980's by Jody Stallings (a survey of the primate species present in Paraguay and their ranges: Stallings 1985) and the initiation of the Para La Tierra Hooded Capuchin Project in 2013.

The issue in Paraguay is not one of opportunities being taken from or denied to local researchers so much as such opportunities being non-existent in the first place. Why this might be the case requires an honest evaluation of the relevance of primatology to developing societies, and a reappraisal of the factors that limit opportunities for potential primatologists. This includes identifying those which are unique to primatology and can be addressed by the primatological community, those which are common to science in the developing world in general and therefore require a broader community approach, and those which are economic or political (either globally, regionally or nationally) and for which the root causes cannot be addressed separately from other social issues that afflict developing nations.

In this paper we address the principal issues as we see them. All authors are citizens or residents of Paraguay and in combination have spent many decades working in biological and primatological research fields in the country. Although the first author is the only trained primatologist on the author line, the manuscript is very much a product of all three of our experiences and opinions. All authors have previously published papers related to primatology in Paraguay which are relevant to the development of primatology in the country. We warn against the seductiveness of simple solutions to complex problems which are invariably more effective at achieving popularity on social media than real change.

Education

According to available metrics, the Paraguayan primary education system is amongst the worst in world and in 2018 Paraguay was ranked at 137/138 globally for the quality of its maths and science education (World Politics Review 2018). Early education about conservation issues has been shown to influence the extent to which students will be interested in conserving nature later in life (Caro 2003; Hossain Bhuiyan 2010). However, the standard Paraguayan national curriculum includes little to no environmental or biological science teaching. This lack of mainstream environmental education has historically robbed generations of Paraguayans of the opportunity to become inspired to work towards the conservation of their country's fragile ecosystems. In recent years the Internet has contributed to a wider understanding of conservation issues, but there are additional educational, political and economic barriers to be overcome by anybody who wishes to dedicate their career to pushing for meaningful change through academia.

There is currently only one biology undergraduate degree ("Bachelors in Sciences – Mention in Biology") in Paraguay, provided by the FACEN (Facultad de Ciencias Exactas y Naturales), Universidad Nacional de Asunción (UNA). The UNA, ranked 137/411 universities in Latin America (64 places above the next Paraguayan institution (QS Rankings 2021)), has a small research budget and, as a result, a comparatively low research output. Although the number of students who can be accepted to this course is capped at 50 per year (25 per term), it is frequently the case that the available places are not filled, and of those students that begin the course, a significant proportion fail to complete the full four-year degree (González-Barrios, pers. comm. 2020).

In 2008 the FACEN began the first Master's degree program in Biology (with a focus on Conservation Biology). The program opens for new students every two years. In 2008-2010 nine students enrolled and six graduated (66.6% graduation), 2011-2014, 14 students enrolled and seven graduated (50% graduation) and in 2015, 23 students enrolled, demonstrating that interest in this program is slowly increasing. However, neither the FACEN's undergraduate nor Master's programs include specialisations in primatology, as none of the faculty staff have experience in primatology and, understandably, the specialist skills required of the primatologist are of limited application in a wider sense in Paraguay.

While it is a positive step forward that these types of degrees now exist in Paraguay, they have been a long time coming and involve significant financial hurdles that must be overcome by any prospective student. For 2021 the undergraduate degree requires a registration fee paid per semester (increasing every semester) of ~$25 American dollars (176,000 Guaraníes) and then class

participation fees of $3/class (18,000 Guaraníes) with a basic requirement of five classes per semester. The two-year master's degree fees reach around $2446 (17 million Guaraníes). In addition to the university fees, completing these degrees requires further financial investment including purchase of all textbooks required for each class (this can be done in a cheaper way by purchasing photocopies of the required books), paying to sit exams, a fee to receive a degree certificate, a fee to defend one's thesis and, for those who do not have a residence in the capital city, additional costs of travel, housing and living. These costs are significant in a country where the minimum wage (in 2021) was ~$330/month (1,824,055 Guaraníes) (or $132/month (917,532 Guaraníes) if you are a domestic worker). The fees charged by the university have caused controversy in the past as the UNA is a public university that, on paper, should not charge any fees (ABC Color 2020a, b, c). However, in reality all potential students are obliged to make this considerable financial sacrifice in choosing to study biology. A large number of potential primatologists from lower-income backgrounds can be priced out of their future careers at the first hurdle, either by the geography of where they live (70% of Paraguay's population lives outside of the greater Asunción area), or the economic status of the household into which they were born, or a combination of both. In 2020, it was estimated that the UNA has a dropout rate of around 45%, in part a result of significant financial burden caused by the fees (ABC Color 2020c).

No biology Ph.D. courses are currently available in Paraguay, and any students wishing to continue their studies to doctorate level (and indeed to take their first steps in studying primatology at all), must have access to the considerable financial resources required to continue their studies outside of the country. Programs that were originally designed to alleviate the financial pressures associated with academic study in Paraguay (or for Paraguayan students to study abroad) such as BECAL, Becas Don Antonio Carlos Lopez, a program that provides scholarships for overseas postgraduate studies to university students, have failed to solve this problem, and have been mainly taken advantage of by students from families in the top income decile (World Politics Review 2018). A significant section of Paraguayan society is therefore financially excluded from ever even attempting to obtain the academic education required to become a primatologist.

Of course, the relative lack of interest in pursuing a career in biology cannot be blamed solely on these economic barriers. It is also a reflection on what "type of knowledge" is prioritised by Paraguayan society. This is likely a factor in the failure of the FACEN to fill its biology course, and is also an indication of how biology is viewed more widely in terms of its "contribution to society". Throughout the country there are several universities offering courses in "Environmental Engineering", however these courses have a strong focus on livestock and agriculture (pursuits that are considered "valuable" to an agricultural economy) and little emphasis is given to ecological research or conservation (which often generate results which might be considered unfavourable to an agricultural economy that is heavily invested in soy and cattle production).

In 2020, the FACEN awarded 33 "Financial hardship" fee-waiver scholarships for undergraduate students. None of these were awarded to students studying biology and over a third were awarded to students of the *Tecnología de Producción* – Bachelor of Production Technology, a degree that aims to "*Train professionals to interpret the problems that arise in companies linked to productive activities in the country, so that at their level of responsibility can effectively assist in solving them, as well as collaborate to produce goods and services*" (FACEN, 2020a). In addition, 13 scholarships for "Academic Excellence" were awarded and again, none of these were awarded to biology students (FACEN, 2020b). No data is available to us on how many applicants requested this financial support for the biology course, but there are only three realistic possibilities: 1) no students applied for support for the biology course (suggesting either a lack of societal interest or an appeal only to students of high income families, or both); 2) all the potential biology students that did apply had weaker applications than the 33 awardees (suggesting that the most gifted students are not choosing to study biology) or 3) financial support for biology students is not considered a priority for scholarships (suggesting that a biology qualification is not valued by Paraguayan academia). Clearly none of these possibilities are consistent with an imminent explosion of primatological opportunities.

Employment prospects

Perhaps equally important in discouraging students from studying biology through to postgraduate level are the limited job prospects available to them after graduating. Opportunities for permanent work for biologists are few and far between in Paraguay, and where they do exist these tend to have a strong focus on habitat conservation rather than behavioural or ecological research. While there are several conservation NGOs operating in Paraguay, paid work for biologists offered by them is often on a by-project basis, and the job requirements of the biologists are defined by the needs of the project. The ability to compete for such contracts thus rewards the generalist biologist far more so than the specialist. Given that only one of the five Paraguayan primates is currently considered to be of conservation concern by IUCN (the hooded capuchin was reclassified as Vulnerable in 2022, partly as a result of the PLT Capuchin Project (Rímoli et al. 2022)), a specialisation in primatology is of limited value in terms of making a person more attractive in the competition for such contracts (which commonly have a strong conservation focus). By consciously over-adapting to a habitat that does not exist, the Paraguayan primatologist

must be prepared to knowingly and willingly reduce their own chance of finding economically viable employment.

Independent financing

The financially-secure Paraguayan primatologist who has successfully received their qualification and found their employment opportunities limited still has the opportunity to go it alone. Independent financing for emerging biologists is difficult to get, but it is out there. While most of this financing comes from abroad, there are limited sources of funding available nationally – if you can convince the local funders that primatology is worth funding.

In 2011, the Consejo Nacional de Ciencia y Tecnología (CONACyT) began the Programa Nacional de Incentivo a los Investigadores (PRONII). This program is designed to promote and expand the scientific community within Paraguay by offering financial incentives that complement the base salary of Paraguayan-based (permanent resident or citizen) scientists. The aims of the PRONII program are "*To strengthen, consolidate and expand the scientific community of the country. Categorize, through periodic evaluation processes, researchers by hierarchical levels according to their scientific production, their international relevance and their impact on the training of other researchers. Establish a system of financial incentives for researchers that makes possible, facilitates and encourages dedication to scientific production in all areas of knowledge, which will be awarded by competitive procedures*" (CONACyT 2020a). There are four different categories for which researchers can apply, and as a biological science, primatology falls under the category of "Agricultural, Natural and Botanical Sciences".

The PRONII program consists of five levels (*Candidato*, 1, 2, 3, *Emérito*), each of which has a distinct set of academic requirements and is rewarded with an increasing pay scale. To qualify for *Candidato* (Candidate - the basic entry level into the program) you need to prove participation in research groups or projects and attendance at congresses (another financial barrier), be affiliated to a government or non-governmental organization, have at least one scientific publication in a peer reviewed journal or at least three presentations at a scientific congress in the last three years. While the basic requirement is a completed bachelor's degree, it is preferred that you have (or are in the process of completing) a Master's or a doctorate. If you are not doing so, or do not have a Master's or doctorate level degree, then you must have published a minimum of six articles in peer reviewed publications in the last three years. Access to the level 1 and 2 of the PRONII scheme requires at least a Master's degree and access to 3 and *Emérito* require a Ph.D.

In 2020, the category of PRONII *Ciencias Agrarias, Naturales y Botánicas* (Agricultural, Natural and Botanical Sciences) contained only 175 people, of which 87 (49.71%) researchers were *Candidato* level, 61 (34.86%) were Level 1, 19 (10.86%) were Level 2, four (2.29%) were Level 3 and four (2.29%) were *Emérito* (CONACyT 2020b). Of these recipients, only around a third of these researchers are biologists and only one (the first author of this paper) is a primatologist, a stark reflection of the small number of people in Paraguay working in the biological sciences (CONACyT 2020b). In addition to the overall small number of biologists, the alarming lack of researchers qualifying for the higher levels of the scheme reflects not only the limited higher education opportunities within the country, but also the limited pool of nationally-based professionals qualified to offer training or development opportunities to their fellow professionals and students.

Logistics

In terms of land distribution, Paraguay is one of the most unequal countries in Latin America, with a thriving *latifundi* system, and over 80% of the land being owned by around 5% of the people. This creates obstacles for anybody intending to engage in independent (or even NGO or university-affiliated) scientific research and/or conservation programs, and introduces unavoidable uncertainties for anybody seeking to set up a long-term field research program. Of course whilst a researcher may have little choice but to trust private landowners who may be unlikely to commit their land entirely to the economically unrewarding (in comparison to soy or cattle production) pursuit of studying primate behaviour, convincing donors and grant-givers to invest their money is rather more difficult.

The only alternative to this is to work in the public sector within the national parks system. On paper this looks like a viable option. There are 16 state-managed national parks throughout the country. However, the national park system is chronically underfunded and understaffed, conditions are poor and the national parks where three of the five species of monkey occur (in the Chaco and Pantanal regions in the north of the country) are so remote that without access to a costly 4x4 vehicle any project would be impossible (distribution maps of the five species are included in Smith et al. 2021). Beyond permission to use their facilities there is no support from the government, meaning one must still generate one's own financial support. Many grant-giving agencies do not allow the payment of wages in the terms of their funding and so even if you succeed in getting the studies off the ground, you are still some distance from turning it into a job that pays a person (or any team one might need) a living wage. Even with a costly education and a cutting-edge project plan you are still faced with significant financial barriers to be able to carry out research (before even considering earning a wage). Nor are these the end of the logistical challenges, with project-specific hurdles such as the habituation of study subjects still ahead. Unlike neighbouring Brazil and Argentina, Paraguay has never benefitted from the set-up of long-term

field stations, and as a result there are few areas with even semi-habituated primates.

Para La Tierra Primate Projects and the development of primatology in Paraguay

In this section, the authors recount our own experience of the difficulties of establishing primatology programs in Paraguay. Since 2013 Fundación Para La Tierra (PLT) (a Paraguayan conservation NGO 80086144-2) has run Paraguay's first, and currently only, long-term behavioural studies of wild primates. Between 2010 and 2017 PLT was based at the privately-owned property Rancho Laguna Blanca in San Pedro department. It took approximately 2.5 years to habituate the capuchin monkeys at this locality. In May 2017 the site fell under legal embargo as the result of a landowner family dispute that required all work on the property to be suspended indefinitely. Five years later the legal dispute is still unresolved. Following the loss of Laguna Blanca, PLT moved to the City of Pilar in Ñeembucú and the capuchin research project moved to Nueva Gambach, a private property at the tip of Areá para Parque San Rafael (Tekoha Guasu). The capuchin research continues at this site and in Pilar we established the first study of the black and gold howler monkey (*Alouatta caraya*) in Paraguay in urban and Humid Chaco environments.

Challenges and accomplishments in the development of Paraguayan primatology

That any primatological research was possible was because of the business non-profit model adopted by PLT. Through the PLT internship program students pay bench fees to design and carry out their own research project in Paraguay under the supervision of PLT scientists, providing an educational experience, with room, board and equipment use included, that involves all aspects of the scientific process from study design and proposal writing to submitting their results for publication in a peer-reviewed journal and/or applying for conference presentations. To date, students have come from over 40 countries and six continents.

This non-profit business model of generating income for the primatological (and other scientific) studies, community engagement and environmental education programs through these international student bench fees was attacked by northern hemisphere academics on social media in September 2020 and accused of being exploitative. PLT's only source of consistent funding (which is invested into the completely non-profit scientific, environmental and social programs) is student bench fees, and much of its advertising takes place on social media. All three authors interpreted these attacks as true academic colonialism, as no constructive solutions for alternative means of funding were offered, and the intent was defamatory and destructive, with no effort made to be constructive or engage in useful debate. No alternative means of funding long-term primatological research that did not depend on foreign capital were proposed by any of the commentators, aside from the ill-considered suggestion that "the government will pay for it" which sadly, the Paraguayan government does not do. Nor did they demonstrate any familiarity with the country or the institution, or any concern for, or understanding of, the social or conservation issues faced by Paraguay and Paraguayans. The dogmatic nature of these indiscriminate criticisms, blindly misapplied concepts of "colonialism" and "exploitation" were without nuance or self-awareness. No interest was shown in the much vaunted "local knowledge" of problems, because it failed to fit the pre-established narrative. When these scientists (many of them through official university lab accounts in the global north) targeted PLT, they attacked the only consistent funding that the only primatology projects in Paraguay receive. Their disinterested and misguided pseudo-morality was thus converted into yet another factor oppressing the development of primatology in Paraguay. We include this example to illustrate not only the hypocrisy of such charges of exploitation (when for-profit higher education fees dwarf the cost of the non-profit bench fees of the PLT internship program) but to highlight the damage they can do to grassroots projects in developing countries by weaponizing social media. It is an inescapable fact that true colonialism is reflected by a person's attitude and actions, not their nationality, and one might justifiably argue that its defining character is the imposition of the ideas of "educated" society onto perceived "less-educated" societies, fuelled only by self-righteous conviction and with scant regard for the cultural or social fall-out of their ideas and actions.

To date, the small multinational staff at PLT has published over 180 peer-reviewed scientific papers in its 13-year existence in the fields of primatology, entomology, herpetology, ichthyology, ornithology, botany and mammalogy. Of these, 16 are a direct result of the primatology projects (with a further three currently under review and 13 in preparation). A total of 17 fee-paying international primatology students have authored or co-authored primatological research papers published or under review in peer-reviewed journals through PLT and 18 (national and international) students have presented their research at national and international primatological (and biological) society conferences, a huge boost to the development of primatology in Paraguay. Again, none of this would have been possible without international students and payment of bench fees.

If primatology as a discipline is going to take off in Paraguay then investment in training opportunities from both national and international parties is essential, and opportunities for putting primatology theory into practice need to be created. Supported by the Latin American Primatological Society (SLAPrim) and Para La Tierra (PLT), "Ka'i Paraguay", a novice primatology interest group was formed following the 1st Paraguayan Zoology conference in 2019 and is encouraging young Paraguayans to take

their first steps into the world of primatology. Whilst this is a positive attempt to create conscience, the group had just 12 active members (all Paraguayan citizens) until 2022 when a call for volunteers expanded membership to 23. The group is mentored mainly by three foreign-born and trained primatologists, including the first author who is the only one who lives in Paraguay. Only a small minority of these members are active (mainly on social media), there is no budget for field work and the group's existence does not ameliorate the lack of a formal primatological training and a near total lack of practical primatological experience amongst its members.

A pressing issue holding back primate conservation in Paraguay is a basic lack of knowledge about the primates that are found in the country. In 2016 the Para La Tierra primate team conducted a survey of visitors to Asunción Zoo. Few participants demonstrated awareness of the species occurring in the country, and several expressed the belief that exotic species such as orangutans or chimpanzees were native to the Paraguayan Chaco. To address this lack of basic knowledge PLT developed a primary school education program to promote familiarity with the country's primates in schools across the country, with the express aim of planting the seeds of a passion for their conservation. This is achieved via two distinct projects:

1. The PLT program "*Voces de la Naturaleza*" (Voices of Nature) (Figure 1) aims to address the lack of environmental education that children receive in schools via the establishment of 36 eco-clubs across eight political departments. The education team have developed an open-access curriculum of over 400 games, arts and crafts activities and lesson plans all designed to teach young children about nature in a participatory manner, encouraging them to ask questions and think through problems, in contrast to the rote-learning mainstream educational method. In 2018 an agreement was reached with the American Peace Corps for their Environment volunteers to establish additional eco-clubs in additional rural localities, employing the "*Voces de la Naturaleza*" curriculum, in an attempt to reach even more primary school children. Part of this curriculum is a series of lessons, developed with the support of the International Primatological Society Lawrence Jacobsen Education Development Award, focusing on Paraguayan primates and discouraging the pet trade. More than 1000 Paraguayan children (7 to 15 years old) in four political departments have so far participated in these lessons. This program has gained international recognition including PLT's Jorge Damián Ayala Santacruz receiving the Charles Southwick Education Commitment Award from the International Primatological Society in 2019 for his dedication to conservation education in Paraguay.

2. In 2018 the PLT primate team began a program of primate conservation focused environmental education in 22 primary schools in four impoverished communities in areas of conservation concern (Caazapá and Itapúa departments) that border the Área para Parque Nacional San Rafael (Tekoha Guasu) (Figure 2). The lessons developed

Figure 1. The *Voces de la Naturaleza* program run by Jorge Ayala has introduced hundreds of Paraguayan children to participatory environmental education since 2016. The curriculum is currently under consideration for inclusion into the national school curriculum.

Figure 2. The Atlantic Forest conservation education program involves 26 rural and indigenous Mbyá Guaraní schools and uses the participatory *Voces de la Naturaleza* curriculum.

for the *Voces de la Naturaleza* eco-clubs were adapted for a classroom setting and have so far reached 587 children aged 6 to 17 in rural, *campesino* and indigenous Mbyá Guaraní schools. In the beginning, some of these lessons were assisted by forest guards from NGO Pro Cordillera San Rafael (PRO COSARA) and the Ministerio de Ambiente y Desarrollo Sostenible (MADEs: Ministry of the Environment and Sustainable Development), in a capacity building manner that would enable them to conduct additional participatory education in other areas. Though it was interrupted by the COVID-19 pandemic, this program restarted in August 2021 and expanded into more schools (including four more Mbyá Guaraní schools) in the area and the implementation of a series of teacher training workshops focused on participatory education techniques supported by both the International Primatological Society and the Primate Society of Great Britain.

The deficiency in primary education is reflected in a lack of a knowledge base amongst adults, that also needs addressing. Para La Tierra runs a variety of primate programs for both national and international students of diverse ages. In December 2018, with the support of the National Geographic Society and the International Primatological Society, the primate team ran a week-long intensive training course in biological field research techniques and participatory environmental education for 42 forest guards from MADEs and five conservation organisations from across Paraguay (PRO COSARA, Fundación Moises Bertoni, Guyra Paraguay, Organización Paraguaya de conservación y desarrollo sostenible, and the Guardaparques Voluntarios), covering all participation costs and subsidising travel costs for participants (Figure 3). This course built a community connected through WhatsApp that is working together to build the first survey of primates in Paraguay's protected areas for more than 30 years. The Para La Tierra Primatology and Primate Conservation online course, launched in June 2020 is free of charge to Latin American students, subsidised by the course fee charged to northern hemisphere participants. Since the launch of this project seven students from five countries across Latin America (including three from Paraguay - one of whom is a member of the Ka'i Paraguay Group) signed up for the course. We are currently working to have the course translated and subtitled in Spanish and ideally, in the future, in Portuguese in order to make the course more accessible to Latin American students.

However, whilst these steps are laying the groundwork for the future, there is a pressing need in the present to develop study opportunities and generate data on Paraguayan primates, so that any capacity building might have an outlet. Para La Tierra runs two long-term primatological research projects (the only such projects that have ever been established in the country): The "Hooded Capuchin Project" and the "Urban Howler Monkey Project".

The "Hooded Capuchin Project" focuses on determining the ecological requirements of the hooded capuchin in what remains of the Upper Paraná Atlantic Forest, examining this species adaptability to anthropogenic habitat destruction. The project began in January 2013 at Laguna Blanca (San Pedro department) and continues at Estancia Nueva Gambach (Itapúa department) at the southern tip

Figure 3. Images from the 2018 Forest Guard training course.

of Área para Parque Nacional San Rafael (Tekoha Guasu) (with the logistical support of Hostettler S.A, the Hostettler family and, until January 2020, the Paraguayan NGO PRO COSARA). Through this project, both national and international students can participate in ten-day field trips as an educational experience to learn about behavioural data collection, field primatology techniques and conservation in the Atlantic Forest.

The "Urban Howler Monkey Project" is based in the town of Pilar (Ñeembucú department). It looks at the behaviour and ecology of Pilar's large and unusual population of urban-dwelling black and gold howler monkeys and aims to determine how they are adapting to the anthropogenic environment with comparisons to populations in nearby natural environments. Students from across the world are invited to design and carry out their own research projects on these monkeys, and they are encouraged to present and publish their findings with the necessary supervision and support of the PLT primatologist. To date over 40 students (including 28 undergraduate and masters level students) from eleven countries including Paraguay have carried out research projects on topics including parasitology, social networks, vocalisations, activity budgets, risk awareness, home ranges and diets. The bench fees that the international students pay to carry out their study and live in the PLT research station partially fund the small salaries of the scientific staff, the "Hooded Capuchin Project" and all the primatological environmental education and community engagement programs. As we have already stated, without the bench fees paid by international students, none of these projects would exist at all.

The long-term aim of these two projects is not only to generate behavioural and ecological data on the species but to develop viable and self-sustaining projects that can one day be taken over by a future Paraguayan primatologist – a longer term plan to play a small part in addressing the lack of employment opportunities.

Final thoughts

The issues affecting the development of primatological science in developing countries are considerably more complex than the simple, but superficially persuasive, arguments that destructive academic colonialism might infer, and the extent to which such arguments are applicable must not only be viewed on a country by country basis, but also in combination with, and not *in lieu* of, other factors that also inhibit the development of local scientists. The charge that foreign scientists cannot have a net positive impact on the communities with which they work must also be challenged, and the failure to entertain the validity of this notion is a betrayal of the stated aims of the anti-colonialist movement. Anti-colonialism can only be anti-interventionist if the conditions for success already exist and are being actively impeded. If they do not exist, and one refuses to assist in creating them, or they do exist and are not being actively impeded but abetted, then such attacks are themselves colonialist, acting to preserve those opportunities solely for the countries that already enjoy a healthy and self-sustaining primatological community.

Paraguay has been predicted to be the first country in the world that will lose all of it moist forests, likely by 2028 (European Commission, 2019), a devastating prospect for primate conservation. If primatology as a discipline is going to be encouraged in Paraguay then it is essential

that the challenges be addressed productively, actively and in cooperation with stakeholders. There are many opportunities to plant the seeds of primatology in this country that is so desperately in need of increased conservation measures, but history has already demonstrated that these are not going to happen organically, or at least not fast enough to address the serious conservation issues Paraguay faces.

Collaborations between international universities and NGOs (such as SLAPrim and PLT's support of the Ka'i Paraguay group) have the potential to make a positive difference, but are unfairly handicapped by the unjustified, rote-learned attacks of comfortable idealists on social media many thousands of kilometres away from the problem, and who need never give a second thought to those who live with the effects of their trite and sometimes vitriolic words. International universities or societies establishing working relationships with Paraguayan universities or NGO's could set up long-term field sites in the country, and such external financing would provide training opportunities in the short term, and potentially employment in the longer term. This can create opportunities for Paraguayan science students with an interest in primatology, such as the members of the Ka'i Paraguay group, helping them to overcome the economic and logistical barriers that are currently insurmountable. Such action is not colonial unless its intentions are colonial, disinterested inaction on the other hand is absolutely colonial, as it preserves the opportunities for the few – there are after all no native monkeys in the USA, Canada or most of Western Europe.

Paraguay is a proud country of proud people. Partnerships between local and international academic and conservation institutions in a strategic plan to develop primatology are essential for the development of the science. Such efforts provide the fledgling primatology community with the tools and opportunity to help themselves, and they deserve everybody's support.

Acknowledgements

We thank all the volunteers and interns of the PLT Primate Projects and all PLT staff for their support. All authors are grateful to the PRONII program of CONACyT. Thanks to the National Geographic Society (2018 - Grant Number: NGS-299C-18), the International Primatological Society Lawrence Jacobsen Education Development Award (2016/2018/2020), the Primate Society of Great Britain Cyril Rosen Award (2020) and the British Ecological Society Training and Travel Grant (2018 – TT18/1167) for financial support of the PLT Capuchin Project research and education initiatives. RL Smith is grateful to the Elphinstone Scholarship for funding her PhD with the University of Aberdeen. JD Ayala Santacruz is grateful to the International Primatological Society Charles Southwick Education Commitment Award (2019). We are grateful to Hans, Christine and Pedro Hostettler and Hosteller S.A for allowing us access to their property and supporting the project and to PRO COSARA for providing accommodation at the Nueva Gambach field site (May 2017-January 2020). Thank you to Susan Smith for her support and comments on early drafts of the manuscript and Dr. David Lusseau for his support of, and contribution to, the capuchin project. Thank you to Jessica W. Lynch and an anonymous reviewer for helpful comments on earlier drafts. Most of all we thank the people of Paraguay, in particular the people of Pilar (Ñeembucú), Alto Vera (Itapúa) and Pedro Giménez (San Pedro).

All of PLT's research is approved by the Ministerio de Ambiente y Desarollo Sostenible (MADEs) and complies with all local laws. All primatological data is collected in a non-invasive manner and complies with the American Primatological Society Best Practices. All work with communities and schools is based on informed consent, mutual agreement of aims and following invitation by the school directors and all photographs are used with full permission. For more information on the primatology projects of, or partnering or collaborating with Para La Tierra or supporting the development of primatology in Paraguay please do not hesitate to contact Dr. Rebecca Smith at rebecca@paralatierra.org or if you would like more information about the *Voces de la Naturaleza* education program or to use our curriculum contact Jorge Ayala at jorge.d.ayala@gmail.com.

References

ABC Color. 2020a. Estudiantes de la UNA se manifestarán pidiendo arancel cero. https://www.abc.com.py/tv/abc-noticias/2020/07/07/estudiantes-de-la-una-se-manifestaran-pidiendo-arancel-cero/. Accessed on 02/01/2021.

ABC Color. 2020b. Estudiantes universitarios queman cubiertas en reclamo de arancel cero. https://www.abc.com.py/nacionales/2020/08/12/estudiantes-universitarios-queman-cubiertas-en-reclamo-de-arancel-cero/. Accessed on 02/01/2021.

ABC Color. 2020c. Estudiantes universitarios se movilizarán por "arancel cero". https://www.abc.com.py/nacionales/2020/08/10/estudiantes-universitarios-se-movilizaran-por-arancel-cero/. Accessed on 02/01/2021.

Alesci, M., Smith, R. L., Santacruz Ayala, J. D. and Camperio Ciani, A. 2022. Attitudes towards urban black and gold howler monkeys (*Alouatta caraya*) in the city of Pilar, Ñeembucú, southwest Paraguay. *Primates* 63: 161–171.

Blair, M. E. 2019. Toward more equitable and inclusive spaces for primatology and primate conservation. *Int. J. Primatol.* 40: 462–464.

Cartes, J. L., Thompson, J. and Yanosky, A. 2015. El Chaco paraguayo como uno de los últimos refugios para los

mamíferos amenazados del Cono Sur. *Paraquaria Nat.* 3(2): 37–47.

Cartes, J. L., del Castillo, H., Kowalewski, M. and Thompson, J. J. Velilla, M. 2017. Primates: los monos. In: *Libro Rojo de Mamíferos del Paraguay*, S. Saldívar, V. Rojas and D. Giménez (eds.), pp.55–60. Asociación Paraguaya de Mastozoología y Secretaría del Ambiente. Asunción, Paraguay.

Cartes, J. L., Velilla, M., González-Brítez, N. and Thompson, J. J. 2018. Estado de Conservación de los Primates en Paraguay. In: *La Primatología en Latinoamérica 2. Tomo 2*, B. Urbani, M. Kosalewski, R. G. T. Cunha, S. de la Torre and L. Cortés-Ortiz (eds.), pp.583–596. Ediciones IVIC, Caracas, Venezuela.

CONACyT. 2020a. https://www.conacyt.gov.py/pronii. Accessed 14th November 2020.

CONACyT. 2020b. https://www.conacyt.gov.py/sites/default/files/upload_editores/u274/criterios_agrarias_1.pdf. Accessed 14th November 2020.

Da Ponte, E., Kuenzer, C., Parker, A., Rodas, O., Oppelt, N. and Fleckenstein, M. 2017a. Forest cover loss in Paraguay and perception of ecosystem services: a case study of the Upper Parana Forest. *Ecosystem Services* 24: 200–212.

Da Ponte, E., Roch, M., Leinenkugel, P., Dech, S. and Kuenzer, C. 2017b. Paraguay's Atlantic Forest cover loss—satellite-based change detection and fragmentation analysis between 2003 and 2013. *Applied Geography* 79: 37–49.

Da Ponte, E., Fleckenstein, M., Oppelt, N., Huth, J. and Kuenzer, C. 2018. Forest Cover loss in Paraguay: Earth Observation Analysis for Deforestation Policies. EARSeL Symposium: Chania, Crete, Greece.

de Vos, A. 2020. The problem of "colonial science." *Scientific American* 1–10. https://www.scientificamerican.com/article/the-problem-of-colonial-science/.

Duffy, X., Wellian, J. and Smith, R. L. 2022. Use of space by black-and-gold howler monkeys (*Alouatta caraya*) in an urban environment in Paraguay. *Urban Ecosystems* 25: 1777–1786. https://doi.org/10.1007/s11252-022-01262-3.

FACEN 2020a. https://www.facen.una.py/es/licenciatura-en-tecnologia-de-produccion/. Accessed on 9th December 2020.

FACEN 2020b. Resolución-N°-0272-2020. https://www.facen.una.py/es/resoluciones-nro-272-273-y-274/. Accessed on 9th December 2020.

Gokken, B. 2018. Recovering conservationist: Q & A with orangutan ecologist June Mary Rubis. Mongabay. https://news.mongabay.com/2018/08/recovering-conservationist-qa-with-orangutan-ecologist-june-mary-rubis/. Accessed on 1st August 2022.

MADEs. 2020. Informe Mayo 2002—Reserva Para Parque Nacional San Rafael. Dirección de Geomatica.

Mecca, B. 2020. When your country is a case study: being an Indonesian environmentalist at Yale. Correspondents of the World. Accessed 1st August 2022.

Nkomo, M. N. 2020. The Achilles heel of conservation. *iLizwe* 1–11. https://ilizwi.co.za/the-achilles-heel-of-conservation/.

Rengger, J. R. 1830. Naturgeschichte der Saeugethiere von Paraguay. Schweighauserschen Buchhandlung, Basel, Switzerland.

Rímoli, J., Smith, R. L., Ludwig, G., Martinez, M., Kowalewski, M., Melo, R. and Lynch, W. 2022. S*apajus cay*. The IUCN Red List of Threatened Species 2022: e.T136366A215548623. https://www.iucnredlist.org/species/136366/222944655. Accessed on 31st July 2022.

Rodrigues, M. 2021. *SpiderMonkeyTales*. http://spidermonkeytales.blogspot.com/2020/06/decolonizeprimatology-reading-list.html. Accessed on 1st August 2022.

Rodrigues, M. A., Kiiza, V., McLennan, M. R., Mendes S. L. and Strier, K. B. 2022. Narratives of positionality in primatology: foreign/range–country collaborator perspectives from Africa and South America. *Int. J. Primatol.* 43: 1133–158. https://doi.org/10.1007/s10764-022-00311-0.

Smith, R. L. 2017. Preliminary observations of complex object manipulation in a wild population of *Sapajus cay* Illiger 1815 (Primates: Cebidae) in a fragment of upper Paraná Atlantic Forest, Rancho Laguna Blanca, eastern Paraguay. *Acta Ethologica* 20: 75–80.

Smith, R. L. and Payne, C. 2017. Consumption of the bark of *Albizia niopoides* (Mimosaceae) by *Sapajus cay* Illiger, 1815 (Cebidae: Primates) in the Atlantic Forest fragment of Rancho Laguna Blanca in Eastern Paraguay. *Mammalogy Notes* 4(1): 17–20.

Smith, R. L. 2017. An observation of an unusual human-directed threat display by *Sapajus cay* Illiger, 1815 (Cebidae: Primates) in a fragment of Upper Paraná Atlantic Forest, eastern Paraguay. *Mammalogy Notes* 4(1): 15–16.

Smith, R. L., Hayes, S. E., Smith, P. and Dickens, J. K. 2018. Sleeping site preferences in *Sapajus cay* Illiger 1815 (Primates: Cebidae) in a disturbed fragment of upper Paraná Atlantic Forest fragment, Rancho Laguna Blanca, eastern Paraguay. *Primates* 59(1): 79–88.

Smith, R. L., Briggs, E. and Smith, P. 2020. Unusual behavioural responses of the South American coati *Nasua nasua* (Carnivora: Procyonidae) to hooded capuchins *Sapajus cay* (Primates: Cebidae) in the Paraguayan upper Paraná Atlantic Forest. *Neotrop. Primates* 26(3): 23–29.

Smith, R. L. 2021. The Ecology and Conservation of the Hooded Capuchin (*Sapajus cay*) in the Paraguayan Upper Paraná Atlantic Forest. University of Aberdeen. Ph.D. Thesis.

Smith, P., Rios, S. and Smith, R. L. 2021. Paraguayan primatology: past, present and future. *Primate Conservation* 35: 1–22.

Smith, R. L., Blood, R. and Smith, P. 2020. Observations of facial malformations, including cleft lip and palate, in wild primates in Paraguay. *Journal of Medical Primatology* 50(3): 193–196.

Smith, R. L., Rebergen, K., Payne, C., Megaponas, E. and Lusseau, D. 2022. Dietary plasticity of an umbrella species (*Sapajus cay*) in a Biodiversity Hotspot: applying ecological traits to habitat conservation in the upper Paraná Atlantic Forest. *Folia Primatol.* 93(1): 53–68.

Smith, R. L. and Lusseau, D. 2022a. Modelling habitat suitability for a potential flagship species, the hooded capuchin, of the Paraguayan Upper Paraná Atlantic Forest. *Ecological Solutions and Evidence* 3(3): e12146.

Smith, R. L and Lusseau, D. 2022b. The hooded capuchin monkey is Vulnerable in Paraguay and at least Near Threatened globally according to Red List Criteria. Poster Presentation. Primate Society of Great Britain Winter Conference 2022, Twycross Zoo, England.

Waters, S., El Harrad, A., Bell, S. and Setchell, J, M. 2021. Decolonizing primate conservation practice: a case study from North Morocco. *Int. J. Primatol.* 43: 1046–1066. https://doi.org/10.1007/s10764-021-00228-0.

Wellian, J. and Smith, R. L. 2022. Risk awareness of black-&-gold howler monkeys (*Alouatta caraya*) living in an urban environment in south-west Paraguay. *Journal of Urban Ecology* 7(1): 1–8. https://doi.org/10.1093/jue/juab010.

Soto, C., Cabello, C., Scribano, R., Garicoche and J., Peckoltz, F. 2015. Riesgo de degradación en el Chaco Paraguayo. *Paraquaria Nat*. 3(2): 48–52.

Stallings, J. R. and Mittermeier, R. A. 1983. The black-tailed marmoset *Callithrix argentata melanura* recorded from Paraguay. *American Journal of Primatology* 4: 159–163.

Stallings, J. R. 1984. Status and conservation of Paraguayan primates. MA thesis, University of Florida, Gainesville, USA.

Stallings, J. R. 1985. Distribution and status of primates in Paraguay. *Primate Conservation* 6: 51–58.

Stallings, J. R., L. West, W. Hahn and I. M. Gamarra. 1989. Primates and their relation to habitat in the Paraguayan Chaco. In: *Advances in Neotropical Mammalogy*, J. F. Eisenberg and K. H. Redford (eds.), pp.425–442. Sandhill Crane Press, Gainesville, USA.

World Politics Review. 2018. Can Paraguay's dysfunctional education system be reformed? https://www.worldpoliticsreview.com/can-paraguay-s-dysfunctional-education-system-be-reformed/.

Wright, P. C. 1994. The behavior and ecology of the owl monkey. In: *Aotus*: *the Owl Monkey*, J. F. Baer, R. E. Weller and I. Kakoma (eds.), pp.97–112. Academic Press, San Diego, USA.

DOI: https://doi.org/10.62015/np.2022.v28.225

PRIMATES AT THE NEWLY ESTABLISHED CAMAQUIRI CONSERVATION INITIATIVE, LIMON, COSTA RICA

Jill D. Pruetz[1], Gavin Brink[2], Eduardo Cruz Palma[2], Kaelyn Dobson[1], Diane W. Husic[3], Thomas C. LaDuke[4], Jennifer Lansing[2], Terry Master[4], and Israel Mesen[2]

[1] Department of Anthropology, Texas State University, San Marcos, TX 78666. E:mail: <pruetz@txstate.edu>
[2] Camaquiri Conservation Initiative, Cariari, Limon, Costa Rica
[3] Department of Biological Sciences, Moravian University, Bethlehem, PA 18018
[4] Department of Biological Sciences, East Stroudsburg University, East Stroudsburg, PA 18301

Abstract

In Costa Rica, Geoffroy's spider monkey (*Ateles geoffroyi ornatus*) is classified as 'Endangered' on the IUCN Red List of Threatened Species. Given the threats it faces, this spider monkey was included in the most recent 'Top 25 Endangered Primate Species' list published by the IUCN (Schwitzer et al. 2019). The newly established Camaquiri Conservation Initiative (CCI) site, located on 200 ha in northeastern Costa Rica in Caribbean lowland rain forest, harbors a population of these monkeys that has yet to be studied. The population size of these primates and the extent to which their habitat may be fragmented is unknown. We conducted transect surveys of spider monkeys, mantled howling monkeys (*Alouatta palliata*) and Panamanian white-faced capuchins (*Cebus imitator*) at Camaquiri in 2019, 2020 and 2021 over the course of 13.5 days, covering 32 km total, to establish baseline information important for this new reserve's conservation management plan, to provide a rough estimate of the number of study subjects available for potential researchers. We recorded, minimally, 10 spider monkeys in at least one community, at least three howling monkey groups and at least one capuchin monkey group resident at CCI. Given that large patches of healthy, intact tropical forest are rarely conserved in Central America, Camaquiri provides an opportunity to conserve endangered primate species and to contribute to our knowledge of these animals. Additionally, its proximity to other field stations provides opportunities for studies of patch connectivity, habitat quality and other characteristics that influence primate populations in this region.

Keywords: Costa Rica, conservation, *Ateles*, *Alouatta*, *Cebus*

Resumen

En Costa Rica, el mono araña de Geoffroy (*Ateles geoffroyi ornatus*) está clasificado como "En peligro" según la Lista Roja de Especies Amenazadas de la UICN. Dadas las amenazas a las que se enfrenta, este mono araña se incluyó en la lista más reciente de las 25 principales especies de primates en peligro de extinción publicada por la UICN (Schwitzer et al., 2019). El sitio de la Iniciativa de Conservación Camaquiri (CCI), recientemente establecido, ubicado en 200 hectáreas en el noreste de Costa Rica en la selva tropical de las tierras bajas del Caribe, alberga una población de estos monos que aún no se ha estudiado. Se desconoce el tamaño de la población de estos primates y la medida en que su hábitat puede estar fragmentado. Realizamos censos transectos de monos araña, monos aulladores de manto (*Alouatta palliata*) y capuchinos cariblancos panameños (*Cebus imitator*) en Camaquiri en 2019, 2020 y 2021 en el transcurso de 13,5 días, cubriendo un total de 32 km, para establecer información de referencia importante por el plan de manejo de la conservación de esta nueva reserva y por proporcionar una estimación aproximada del número de sujetos de estudio disponibles para los investigadores potenciales. Registramos, como mínimo, 10 individuos diferentes de monos araña en al menos una comunidad, al menos tres grupos diferentes de monos aulladores y al menos un grupo de monos capuchinos residente en CCI. Dado que en América Central rara vez se conservan grandes parches de bosque tropical saludable e intacto, Camaquiri brinda la oportunidad de conservar especies de primates en peligro de extinción y contribuir a nuestro conocimiento de estos animales. Además, su proximidad a otras estaciones de campo brinda oportunidades para estudios de conectividad de parches, calidad del hábitat y otras características que influyen en las poblaciones de primates en esta región.

Palabras clave: Costa Rica, conservación, *Ateles*, *Alouatta*, *Cebus*

Introduction

Approximately 60% of non-human primate species (hereafter, primates) are threatened with impending extinction, while 75% show population decline (Estrada et al. 2017). Recently, primatologists have called for increased emphasis on conserving primates in their natural habitats (Garber 2022). A review reveals that those more closely related to us, such as apes, have received greater attention than other species (Bezanson and McNamara 2019). Monkeys in the Americas are less studied than many other primate species, and these species are reliant on forested areas. Unlike many primates in Africa and Asia that are semi-terrestrial and live in more open and drier environments, the destruction of Neotropical forests is much more likely to cause local extinction of the arboreal monkey species that are reliant on Neotropical forest habitats (Benchimol et. al. 2014; Daily et al. 2003; Peres 1997) The converse is also true. The lack of primates in a forest may contribute to forest health decline, as most primate species are effective seed dispersers of tropical forest tree species, and are instrumental in the sustainability of biodiverse-rich areas of the world (Chapman and Onderdonk 1998).

In this article we provide information about the study site and describe our preliminary transect surveys to determine presence of monkey species along trails throughout the site. We also report the number of different groups observed for each species and average group sizes.

Methods

Study Site

The Camaquiri study site was established as a private reserve in 2018, following the formation of a consortium of professors and conservationists from the United States and Costa Rica. The site was privately owned by a single individual for >30 years, until it was sold to the Camaquiri Conservation Initiative (CCI). Two of the seven investors are Costa Rican, and they each hold 20% of shares of CCI. Israel Mesen serves as the manager of the station, hiring all local staff. Resources at the site include an excellent network of well-maintained trails, cabins for researchers and kitchen facilities, along with a site manager and cooks. CCI is community-based, serving as a site of employment, a food pantry and community garden, a site for environmental and conservation education for regional school children (when there is not a pandemic), and a site that collaborates closely with MINAE (essentially the Ministry of Environment and Energy) and the Barra del Colorado Wildlife Refuge of Costa Rica and the regional government entity for Pococí. The local elementary school is built on CCI property, and CCI supports costs associated with maintenance of the property. Activities that CCI hosts include a number of Environmental education and conservation projects such as the Barra del Colorado Annual Bird Count, Taller de Fincas Integrales and Consejo Municipal and programming with visiting college and university groups from the U.S. with regional K-12 schools.

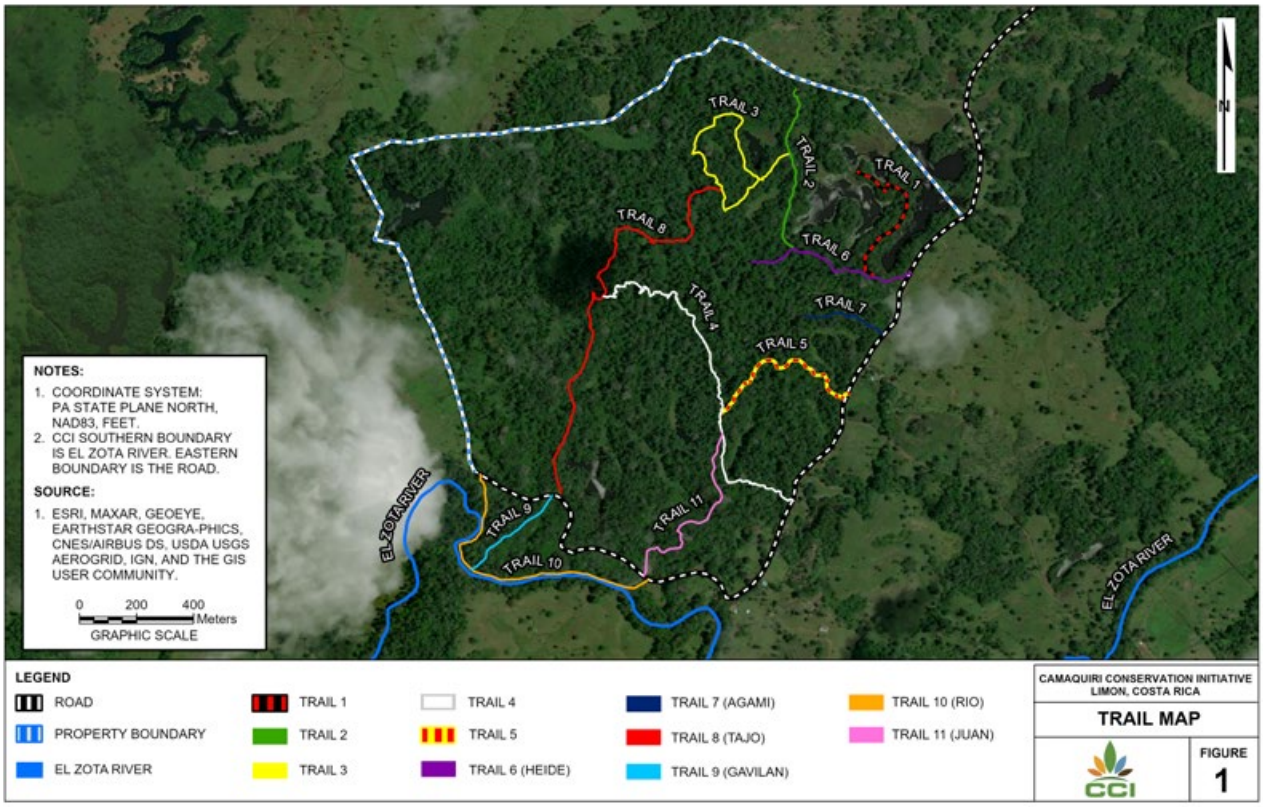

Figure 1. Map of Camaquiri Conservation Initiative, Limon, Costa Rica.

The site consists of approximately 200 ha (500 acres) of Caribbean lowland tropical rain forest that includes swampy areas and lagoons, located in northeastern Costa Rica (10.535458, -83.745436) (http://www.camaquiri.com). While Camaquiri is surrounded by a patchwork of pasture and forest, the forests on the property are mature with no signs of being logged (Figure 1). On the northern border CCI's forests are connected to forests in the Barra del Colorado Wildlife Refuge via a 0.3 km forest bridge and also a forested riparian corridor. Along CCI's eastern border its forest connectivity links it to forest within the El Zota biological station.

Data Collection

The swamp forest that characterizes this area of northeastern Costa Rica is suited to piecewise linear transects (Anderson et al. 1979) rather than random parallel transects given the topography and features of the site (i.e., designing transects around deep swamps and following natural contours, such as ridges or riverbanks). Transect sampling was scheduled such that the likelihood of recording the same monkeys on different transects was minimized, i.e., observers simultaneously surveyed transects that were more distant from each other than closer ones.

Our preliminary study followed standard methods used to quantify non-human primates involving systematic transect surveys (Paterson 2001; Elphick 2008). Surveying primates in swampy habitats is challenging, but recent work has attempted to standardize methods used in such environments (Nowak et al. 2019). Measuring and marking transects was done in December 2019. Trails were marked with a trail code and distance from the start of the trail in 10 m increments with flagging tape (Table 1). A total of 11 trails were available for survey at Camaquiri, with six oriented north-south and five oriented east-west (Table 1). Total trail distance was 8,084 m (2,868 m of trails oriented east-west, 5,216 m oriented north-south), with trails averaging 735 meters in length (Figure 1). Trail heads started or ended at gravel access roads for seven of the 11 trails, and these two gravel roads formed the western (1.2 km) and eastern (1.2 km) boundaries of the Camaquiri property save for a narrow strip of forest bordering the El Zota River to the west of the western road.

A total of 10 survey days included six full survey days in late December 2019 and early January 2020, that included at least two observers walking two different transects of at least one kilometer simultaneously each morning and again each late afternoon. In 2021, one of these observers (JDP) again walked different transects each morning and late afternoon for 3.5 days (July 31-August 4, 2021). We walked transects at a speed of one to two kilometers per hour, slower than the recommended 3 km per hour rate suggested for most primate surveys (Paterson 2001). In order to meet the assumption that animals above the transect line are detected (Anderson et al. 1979) the slower rate of 1 km per hour, along with a 5-minute stop, look and listen point each 100 meters along the transect, provided a reliable means with which to detect unhabituated howling monkeys, in particular, over or near the transect line. Surveys began at approximately 0600 hours and ended before 1100 hours, when primates were more likely to be resting. Afternoon surveys started after 1430 hours and ended before 1730 hours, at dusk. A maximum of two people surveyed one transect together at one time,

Table 1. Trail system at Camaquiri Conservation Initiative during study*.

Trail name/number	Length (meters)	Orientation	Intersects which trails?
Laguna Trail 1 (T1)	430 m	N-S	HT
Almendro Trail 2 (T2)	530 m	N-S	HT, T3
Ceiba Trail 3 (T3)	1066 m	N-S loop	T2, TT
Potoo Trail 4 (T4)	1153 m	N-S	T5, TT, PT
Danta Trail 5 (T5)	540 m	E-W	T4
Tajo Trail (TT)	1427 m	N-S	T4, T3
Agami Trail (AT)	290 m	E-W	-
Rio Trail (RT)	1195 m	E-W	GT
Gavilan Trail (GT)	283 m	E-W	RT
Juan's (pink) Trail (PT)	610 m	N-S	T4
Heide Trail (HT)	560 m	E-W	T1, T2

*Total trail length 8,084 m., not including gravel access roads (East Road = 1.2 km, West Road = 1.2 km). As some trails were given names after our study, we have included these, along with the previous numbering and flagging color system.

and two observers surveyed transects simultaneously during the majority of surveys. When a monkey was detected: (1) the mode of detection was recorded (sight, sound, smell) as well as (2) the monkey species; (3) their location (via a Global Positioning System, Garmin brand, in addition to the nearest trail marker); (4) number of individuals and their age and sex (adult male, adult female, immatures); (5) the monkeys' activity (travel, feed, rest, alarm call or other reactions to observers); and (6) the straight line distance from the nearest monkey to the transect as well as (7) to the observer, and; (8) the estimated angle between the observer, monkey and transect line. Although standard methods allow for a 10-minute contact period with each group encountered, Pruetz and Leasor (2002) found that spending at least 20 minutes with primate social groups of the same species at the nearby La Suerte site gave a better estimate of the number of individuals and their age and sex classes comparing transect surveys and census of known groups at the nearby La Suerte site.

Results and Discussion

Approximately 22 km (22,360 m) of trail and connecting roads were surveyed at Camaquiri during 15 transect walks by JDP and KD on six consecutive days between 27 December 2019 and 1 January 2020. Approximately 10 km (9,910 m) was surveyed by JDP on three consecutive days between 31 July and 3 August 2021, for a grand total of almost 32 km surveyed (n=31.9 km). Although preliminary, these data can provide a baseline for future surveys and allow comparison with the nearby El Zota and La Suerte Field Stations where students in primatology field courses conducted similar survey exercises annually for many years.

Most contacts during trail surveys were with parties of spider monkeys. A total of 26 *Ateles geoffroyi* contacts, nine *Alouatta paliatta* contacts and five *Cebus imitator* contacts were recorded (n=21 contacts with *Ateles*, 6 with *Alouatta*, 4 with *Cebus* in 2019-2020 and n=5 contacts with *Ateles*, 3 with *Alouatta*, and 1 with *Cebus* in 2021). Longer contacts with groups in 2021 compared to 2019-2020 records indicate groups may be better habituated. Contacts with subgroups or parties during the encounters with *Ateles* along transects lasted an average of 14.3 minutes per encounter in 2019-2020 and 17 minutes in 2021. In 2019-20, encounters with *Cebus* lasted on average 14.5 minutes per encounter, while those with *Alouatta* lasted 13.75 minutes per encounter, with 2021 surveys resulting in 20 minutes average with *Cebus* and 17.3 minutes average with *Alouatta*. Including an additional three encounters with spider monkeys outside of our transect surveys, we calculated party size to be 2.2 individuals per encounter (n=24 encounters; range 1-6 individuals) in 2019-20. In 2021, we recorded an average of 3 individuals (n=13 encounters; range 2-5 individuals) with parties during transect surveys and outside of survey times for spider monkeys.

Based on females' coloring and their accompanying offspring, we conservatively identified at least five different adult female spider monkeys at Camaquiri and at least three different adult or subadult male spider monkeys during our survey, for a total of eight different adults. In 2021, JDP observed a juvenile male that had a missing

Table 2. Frequency and distances surveyed along trails at Camaquiri in 2019-2021*

Trail #	Distance surveyed	Date	Time
Laguna Trail 1 (red/black)	430 m, 430 m	12/29, 8/1	p.m., a.m.
Almendro Trail 2 (green)	530 m, 340 m, 340 m, 340 m	12/29, 12/31, 1/1, 8/3	a.m., a.m., a.m.
Ceiba Trail 3 (yellow)	1066 m, 1066 m, 1066 m	12/29, 1/1, 8/3	a.m., a.m., a.m.
Potoo Trail 4 (white)	310 m, 750 m, 750 m	12/29, 12/31, 8/1	a.m., a.m., p.m.
Danta Trail 5 (red/yellow)	544 m, 544 m, 544 m	12/28, 12/31, 8/3	a.m., p.m., p.m.
Heide's Trail	560 m, 400 m, 400 m, 400 m, 400 m	12/29, 12/29, 12/31, 1/1, 8/3	a.m., p.m., a.m., a.m., a.m.
Tajo Trail	690 m, 690 m, 1427 m, 737 m	12/29, 12/31, 1/1, 8/3	a.m., a.m., p.m.
Rio Trail	1195 m, 1195 m	12/30, 7/31	a.m., a.m.
Western Road	1000 m	8/4	a.m.
Agami Trail	290 m	12/31	a.m.
Juan's Trail (pink)	610 m, 610 m, 610 m	12/28, 12/31, 8/1	a.m., p.m., a.m.

*As some trails were given names after our study, we have included these, along with the previous numbering and flagging color system.

lower right arm, bringing the estimate of five different female spider monkeys to six, when his mother was included, and the total number of individuals so far identified at CCI to at least 10. At least three howling monkey groups (Camp Group, Freddy's Group, Tajo Lagoon Group) were identified at Camaquiri in 2019-20, based on simultaneous encounters during surveys as well as location and membership information. This number increased to five in 2021, based on the use of a large fruiting *Ficus* tree by at least two howler groups (including one now called 'Eduardo's' group) near the southern boundary edge of CCI, at the end of Sendero Rio, along with sightings of the Camp Group, a group ranging near the Perezoso Pulperia (possibly Freddy's group) and near Tajo Lagoon (Tajo group), within roughly the same time period. At least one individual in the well-habituated Camp Group exhibited lack of pigmentation on her tail (Dunn et al. 2014; Ramos-Luna et al. 2022), while another in one of the groups using the *Ficus* on Sendero Rio was seen with a lack of pigmentation on its tail and right leg in 2021.

Comparisons to other sites in the area

Based on surveys using similar piecewise transects conducted during primatology field courses between 1999-2015 at the nearby El Zota Station, primate groups were contacted less frequently at Camaquiri. At the larger El Zota forest patch (~1000 ha), primate groups were contacted on average four times per km of transect (range 1–7 groups; Pruetz, unpublished data). However, most trails at El Zota are situated in the 200-ha regenerating forest patch, in contrast to the mature, unlogged Camaquiri site. This may explain the relatively infrequent contacts with howling monkey groups at Camaquiri compared to El Zota. However, the ability for howling monkeys to disperse between Camaquiri and other sites should also be considered. In a larger survey of the region, Tafoya et al. (2020) encountered primate groups in general at a rate of 0.35 per kilometer surveyed. Another explanation is that the howler monkey groups at Camaquiri are habituated to humans at forest edges along roads and adjacent to dwellings. The Camp Group of howling monkeys and Freddy's Group of howling monkeys, each observed at road edges almost daily during the survey, were better habituated to humans, while the Tajo Lagoon Group of howlers, which were frequently seen near a lagoon, 700 m from the main road, were observed to move away from approaching human observers. In 2021, a group on the Yellow Trail, which may have been the Tajo group, ceased vocalization until seen by the observer, after which two adult males of this group began howling at the observer until she finished the survey contact period and moved off. This group deeper within the Camaquiri forest patch was less habituated to people.

The spider monkeys at Camaquiri were surprisingly well-habituated, even in forest interiors, despite the fact that the establishment of the trail system began in March 2019. A likely explanation is that the El Zota South community of spider monkeys uses Camaquiri forest as well. Less than 0.5 km separates the northern edge of Camaquiri with the southern edge of El Zota, with a patchwork of forest and gallery forest corridors characterizing two properties between these field stations. Given the relatively large home and day ranges of this species, *Ateles* here might be transferring their habituation to humans in areas like roads and houses to interior forest areas. The trail system used for surveys at Camaquiri is spaced such that primate encounters are more likely to be independent than those at El Zota, where the narrowness of forested areas could result in a lack of independence in primate encounters (see map of El Zota in Pruetz and LaDuke 2001). Camaquiri is available for both field courses and research, which provides the intriguing opportunity to make comparisons with La Suerte and El Zota and to also examine the role of field stations in conserving primate species living in a patchy anthropogenic landscape in lowland Costa Rica.

While our sample sizes prevent us from calculating proper densities of the species, encounters with the three primate species at Camaquiri suggest that all three monkey species do not exhibit low densities here. Our contact with *Cebus* was relatively low but not surprising given the larger home ranges than *Alouatta* but shorter daily path lengths and more cohesive travel by this species when compared to *Ateles,* which travels farther per day and frequently splits into subgroups or parties.

Finally, the presence of a juvenile spider monkey with a partially missing limb should be further investigated. To our knowledge, this is the third such individual within the larger *Ateles* population surrounding CCI. At the El Zota site, two immature spider monkeys were also observed with partially missing limbs in previous years: A juvenile female missing her left arm and a juvenile male missing most of his right (Wackerly 2016). Future studies that take into account gene flow, possible inbreeding and potential environmental toxins could shed light on this phenomenon. The underlying explanations for such disabilities make for important research topics, as we have yet to observe adults with missing limbs, implying that spider monkeys may not survive to adulthood with such afflictions and therefore of concern to conservation of this endangered primate species at Camaquiri and El Zota.

Acknowledgments

Funding for this research was provided by the Texas State University Research Enhancement Program. Field assistance by S. Cannon, K. Murman, K. Juchno and C. Janusz of East Stroudsburg University was invaluable to the completion of this survey.

References

Anderson, D. R., Laake, J. L., Crain, B.R. and Burnham K.P. 1979. Guidelines for line transect sampling of biological populations. *Journal of Wildlife Management* 43: 70–78.

Benchimol, M. and Peres, C. A. 2014. Predicting primate local extinctions within "real-world" forest fragments: a pan-neotropical analysis. *Am. J. Primatol.* 76(3): 289–302.

Bezanson, M., McNamara, A. 2019. The what and where of primate field research may be failing primate conservation. *Evolutionary Anthropology* 28: 166–178.

Chapman, C. A. and Onderdonk, D. A. 1998. Forests without primates: primate/plant codependency. *Am. J. Primatol.* 45: 127–141.

Daily, G. C., Ceballos, G., Pacheco, J., Suzán, G. and Sánchez-Azofeifa, A. 2003. Countryside biogeography of neotropical mammals: conservation opportunities in agricultural landscapes of Costa Rica. *Conservation Biology* 17(6): 1814–1826.

Dunn, J. C., Shedden-González, A., Cristóbal-Azkarate, J., Cortés-Ortiz, L., Rodríguez-Luna, E. and Knapp, L. A. 2014. Limited genetic diversity in the critically endangered Mexican howler monkey (*Alouatta palliata mexicana*) in the Selva Zoque, Mexico. *Primates* 55(2): 155–160.

Elphick, C. S. 2008. How you count counts: the importance of methods research in applied ecology. *Journal of Applied Ecology* 45: 1313–1320.

Garber, P. A. 2019. Distinguished primatologist address—moving from advocacy to activism: changing views of primate field research and conservation over the past 40 years. *Am. J. Primatol.* 81(9): e23052.

IUCN. 2022. The IUCN Red List of Threatened Species. Version 2021-3. International Union for the Conservation of Nature (IUCN), Gland.
Website: www.iucnredlist.org. Accessed 19 June 2022.

Luckett, E., Danforth, E., Linsenbardt, K. and Pruetz, J. D. 2004. Planted trees as corridors for primates at El Zota Biological Field Station, Costa Rica. *Neotrop. Primates* 12: 143–146.

Nowak, K., Barnett, A. A. and Matsuda, I. 2019. *Primates in Flooded Habitats: Ecology and Conservation*. Cambridge University Press, Cambridge, UK.

Paterson, J. D. 2010. *Primate Behavior*. Waveland Press, Inc., Long Grove.

Peres, C. A., 1997. Effects of habitat quality and hunting pressure on arboreal folivore densities in neotropical forests: a case study of howler monkeys (*Alouatta* spp.). *Folia Primatol.* 68(3–5): 199–222.

Pruetz, J. D. and LaDuke, T. C. 2001. New field site: preliminary census of primates at El Zota Biological Field Station, Costa Rica. *Neotrop. Primates* 9(1): 22–23.

Pruetz, J. D. and Leasor, H. C. 2002. Densities of primate species in forest fragments at La Suerte Biological Field Station, Costa Rica. *Neotrop. Primates* 10: 4–9.

Ramos-Luna, J., Alvarez-Velazquez, M. F., Chapman, C. A. and Serio-Silva, J. C. 2022. Anomalous pigmentation in American primates: review and first record of a leucistic black howler monkey in southeast Mexico. *Folia Primatol.* 1: 1–9.

Schwitzer, C., Mittermeier, R. A., Rylands, A. B., Chiozza, F., Williamson, E. A., Byler, D., Wich, S., Humle, T., Johnson, C., Mynott, H. and McCabe, G. 2019. Primates in peril: the world's 25 most endangered primates 2018–2020. IUCN SSC Primate Specialist Group, International Primatological Society, Global Wildlife Conservation, and Bristol Zoological Society: Washington, DC.

Wackerly, N. 2016. Positional behavior of black-handed spider monkeys (*Ateles geoffroyi*), including a one-armed individual, at El Zota Biological Field Station, Costa Rica. MA thesis, Iowa State University, Iowa.

DOI: https://doi.org/10.62015/np.2022.v28.226

EUROPEAN *EX SITU* PROGRAMMES FOR LARGER NEW WORLD MONKEYS

Jan Vermeer[1], Adrian Baumeyer[2]

[1]WildZOOm Animal Management & Conservation, Duizendschoon 12, 7322GZ Apeldoorn, The Netherlands.
E-mail: <jan.vermeer@callicebus.nl>
[2]Chair EAZA Larger New World Monkey TAG, Zoo Basel, Binningerstrasse 40, 4054 Basel, Switzerland.

Abstract

Captive breeding programmes for primates can support the conservation of *in situ* populations of endangered species. European zoos, organised in the European Association of Zoos and Aquaria, keep almost 4000 of the larger Neotropical primates in their collections. Most of the species are managed in cooperative breeding programmes of various sizes. We report the current state of the European captive breeding programmes for these species and discuss the role assigned to each concerning the conservation of primates *in situ*. European zoos are successfully breeding most species currently kept under their care and are able to make an important contribution to the captive breeding of other, more endangered primate species, if requested by range countries. Many zoos that keep larger Neotropical primates provide financial or technical support to *in situ* conservation projects.

Keywords: captive breeding, zoos, EAZA, Larger New World Monkey TAG, conservation

Introduction

Modern zoos play an important role in the conservation of species and habitats, and large conservation organisations such as the International Union for Conservation of Nature (IUCN) recognize that *ex situ* management is one option that can contribute to the conservation of threatened species (IUCN SSC 2014). While zoos are important financial contributors to nature conservation, they can also support conservation initiatives through technical assistance, research projects and educational programmes. It is important that international authorities, governments and conservationists are aware of the wide array of support that modern zoos can provide to nature conservation activities. *Ex situ* populations of animals are important for their educational and research roles, and can furthermore serve to reinstate or reinforce wild populations. However, intensive management is necessary to guarantee their demographic and genetic health. Different regional zoo associations have set up *ex situ* programmes (Mũnoz Lora et al. 2020) and here we describe the organisation of such programmes and the status of larger Neotropical primates in European zoos.

Organisation of *Ex Situ* Programmes in European Zoos

The captive breeding programmes in European zoos are coordinated by the European Association of Zoos and Aquaria (EAZA) and are named EAZA *Ex Situ* Programmes (EEPs). At this moment, more than 400 taxa are managed in an EEPs of both vertebrates and invertebrates. In January 2018 EAZA implemented a new Population Management Structure, guided by the One Plan Approach to species conservation planning (Byers et al. 2013) and the IUCN Species Survival Commission (SSC) Guidelines on the Use of *Ex Situ* Management for Species Conservation (IUCN SSC 2014). The main participants of the EEPs are EAZA members, but in specific cases non-EAZA zoos (including those from other regions) and even private breeders can be approved for participation, provided that they meet the EAZA standards and their participation is important for the EEP. The EEP Committee is responsible for the functioning and development of the EEPs and long-term animal collection planning. An extensive Population Management Manual has been developed by EAZA (EAZA 2022), and is constantly being updated. Each taxonomic group of animals is overseen by a Taxon Advisory Group (TAG), consisting of a Chair and one or more Vice Chair(s) and a core group of experts and studbook keepers. Experts from in- and outside EAZA can be invited as advisors. Considering the large number of Neotropical primate species kept in European zoos, it has been decided to manage the EEPs for the callitrichids in the Callitrichid TAG and all other species in a Larger New World Monkey TAG. Here we focus only on the species managed in the latter. The main tasks of the TAG are the development and implementation of the Regional Collection Plan (RCP) for the EAZA region and assisting EEP coordinators in the development of their programmes. In the RCP, the TAG determines which species are recommended for management under an EEP. The most recent RCP for the Larger New World Monkey TAG was published in 2007 (Vermeer 2007). When compiling the RCP, the TAG has to find a balance between the needs of the species, their availability in

captivity, the institutional wishes of EAZA members, the husbandry requirements of a species and the capacity in zoos (enclosure space, staff, etc.). Ideally, we would have EEPs for all species that are in need of *ex situ* management. However, the current species' presence in zoos should be seen in an historical context and reflects the species that were obtained in the past through animal dealers. In many cases these are non-endangered species. However, keeping non-endangered species can also be beneficial for conservation (e.g., for research and education), and for species that are currently considered to be "safe" that could become endangered in the near future. An important condition to decide the initiation of an EEP for a certain species is the availability of sufficient animals to manage a demographically and genetically viable population (Ballou et al. 2010). In most cases, these animals need to be available in captivity outside range countries, as import from range countries is often impossible. There are exceptions, such as the EEP of the buff-headed capuchin monkey (*Sapajus xanthosternos*). This species was not present in zoos outside Brazil and an *ex situ* population was created in Europe with the cooperation of the Brazilian government. The TAG has implemented a nonbreeding policy for the population of non-endangered capuchins in EAZA zoos, in order to provide more space for the critically endangered buff-headed capuchin monkeys. Following the example of the buff-headed capuchin monkey EEP, EAZA zoos would be available to initiate or participate in international breeding programmes for endangered species that are in need of a well-managed *ex situ* breeding programme that are not yet present in European zoos. Space in zoos is restricted, but populations of non-endangered species could be phased-out by nonbreeding policies to create space for endangered species. Most endangered Neotropical primate species are no less attractive than the species currently kept in European zoos, so visitors will hardly see the difference. Many visitors would, however, appreciate the efforts of zoos for wildlife conservation through captive breeding. Zoos and rescue centres in range countries often keep endangered primates that for some reason cannot be returned to the wild, and such individuals could be very suitable for cooperative captive breeding programmes.

Roles of EAZA *Ex Situ* Programmes

As mentioned, there are various ways that keeping non-endangered species in zoos can serve nature conservation. The different roles that can be assigned to an EEP are direct conservation (insurance population for future restoration or reinforcement, rescue, research, training, education) and indirect conservation (providing knowledge, education, lobbying, fundraising) (EAZA 2022). With close to one billion visitors annually, zoos can have a huge impact on people's attitudes towards nature and environmental protection, and the conservation status of the presented species is hardly an issue for this role. Non-endangered species can serve as models for research that can help the conservation of endangered species. A good example is that the extensive experience with keeping non-endangered callitrichids in zoos has served as a guide for the initiation of captive breeding programmes for endangered species such as *Callithrix aurita* and *Oedipomidas leucopus*. The non-endangered species can also serve as ambassadors for their wild counterparts, resulting in the initiation of or support for conservation projects for endangered species. After receiving a breeding group of coppery titi monkeys (*Plecturocebus cupreus*), La Vallée des Singes primate park in France initiated Proyecto Mono Tocón, for the conservation of the critically endangered San Martín titi monkey (*Plecturocebus oenanthe*) in Peru (Bóveda-Penalba et al. 2009; Vermeer and Shanee 2020). This project exists thanks to the financial support of coppery titi EEP participants and resulted in several other conservation initiatives for this species in Peru.

Table 1. Examples of some conservation programmes supported by EAZA zoos.

Species	Country	Conservation Partners
Sapajus xanthosternos	Brazil	Universidade Federal de Mato Grosso, UNIMONTES and others
Ateles fusciceps	Ecuador	Proyecto Washu
Ateles fusciceps	Colombia	Neotropical Primate Conservation
Ateles hybridus	Venezuela	Spider Monkey Conservation Project
Ateles geoffroyi	Nicaragua	Paco Pacífio
Ateles geoffroyi	Belize	Wildtracks USA, International Tropical Conservation Fund
Ateles paniscus	French Guiana	Kwata
Lagothrix lagothricha	Peru	Ikama
Lagothrix flavicauda	Peru	ONG Ucumari, Neotropical Primate Conservation
Plecturocebus oenanthe	Peru	Proyecto Mono Tocón

Current State of Larger New World Monkeys Populations in EAZA Zoos

Muriquis, Brachyteles *spp.*
There are no captive muriquis outside Brazil and very few in Brazilian zoos or other institutions. Although muriquis in European zoos could be great ambassadors of the Atlantic forest, it doesn't seem to be realistic to export animals to Europe unless captive breeding in Brazil becomes very successful and space is needed for surplus animals.

Woolly monkeys, Lagothrix *spp.*
Woolly monkeys have proven to be very difficult to keep in captivity. As the population in Europe has dropped to less than 35 individuals, most of them being subspecific hybrids, there has been a decision to discontinue the existing EEP. Zoos are urged not to import new animals from South America and to focus on spider monkeys as the representative of the large atelids.

Spider monkeys, Ateles *spp.*
Spider monkeys are relatively easy to keep in captivity. The large population of almost 250 Colombian black spider monkeys (*Ateles fusciceps rufiventris*) is managed in an EEP that was initiated in 1995. This population has shown steady growth since the arrival of the first registered animals in the early 1960's. At least 35 founder animals contributed to the EEP population and 25 years of management resulted in a current retained gene diversity of 97% (Ballou et al. 2010). Genetic tests of this population are underway; there is some concern that hybridisation with other species has taken place, although it is also possible that some of the wild born founders originated from a region where introgression with *A. hybridus* is known to occur (Ruiz-García et al. 2006).

The red-faced spider monkey (*Ateles paniscus*) has never been common in EAZA zoos and the population has never thrived. The situation changed somewhat in 2006, when GaiaZoo and La Vallée des Singes were requested to accommodate six females from a closed rescue centre in French Guiana. Guyana Zoo (in French Guiana) is an EAZA member and occasionally receives abandoned or confiscated spider monkeys that are also integrated in the EEP. Currently there are 45 living red-faced spider monkeys managed in the EEP. Despite the addition of the wild born animals, of which several are unfortunately unsuitable for breeding due to behavioural or physical problems, there is still very little growth of the population. However, considering that almost 50% of the population is less than 10 years old, one can expect that the population will increase in the near future.

In 2000, the EEP for the brown spider monkey (*Ateles hybridus*) was initiated. A growing population of approximately 70 animals in the EAZA region descends from 16 founder animals. Considering that 25% of the population is less than 4 years old, further growth of the population can be expected. Recently the last two viable breeding males from the USA were received, and both have already bred and bring with them viable new bloodlines to the population. Despite the small population, 92% of gene diversity has been preserved and imports of new founders from other regions should not be impossible.

The difficulties we have with the management of spider monkeys are mostly the same for all three species: although the sex ratio at birth is female-biased, there is a surplus of males for which it is difficult to find a place in other zoos. This is of course normal for a species that lives in groups with generally more females than males. Keeping more than one adult male in a group is recommended but not always possible; other males are kept in bachelor groups.

The RCP defines the role of these EEPs as a "conservation/insurance population". The maximum size of the populations, mainly based on space availability, has been defined at 250 individuals for *Ateles fusciceps rufiventris*, 100 individuals for *A. paniscus* and 150 individuals for *A. hybridus*, meaning that breeding now needs to be restricted for the Colombian black spider monkeys. Zoos keeping spider monkeys support conservation projects for spider monkeys in Colombia, Venezuela, Ecuador, Peru and Nicaragua (Table 1).

Ateles fusciceps fusciceps and *A. marginatus* are not present in EAZA, while *A. chamek* and *A. belzebuth* have always been rare in European zoos and are being phased out slowly. Less than 45 *A. geoffroyi* (different subspecies) remain in European zoos; the population is not viable, so it has been decided to phase them out. Suitable individuals have already been or will be transferred to regions with a breeding programme (USA and Australia).

Howler monkeys, Alouatta *spp.*
Only three species of howler monkeys are present in EAZA zoos, *Alouatta macconnelli*, *A. seniculus* and *A. caraya*. Considering that the populations of the Guianan red howler monkey (*A. macconnelli*) and the Colombian red howler monkey (*A. seniculus*) are small and not viable, that both are of Least Concern and that space for howler monkeys in zoos is limited, it has been decided that breeding of these species should be restricted to keeping a stable population for husbandry research purposes. The black and gold howler monkey (*A. caraya*) has priority and a breeding programme for that species was initiated in 1995. Black and gold howler monkeys are not very difficult to keep and can live up to 30 years in captivity. The population is based on 20 founder animals and has grown to 130 individuals. Gene diversity is 93%; with strict genetic management, population growth to 200 animals and the addition of one new founder each 20 years, the genetic health of the population would be guaranteed. Black and gold howler monkeys are also kept in

zoos in range countries and the USA, and obtaining new (captive born) founders should not be a problem. The role of the species in the RCP is defined as "education". The TAG would like to focus on more endangered howler monkey species, but these are not available in sufficient numbers to start a viable insurance population.

Capuchin monkeys, Cebus *spp. and* Sapajus *spp.*
More than 750 capuchin monkeys live in EAZA zoos, but unfortunately most have little direct conservation value, as they are (sub)specific hybrids or belong to non-endangered taxa. As representatives of the capuchins, the TAG decided in the RCP to focus on two species, the critically endangered *Sapajus xanthosternos* and the vulnerable *Cebus imitator*. All other capuchins should be phased out, but considering that they may live more than 50 years (Hakeem et al. 1996), this will take some time.

The EEP for the white-throated capuchin (*Cebus imitator*) was initiated in 2005. Although we know that at least a part of the population originates from Central America, it is not clear if all animals in the population are pure *C. imitator* and genetic studies should teach us more about this situation. Space for capuchins in European zoos is limited and needs to be reserved for more endangered taxa, therefore the RCP recommends to restrict breeding to keep the population at approximately 100 individuals.

The European population of buff-headed capuchin monkeys (*Sapajus xanthosternos*) was created in 1990, when Mulhouse Zoo (France) received the first animals from the Rio de Janeiro Primate Centre. In 2000 an EEP was initiated, as numbers were growing quickly and genetic management was necessary. Animals living in Brazilian institutions are registered in the studbook, though not actively managed through the EEP. The European population has increased in 30 years to almost 220 individuals, and because of space problems breeding restrictions are instated. The population is genetically very healthy and in the future new bloodlines from Brazilian institutions could be added. The main difficulties of the programme are the fast growth of the population and the highly skewed sex ratio at birth, causing a surplus of males. Since the beginning of the programme, European zoos that keep buff-headed capuchin monkeys provide vital financial support to fieldwork in Brazil (Table 1).

Uakaris, Cacajao *spp. and bearded saki monkeys,* Chiropotes *spp.*
Although some uakaris survived in the past for more than 30 years in European zoos, they have always been rare and nowadays none are present. There are currently a few reddish-brown saki monkeys (*Chiropotes sagulatus*), but breeding results are sporadic. The RCP states that the species should be monitored and that a small population could be kept for husbandry research.

Saki monkeys, Pithecia *spp.*
Only one species of *Pithecia* is present in European zoos, the white-faced saki monkey (*Pithecia pithecia*). As with some other taxa, European zoos would be happy to use their extensive and successful experiences for the *ex situ* programme of another, endangered species, if sufficient animals would be available. At this moment, the saki monkeys in zoos mainly have an educational value, which is also very important. The EEP for the white-faced saki monkey was initiated in 1995. The species is doing very well in European zoos and the population has grown to more than 300 individuals. As space is limited, breeding is currently controlled to avoid a further growth of the population. Captive saki monkeys can live very long, the oldest living animal is 37 years old. Although the species can live in the wild in larger groups (Thompson 2016), in zoos they are kept usually in pairs as adults of the same sex do not accept the presence of another. Sex ratio is skewed towards males, which is a problem as it is not easy to keep white-faced saki monkeys in large bachelor groups.

Titi monkeys, Plecturocebus *spp.*
The coppery titi monkey (*Plecturocebus cupreus*) is the only species of titi monkeys kept in European zoos. As with some other taxa, European zoos would be very interested in focussing on an endangered species, such as one of the Atlantic Forest titi monkeys (*Callicebus* spp.), if requested by the authorities of the range country. The EEP for the coppery titi monkey was established in 2002, when 28 individuals were received from the successful colony of the California National Primate Research Center – UC Davis (CNPRC). Unfortunately, some of the animals are hybrids of *P. cupreus* and *P. discolor* (Hoyos et al. 2016). The population has developed slowly to a total of 115 animals. A total of 259 births have been reported, but neonatal mortality (<30 days) was 32%. This mortality was partly caused by poor parental behaviour. The oldest recorded animal lived almost 35 years (captive born). In the RCP the primary roles of this EEP have been defined as education and husbandry research.

The EEP has adopted Proyecto Mono Tocón as its conservation project and the participants of the EEP are the main financial contributors to this project. Proyecto Mono Tocón has been initiated by La Vallée des Singes (France) for the conservation of the critically endangered *Plecturocebus oenanthe*, endemic to a small part of Peru. The attractive (non-endangered) coppery titi monkey is a perfect ambassador for its endangered Peruvian cousin.

Night monkeys, Aotus *spp.*
The studbook for night monkeys was initiated in 2000. The animals in European zoos were separated in two populations, based on karyotype or phenotype, *Aotus griseimembra* and *A. azarae boliviensis*. However, as there is only a limited interest for night monkeys in European

Table 2. Current population size of larger Neotropical primates in EAZA zoos, with the RCP population goals and roles.

Taxon	Red list status	Population size	RCP goal	RCP Roles
Lagothrix lagothricha ssp.	Vulnerable	35	≤ 35	Education, husbandry research
Ateles fusciceps rufiventris	Vulnerable	240	250	Conservation, education
Ateles paniscus	Vulnerable	45	100	Conservation, education
Ateles hybridus	Critically Endangered	70	150	Conservation, education
Ateles geoffroyi ssp.	Endangered	45	Replace	None
Ateles chamek	Endangered	6	Replace	None
Alouatta caraya	Near Threatened	130	200	Education
Alouatta macconnelli	Least Concern	6	≤30	Husbandry research
Alouatta seniculus	Least Concern	35		
Cebus imitator	Vulnerable	110	100	Education
Cebus spp.	Least Concern	45	Replace	None
Sapajus xanthosternos	Critically Endangered	220	250	Conservation, education
Sapajus spp.	Least Concern	>375	Replace	None
Chiropotes sagulatus	Least Concern	15	50	Education, husbandry research
Pithecia pithecia	Least Concern	300	300	Education
Plecturocebus cupreus	Least Concern	112	150	Education, husbandry research
Aotus griseimembra	Vulnerable	85	150	Conservation, education
Aotus spp.	Least Concern	60	Replace	None
Saimiri b. boliviensis	Least Concern	800	800	Education
Saimiri b. peruviensis	Least Concern	250	250	Education
Saimiri sciureus	Least Concern	500	750	Education
Saimiri spp.	Least Concern	>100	Replace	None
TOTAL		**>3500**	**≤3570**	

zoos (partly because there are few zoos with nocturnal houses) and not enough space for two viable populations of this interesting primate, it was decided in 2017 to give priority to the grey-handed night monkey (*A. griseimembra*), that is listed as Vulnerable and has the largest captive population. The current population of this species includes almost 100 individuals, with a balanced sex ratio. Work is underway to genetically test all animals, as night monkeys are difficult to identify by phenotype only and hybridisation is known to exist in captivity. In the past years, approximately ten births have been recorded annually, but the population remains more or less stable due to equal mortality numbers. The oldest recorded animal in the population lived an estimated 36 years (wild born). The roles for this population are defined in the RCP as conservation (insurance population) and education (the only nocturnal Neotropical primate genus).

Squirrel monkeys, Saimiri *spp.*

Squirrel monkey are popular animals in zoos, as they are very active and can live in large groups. In EAZA zoos, *Saimiri boliviensis boliviensis*, *S. b. peruviensis* and *S. sciureus* are managed in separate EEPs. None of these taxa are endangered in the wild, therefore their roles have been defined in the RCP as education. The TAG would be very interested in the initiation of an EEP for the red-backed squirrel monkey (*S. oerstedii*), if requested by range countries.

The EEP for the two subspecies of *Saimiri boliviensis* was initiated in 2001 when it had become clear that the population in European zoos was threatened due to a lack of breeding and that genetic management was necessary to maintain its viability. The EEP population of the black-headed *S. b. boliviensis* is very large, with approximately 800 individuals. The main challenge now is to limit population growth, as there is limited space in zoos. Projections show that, without breeding restrictions, the population could grow to more than 1500 in less than 20 years. The population has a healthy genetic diversity, but strict breeding recommendations are necessary to keep the population viable. While the nominate subspecies has been kept for a long period in European zoos, the population of the Peruvian squirrel monkey *S. b. peruviensis* was only founded in 1998, when La Vallée des Singes primate park (France) imported a group of 51 animals from the USA. Since then the European population has increased to more than 250 animals, with a healthy genetic diversity.

The EEP of the Guianan squirrel monkey (*Saimiri sciureus*) was initiated in 2007. European zoos imported a considerable number of wild caught squirrel monkeys from Guyana and Suriname in the early 1990's, which are the basis of the current managed population that has grown to more than 500 individuals. The populations of other common squirrel monkeys, of unknown origin and possibly belonging to other species (*S. cassiquiarensis*, *S. macrodon*) have not been mixed with the Guianan squirrel monkeys and will be phased out. Squirrel monkeys are popular in zoos, but with a total of 1660 individuals the maximum capacity in European zoos has almost been reached and growth is being restricted. A separately managed population of *S. b. boliviensis* with animals originating from European zoos has already been set up in Australia. For a species living in large groups with often only one adult male and a large number of females, a male surplus is a logical result. Fortunately, males can be kept very well in bachelor groups.

Discussion

More than 3500 larger Neotropical primates live in EAZA zoos, most of them managed by EEPs. The first EEPs were initiated in 1985 and have developed to professionally managed breeding programmes, with a focus on a good demographic and genetic health of the populations (Ballou et al. 2010). Natural social behaviour and individual characters are other important factors that are considered when managing a population and transferring animals between groups. The Regional Collection Plan is an important tool to manage the populations of Larger New World Monkeys in EAZA zoos. When adhering to the recommendations of the RCP, zoos should consider liberating space not only for recommended species but also for new species that may be in need of captive management. Providing optimal care is an important goal of the TAG and the compilation of Best Practice Guidelines is a useful tool to help zoos take good care of their animals.

Ex situ breeding programmes can play an important role in the conservation of endangered primates. Captive populations may serve as insurance populations for possible reintroductions, *ex situ* research can help researchers in the field, and education may change people's consumption of products that can be harmful for nature (such as non-certified palm oil, coffee, soy and tropical hardwood). Zoos also provide financial or technical support to conservation projects: in the past 5 years EAZA zoos have supported many *in situ* conservation or research projects for Larger New World Monkeys (Table 1).

The EAZA Larger New World Monkey TAG is eager to cooperate with zoos, authorities and conservation organisations worldwide to further support the conservation of Neotropical primates.

Acknowledgements

We want to thank all colleagues for their efforts to manage primates in captivity, with nature conservation as the ultimate goal. We are especially grateful for the dedication and investment of the EEP coordinators and their species committees, as we know that it is not always easy to find the time for the ever-growing workload, and we thank them for allowing us to use their data.

References

Ballou, J.D., Lees, C., Faust, L.J., Long, S., Lynch, C., Bingaman Lackey, L. and Foose, T.J. 2010. Demographic and Genetic Management of Captive Populations. In: *Wild Mammals in Captivity: Principles and Techniques for Zoo Management*. 2nd ed., D. G. Kleiman, K. V. Thompson and C. Kirk Baer (eds.), pp.219–252. The University of Chicago Press, Chicago and London.

Bóveda-Penalba, A.J., Vermeer, J., Rodrigo. F. and Guerra-Vásquez, F. 2009. Preliminary report on the distribution of *Callicebus oenanthe* on the eastern feet of the Andes. *Int. J. Primatol.* 30(3): 467–480.

Byers, O., Lees, C., Wilcken, J. and Schwitzer, C. 2013. The One Plan Approach: the philosophy and implementation of CBSG's approach to integrated species conservation planning. *WAZA News Magazine* 14: 2–5.

EAZA. 2022. EAZA population management manual: standards, procedures and guidelines for population management within EAZA. European Association of Zoos and Aquaria, Amsterdam, the Netherlands.

Hakeem, A., Sandoval, R. G., Jones, M. and Allman, J. 1996. Brain and life span in primates. In: *Handbook of the Psychology of Aging*, 4th edition. J. E. Birren and K. W. Schaie (eds.), pp.78–104. Academic Press, San Diego, USA.

Hoyos, M., Bloor, P., Defler, T.R., Vermeer, J., Röhe, F. and Pires Farias, I. 2016. Phylogenetic relationships within the *Callicebus cupreus* species group (Pitheciidae: Primates): biogeographic and taxonomic implications. *Mol. Phylogenet. Evol.* 102: 208–219.

IUCN/SSC. 2014. Guidelines on the use of ex Ssitu management for species conservation. Version 2.0. IUCN Species Survival Commission, Gland, Switzerland.

Muñoz Lora, M. L., Gómez Cadenas, K., Falla Beltrán, A. C. and Soto Calderón, I. D. 2020. Trends in the use of studbooks in captive breeding programs of Neotropical primates. *Neotrop. Primates* 26(1): 30–40.

Ruiz-Garcia, M., Parra, A., Romero-Aleán, N., Escobar-Armel, P. and Shostell, J. M. 2006. Genetic characterization and phylogenetic relationships between the *Ateles* species (Atelidae, Primates) by means of DNA microsatellite markers and craniometric data. *Primate Report* 73: 3–47.

Thompson, C. L. 2016. To pair or not to pair: sources of social variability with white-faced saki monkeys

(*Pithecia pithecia*) as a case study. *Am. J. Primatol.* 78(5): 561–572.

Vermeer, J. and Shanee, S. 2020. *Plecturocebus oenanthe*. The IUCN Red List of Threatened Species 2020. Website: https://www.iucnredlist.org/species/3553/17975319. Accessed 31 December 2022.

Vermeer, J. 2017. Regional collection plan for the larger New World monkeys, 2nd edition. European Association of Zoos and Aquaria.

DOI: https://doi.org/10.62015/np.2022.v28.227

COMPOSITION, DISTRIBUTION AND MOVEMENT OF HOWLER MONKEY GROUPS (*ALOUATTA PALLIATA*) IN THE AGRICULTURAL LANDSCAPE OF PITAL, SAN CARLOS, COSTA RICA

Paulina Vargas-Alpízar[1], Esteban Calderón-Sancho[2], Lilliana Piedra-Castro[3], Ronald Sánchez-Porras[4]

[1] Escuela de Ciencias Biológicas, Universidad Nacional, Costa Rica. E-mail: <pvargasalpizar@gmail.com>
[2] Escuela de Ciencias Biológicas, Universidad Nacional, Costa Rica. E-mail: <estebancs185biologia@gmail.com>
[3] Laboratorio de Recursos Naturales y Vida Silvestre (LARNAVISI), Escuela de Ciencias Biológicas, Universidad Nacional, Costa Rica. E-mail: <lilliana.piedra.castro@una.cr>
[4] Universidad de Costa Rica, Sede de Occidente. E-mail: <ronald.sanchez@ucr.ac.cr>

Abstract

Some areas intensively used by humans provide suitable habitat for wildlife, and knowledge of basic population characteristics of wildlife in these areas can help prioritize appropriate actions for their protection. The objective of the present study was to determine the distribution, composition and movement of groups of howler monkeys in an agricultural landscape of 8,400 ha in Pital of San Carlos, Costa Rica. This area contains a total of 115 forest fragments larger than 0.5 ha, of which 103 were evaluated, and 39 were occupied by monkeys. A total of 561 individuals were counted, for an ecological density of 1.44 individuals/ha. On average, groups were composed of 24% adult males, 45% adult females, 24% juveniles, and 7% infants. Most of reported monkey movements (76%) between fragments and through deforested areas covered less than 300 m. There is a positive relationship between increase in size and vegetation quality of the forest fragments with the number of howler monkeys found in the fragments. The high number of individuals encountered in this study compared to that in other areas may be related to the quality of the vegetation in the forest fragments inside the study area and their surroundings.

Key words: Platyrrhini, demography, forest fragments, Central America, group composition

Resumen

Algunas áreas de intensivo uso humano proporcionan hábitat adecuado para la vida silvestre, el conocimiento de las características básicas de la población de vida silvestre en estas áreas puede ayudar a priorizar las acciones apropiadas para su protección. El objetivo del presente estudio fue determinar la distribución, composición y movimiento de las manadas de monos aulladores en un paisaje agrícola de 8.400 ha en Pital de San Carlos, Costa Rica. Esta área contiene un total de 115 fragmentos de bosque mayores de 0,5 ha, de los cuales 103 fueron evaluados y 39 estaban ocupados por monos. Se contabilizaron un total de 561 individuos, para una densidad ecológica de 1,44 individuos/ha. En promedio, las tropas estaban compuestas por 24% de machos adultos, 45% de hembras adultas, 24% de juveniles y 7% de crías. La mayoría de los reportes de movimientos de monos entre fragmentos (76%), a través de áreas deforestadas, cubrieron menos de 300 m de distancia. Existe una relación positiva entre el aumento de tamaño y la calidad de la vegetación de los fragmentos de bosque con el número de monos aulladores encontrados en ellos. El alto número de individuos encontrados en este estudio, en comparación con el de otras áreas, puede estar relacionado con la calidad de la vegetación en fragmentos dentro del área de estudio o sus alrededores.

Palabras clave: Platyrrhini, demografía, fragmentos de bosque, América Central, composición de grupos

Introduction

To succeed in species conservation, protection efforts should not be focused solely on protected areas, which are generally insufficient to maintain stable populations in the long term (Harvey and Sáenz 2008). Areas that are intensively used by humans are also important for the conservation of biodiversity, making it necessary to preserve their native vegetation and establish connections that facilitate movement or that provide suitable habitats for wild species within these modified landscapes (Ranganathan and Daily 2008). These types of landscapes are frequently found in rural areas of Costa Rica, including the area of Pital of San Carlos, where economic growth has been achieved by cattle ranching and the more recent

introduction of crops such as cassava (*Manihot esculenta*) and pineapple (*Ananas comosus*), which has also led to a substantial loss of forest cover (Programa Estado de la Nación 2009).

The mantled howler monkey (*Alouatta palliata*) is a common primate in forest remnants in low and mid-altitude areas in Costa Rica, and is recognizable by its loud calls. Like many other populations throughout the distribution of this species, the howler monkeys in Costa Rica are affected by forest fragmentation and loss (Estrada et al. 1994; Juan et al. 2000; Quan 2008). *Alouatta palliata* is included in Appendix I of CITES (CITES 2017), is listed as Vulnerable on the IUCN Red List (Cortés-Ortiz et al. 2020), and is protected in Costa Rica by the Wildlife Conservation Law No. 7317 and its regulations, as well as by the Environment's Organic Law No. 7554.

Research on *A. palliata* in landscapes that have been extensively modified by human use is vital for the long-term conservation of this species. Any management and protection decisions should be based on knowledge of the basic characteristics of *A. palliata* populations, which can contribute to understanding the prospects of these populations in particular settings. Therefore, the objective of this study was to determine the distribution, group composition, and movement patterns of *A. palliata* in different forest fragments in the district of Pital de San Carlos, as well as the variation in the number of individuals in these groups as a response to the size and vegetation quality of forest fragments in an agricultural landscape.

Methods

Study area

We carried out this study in the district of Pital, canton of San Carlos, province of Alajuela, between the Toro Amarillo and Tres Amigos rivers, approximately 50 km south of the northern border of Costa Rica (Figure 1). The annual average temperature is around 26–27ºC, precipitation ranges between 3,000 and 4,000 mm per year, with a dry season lasting between 0 and 5 months (MAG 2000 climatic map for the Northern Zone, cited by Chassot et al. 2006).

In Pital, the main productive activities are agriculture and cattle ranching. Cassava, tiquizque roots, yams and plantains have traditionally been cultivated in the area, and more recently some places have been converted into

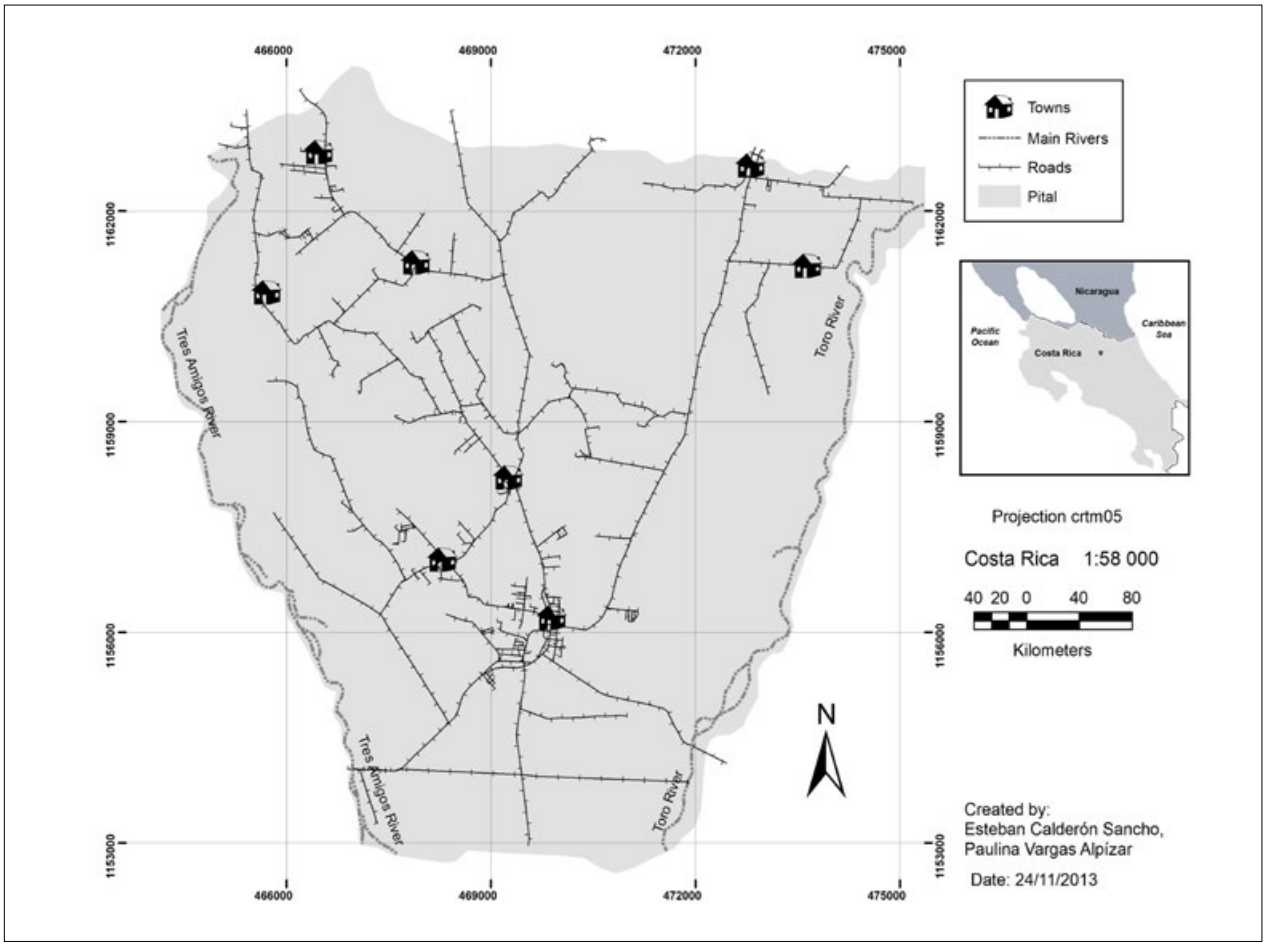

Figure 1. Location of the study area, showing small towns, roads and the two main rivers in Pital, San Carlos, Costa Rica.

monoculture pineapple plantations (Programa Estado de la Nación 2009; Arguedas et al. 2021). The area studied covers approximately 8,400 ha and encompasses a number of private properties used for a variety of purposes, with fragments of humid tropical forest in different stages of regeneration, most of which are found on the banks of streams and rivers, and in flood zones.

Quantity and size of fragments

We detected forest fragments using aerial photographs on the Google Earth Pro program dated April 4, 2010, which were obtained from the map library of the School of Geographical Sciences of the Universidad Nacional de Costa Rica.

We defined a fragment as a forest larger than 0.5 ha separated from other forest patches by a matrix landscape. We considered forest separated by a road as different patches, as long as there was no interconnection between canopies. We determined the area of each fragment (i.e., the fragment size) through photo interpretation and surveying of the forest cover with the ArcGis 9.3 program (ESRI 2008), using the Patch Analyst 3.12 extension for ArcView software (Elkie, Rempel and Carr 1999). Due to the rapid changes in the landscape, we carried out fieldwork to verify current presence of the fragments. Fieldwork was conducted between March and October of 2011. We achieved ~1100 hours of observations, spread over 210 days.

Distribution and group composition of the howler monkey population in Pital de San Carlos

We located howler monkey groups using directions provided by residents, as well as by listening to morning vocalizations by howlers. The daily number of sites sampled and the people participating (2–5) depended on the size and proximity of the fragments. Fieldwork began at 4:30 a.m. and finished when all members of the groups were counted and classified into age-sex categories (Table 1) using binoculars.

To identify the groups of howler monkeys and confirm the accuracy of our observations, we visited most fragments on two occasions on consecutive days. We recorded the geographical location of observed groups and the number of the fragment in which each group was found. We uniquely identified each group based on pelage coloration marks or scars present on the skin of certain group members, as well as by the number of individuals of each sex. Forest fragments that were separated by less than 300 m were visited by different people simultaneously to avoid recounting the same monkey groups in different fragments in case those groups moved from original forest fragment to another nearby.

Group movements

We conducted surveys with people of the local communities to estimate the movement of howler monkey groups.

Table 1. Age-sex categories for the classification of howler monkey individuals in each group in an agricultural landscape in Pital de San Carlos, Alajuela, Costa Rica.

Category	Description
Adult male	Large, with a bushy beard and a visible white scrotum; emit loud vocalizations.
Adult female	Approximately 15% smaller than the adult male, with a small beard; sometimes carry infants.
Juvenile	Smaller and thinner than adults, no development of external sexual characters; independent of the mother.
Infant	Small individual, dependent on the mother and rarely separated from her.

We applied two types of questionnaires to the residents of Pital: A) for owners of properties we asked about the location of howler monkey groups and the benefits they provided or the damage they caused to their farms and/or their productive activities; and B) for members of the community who live or work in the vicinity of the forest patches, we obtained information on group location, movement within and between patches, and in areas without forest cover.

Vegetation quality index

We carried out a rapid vegetation evaluation in the forest fragments inhabited by monkeys. We established one or two plots of 50 x 50 m (depending on the size of the fragment) at the site where the groups were sighted and recorded the following variables: V1 = number of strata present, V2 = percentage of light entering the forest, V3 = number of trees with a diameter at breast height (DBH) greater than 40 cm, V4 = the number of tree species present, and V5 = land use or anthropic damage. To determine V1, we traversed each fragment and recorded the number of forest strata, based on a modification of the classifications of Mostacedo and Fredericksen (2000) by Ochoa et al. (2009) (Table 2).

We used an Importance Value Index, this number is a mathematical weight between 0 and 1 assigned to ranges of each variable in each fragment. The larger the value the greater is the positive influence of that particular variable on the quality of the vegetation as habitat of the monkeys. For V1, we assigned an Importance Value Index to each fragment based on the presence or absence of particular strata. More complex forest structures were assigned with higher values: all strata present = 1; lacking a stratum other than the canopy = 0.5; lacking a canopy, or having no more than one stratum = 0.2. Since the monkeys mainly use the canopy (Field and Carrillo 2002), and the absence of this stratum corresponds to a patch in the initial stages of regeneration, these types of fragments were assigned low Importance Values.

Table 2. Classification of forest strata used to evaluate forest fragments in Pital de San Carlos, Alajuela, Costa Rica.

Forest stratum	Description
Canopy of emergent crowns	Crowns of tall trees (35 to 45 m) protruding from the continuous canopy of crowns. Totally exposed to vertical light and free from lateral competition.
Canopy of continuous crowns	Crowns of trees between 25 and 35 m high intertwined with each other. There is abundant sunlight, with many epiphytic plants growing between branches.
Shrubby	Located totally under the canopy; receive diffuse rather than direct light, but can be exposed to direct lateral light due to a gap or edge of the upper canopy.
Undergrowth	Made up of shrubs, herbs and palms, little light penetrates there.

Source: Modified from Mostacedo and Fredericksen (2000) and Ochoa et al. (2009).

At each corner of the plot we measured the percentage of light penetrating the patch (V2) with a convex spherical crown densitometer (Model A). We obtained averages of the percentage of light and assigned Importance Values between 0 and 1, with higher values given to condition in which there was lower penetration of light corresponding to a more closed canopy. The following criteria were used: 1-10% light penetration = 1.0; 11-30% light penetration = 0.7; 31-50% of light penetration = 0.5; and >51% light penetration = 0.3.

We counted all trees with a diameter at breast height (DBH) greater than 40 cm (V3) and extrapolated that value to the size of the fragment (in hectares). Since the presence of large trees in the fragments suggests greater production of fruits and leaves, and more substrate for the monkeys to rest and perform other activities (Arroyo-Rodríguez and Mandujano 2003), the Importance Value for this variable was assigned as follows considering all trees with DBH >40 cm: from 0 to 10 trees/ha = 0.4; from 11 to 18 trees/ha = 0.6; from 19 to 30 trees/ha = 0.8; and more than 30 trees/ha = 1. Finally, we counted morphospecies of trees present in the fragments (V4) by evaluating which trees looked the same, without identifying them at species level, and a value of importance was assigned as follows: more than 8 morphospecies present = 1; from 6 to 7 morphospecies = 0.8; from 4 to 5 morphospecies = 0.6; and 3 or less morphospecies = 0.4.

Finally, for each forest fragment we recorded signs of land use and anthropic damages (V5) including livestock browsing and trampling by looking for where the understory leaves and branches were nibbled or trampled respectively, and for human firewood extraction, and erosion and sedimentation. We categorized this variable based on how common these anthropic damages seemed to be as: (1) none; (2) low; (3) medium; and (4) high or intense, and assigned Importance Values between 0 and 1 based on the sum of such anthropic damage values: none = 1; damage sum between 1 and 2 = 0.9; damage sum between 3 and 4 = 0.7; damage sum between 5 and 6 = 0.5; damage sum between 7 and 8 = 0.3; and damage sum >8 = 0.1.

We used the Importance Values for each variable in Equation 1 to determine a Vegetation Quality Index for each fragment. Given that variables V3 and V4 have direct positive or negative effects on monkeys, we decided that their contribution to the final Vegetation Quality Index should be double that of the other variables used.

$$Vegetation\ quality\ index = \frac{V1+V2+(2*V3)+(2*V4)+V5}{7} \quad \textbf{Equation 1}$$

Data analysis

All statistical analyses were conducted in R version (3.6.3) (R Development Core Team 2012). We performed Generalized Linear Models (GLM) with Poisson distribution to evaluate the relationship of number of howler monkeys with fragment size and vegetation quality. We used fragment size and vegetation quality as predictor variables, and number of howler monkeys as response variable. Specifically, we used the vegetation quality index as our measure of vegetation quality. We performed one GLM per predictor variable. We log-transformed fragment size to improve normality and tested for statistical significance (χ^2 test.statistic) of the predictor variable in each model using the Anova() function from the R package "car". We visualized the relationship of predictor variables with number of howler monkeys using the R packages "visreg" and "ggplot2".

Results

Number and size of fragments

We recorded a total of 115 forest fragments representing 10.25% of the total study area (Fig. 2). Of these, only 103 fragments were visited because some owners of lands dedicated to pineapple production did not grant permission to enter their properties. 80.5% of the visited fragments had an area smaller than 10 ha, one had an area of 120 ha, and the rest had areas between 10 and 51 ha.

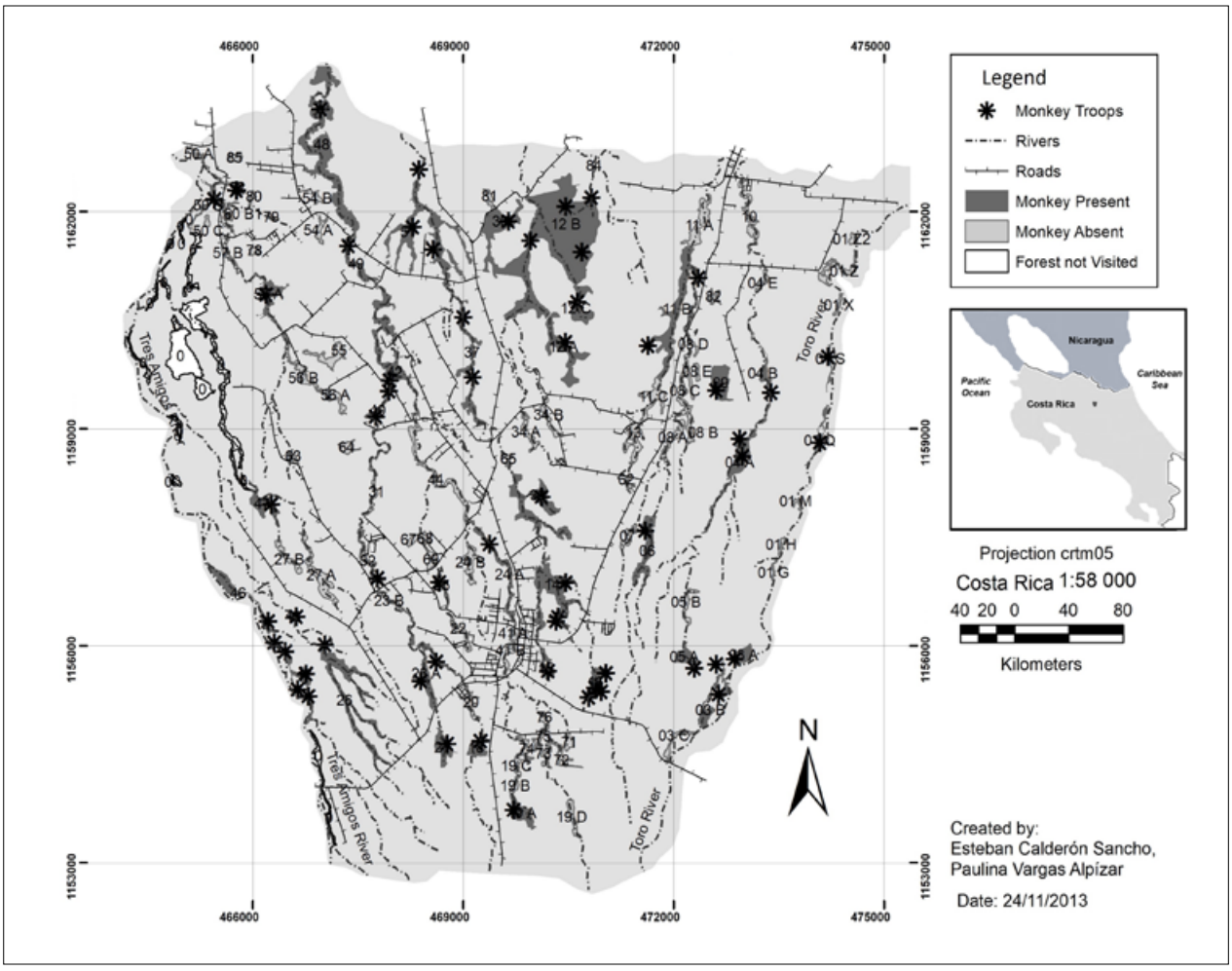

Figure 2. Fragments of forest and distribution of howler monkey groups in the study area in Pital, San Carlos, Costa Rica. Numbers for each fragment are consistent with those presented in Table 3.

Distribution and composition of the howler monkey population

We recorded the presence of howler monkeys in 39 fragments (37.86% of visited fragments), and 12 fragments were inhabited by more than one group. In total, we observed 576 howler monkeys in 59 groups (Table 3). The average group size was 9.76 individuals, and the average ecological density was 1.23 individuals/ha. Of the total number of individuals, 139 were adult males, 255 were adult females, 138 were juveniles, and 44 were infants. The average troop composition was 34.27% males, 40.13% females, 19.37% juveniles, and 6.23% infants. The average ratio of juveniles and infants to adult females was 1:0.8, ranging from 1:0.3 to 1:2.0.

Troop movement: survey data

We conducted a total of 73 interviews. Most respondents agreed that the monkeys traveled mostly within forested areas. However, 45% of the respondents also reported that they moved through areas without forest cover. In these cases, 76% of the reported movement involved distances of less than 300 m, indicating that most of these groups were crossing bridges, streets and roads to neighboring fragments. Reporting of movement of more than 300 m was rare, and associated mostly with solitary individuals. No respondent reported howler monkeys causing damage to their productive activities or their properties. We observed other species of primates, white-faced capuchins (*Cebus imitator*) and black-handed spider monkeys (*Ateles geoffroyi*), in four of the forest fragments visited (see Table 3).

Vegetation quality (Vegetation Quality Index)

We only calculated the Vegetation Quality Index for fragments inhabited by howler monkeys. The obtained values ranged between 0.44 and 0.89, and the majority (65%) of the fragments had indices higher than 0.70. No groups or solitary individuals were observed in fragments that did not have a canopy layer. The most common anthropogenic damage observed in the fragments were trampling by cattle and accumulation of sediments from agricultural fields.

Relationship between number of monkeys with fragment size and vegetation quality

We found a significant relationship between number of monkeys and fragment size (χ^2 = 188.97, df = 1, p <

Table 3. Howler monkey groups and forest fragments in Pital, San Carlos, Costa Rica. "Other species" refers to the presence of other primate species (*Cebus imitator* or *Ateles geoffroyi*) in the same fragment. Fragment ID is the same as in Figure 2.

N	Fragment ID	Area (ha)	N° groups	Group size	AGE CLASSIFICATION				Ecological Density	Other species present
					Males	Females	Juveniles	Infants		
1	01 G	0.59								
2	01 H	0.89								
3	01 M	0.69								
4	01 Q	4.12	1	7	2	4	1		1.70	
5	01 S	2.20	1	8	2	4	1	1	3.64	
6	01 X	0.84								
7	01 Z	4.67								
8	01 Z2	0.87								
9	03 B	9.26	2	9	2	4	3		2.37	
				13	3	5	3	2		
10	03 C	2.58								
11	03 A	5.12	1	11	3	4	3	1	2.15	
12	04 A	16.52	2	17	6	10	1		2.30	
				21	3	12	6			
13	04 B	6.40	1	4	1	3			0.63	
14	04 E	1.61								
15	05 A	6.00	1	11	2	5	4		1.83	
16	05 B	2.91								
17	06	14.23	1	12	3	4	3	2	0.84	
18	7	2.85								
19	08A	4.38								
20	08B	2.19								
21	08C	7.59								
22	08D	1.04								
23	08E	0.90								
24	09	10.85	1	6	1	3	1	1	0.55	
25	10	6.97								
26	11A	9.11								
27	11 B	31.41	2	3	1	1		1	0.60	
				16	4	7	3	2		
28	11 C	7.30								
29	12 B	120.47	4	16	7	6	3		0.56	*C. imitator*
				23	6	11	5	1		
				22	6	8	4	4		
				6	6					
30	12 A	17.24	1	18	3	11	3	1	1.04	
31	12 C	10.29	1	10	1	5	2	2	0.97	*C. imitator*
32	13	7.22								
33	14	28.38	3	5	1	3		1	1.09	
				9	1	5	2	1		
				17	2	8	5	2		

N	Fragment ID	Area (ha)	N° groups	Group size	AGE CLASSIFICATION				Ecological Density	Other species present
					Males	Females	Juveniles	Infants		
34	15	5.34	1	4	1	1	2		0.75	
35	16	7.86	4	15	6	7	1	1	2.54	
				3	2	1				
				1	1					
				1		1				
36	17	9.09	4	4	1	2	1		1.43	
				1	1					
				7	3	2	2			
				1	1					
37	18	5.70	1	5	1	3	1		0.88	
38	19 A	7.83	1	7	2	3	2		0.89	
39	19 B	1.48								
40	19 C	1.66								
41	19 D	3.67								
42	20	2.80								
43	21	7.62	1	13	2	5	5	1	1.71	
44	22	3.10								
45	23A	16.33	2	3	1	1	1		0.49	
				5	1	3	1			
46	23 B	1.78								
47	24B	6.02								
48	24A	11.51	1	1	1				0.09	
49	25	3.85	1	1	1				0.26	
50	26	30.22	1	9	2	4	2	1	0.30	
51	27 A	10.33								
52	27 B	3.77								
53	31	2.86								
54	32	6.47	1	12	3	6	3		1.86	
55	33	25.95	1	6	1	3	2		0.23	
56	34 A	3.80								
57	34 B	3.00								
58	36	14.18	1	24	4	13	7		1.69	
59	37	18.31	2	7	2	3	2		1.53	
				21	3	9	7	2		
60	40	7.68	2	18	3	9	4	2	3.91	
				12	4	4	3	1		
61	41 A	1.35								
62	41 B	2.11								
63	42	25.51	1	16	2	6	8		0.63	
64	43	1.62	1	2	2				1.24	
65	44	9.27								
66	46	10.45	2	14	3	5	4	2	1.91	*C. imitator*
				6	1	2	2	1		
67	47	9.87	1	3	1	2			0.30	

N	Fragment ID	Area (ha)	N° groups	Group size	AGE CLASSIFICATION				Ecological Density	Other species present
					Males	Females	Juveniles	Infants		
68	48	51.01	1	11	2	4	3	2	0.22	A. geoffroyi
69	49	7.70	1	14	3	7	3	1	1.82	
70	50 A	1.30								
71	50 C	0.93								
72	50 B	7.19	1	1	1				0.14	
73	51	37.16	3	20	3	8	6	3	1.40	
				24	3	11	7	3		
				8	2	3	2	1		
74	52	2.53	1	2	1	1			0.79	
75	54 A	2.23								
76	54 B	1.28								
77	55	6.21								
78	56 A	2.51								
79	56 B	6.18								
80	57 A	11.57	1	10	2	3	4	1	0.86	
81	57 B	2.49								
82	60 B	3.57								
83	62	0.78								
84	63	1.03								
85	64	2.61								
86	65	1.24								
87	67	1.49								
88	68	1.52								
89	69	2.22								
90	71	1.87								
91	72	3.04								
92	73	2.00								
93	74	2.91								
94	75	1.37								
95	76	1.85								
96	78	1.10								
97	79	0.65								
98	80	0.85								
99	81	1.59								
100	82	1.16								
101	84	0.50								
102	85	1.76								
103	86	0.49								

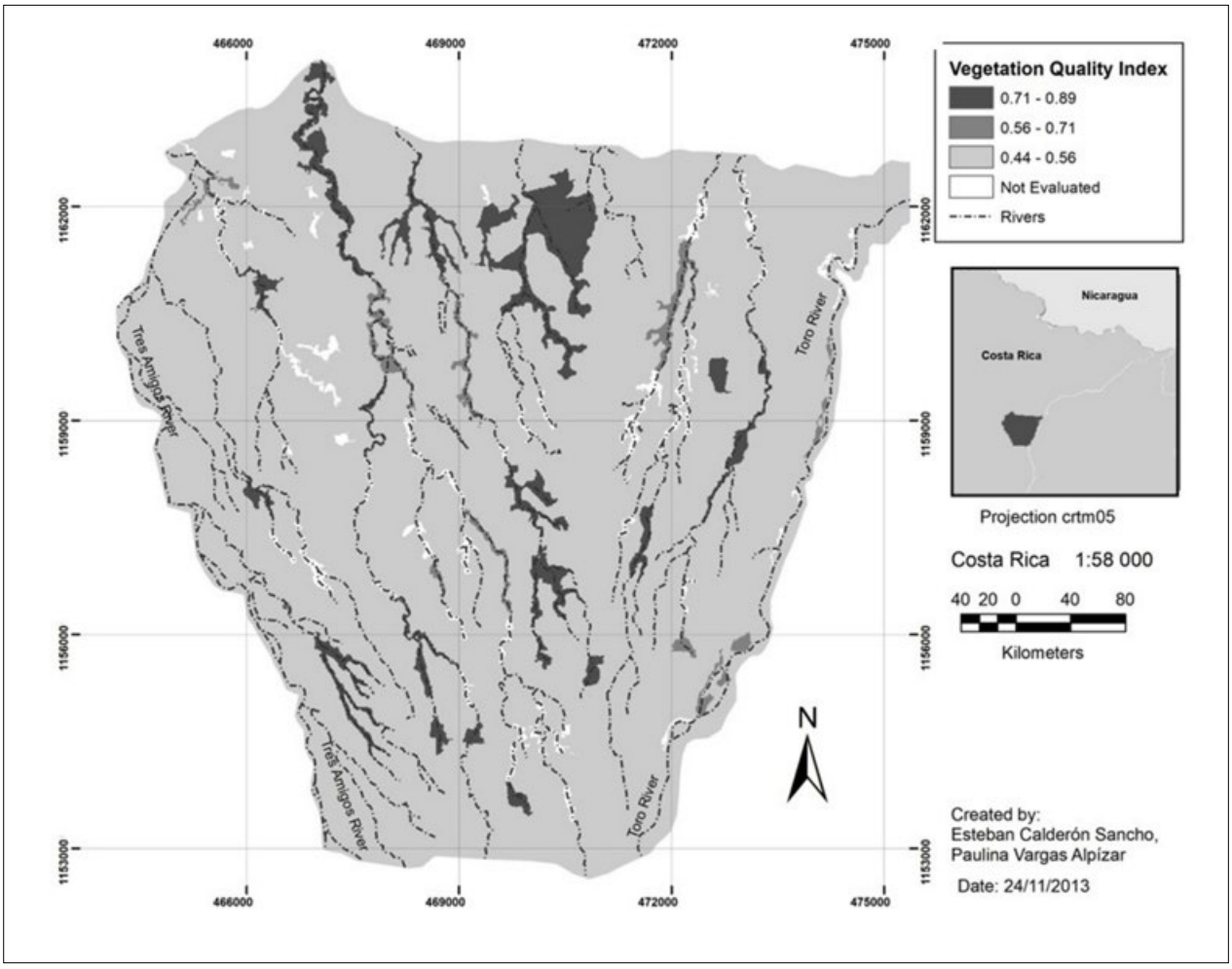

Figure 3. Vegetation Quality Index for all forest fragments evaluated on this study. Pital, San Carlos, Costa Rica.

0.0001). The model estimates indicate a positive relationship between number of monkeys and fragment size, where for each increment of one hectare in the size of the fragment the number of howler monkey individuals increased by a factor of 1.86 (~14%) (Figure 4A). We also observed a significant association between number of monkeys and vegetation quality ($\chi^2 = 18.076$, df = 1, $p <$ 0.0001). The model estimates indicate a positive relationship between number of monkeys and vegetation quality, where for each increment of one unit in vegetation quality the number of monkeys increase by a factor of 3.59 (~41%) (Figure 4B).

Discussion

Forest fragments in the study area were mostly small (>10 ha), with few of intermediate size and only one larger than 100 ha, a pattern typical of areas used for agriculture (Estrada and Coates-Estrada 1996; Quan 2008). Most of the remnant fragments were either strips of trees bordering streams and springs, or swampy areas unsuitable for agriculture and livestock.

The percentage of occupied fragments (37.9%) was similar to what was reported in Mexico by Estrada and Coates-Estrada (1995, cited by Escobedo-Morales and Mandujano 2008), who found that 40% of 120 forest fragments visited in their study were occupied by howler monkeys. Escobedo-Morales and Mandujano (2008) reported an average occupation of 18% over three years in 92 fragments in a highly fragmented landscape in Los Tuxtlas, Mexico. These two studies showed similar fragment sizes and number of monkeys, which demonstrates the capacity of fragmented landscapes as habitat to the species, and the ability of the species to survive in highly fragmented areas.

In our study site, we found howler monkeys distributed throughout the area. An understanding of the distribution of the groups is important for future management plans.

Compared to other sites, the area evaluated here has a higher number of individuals. For example, Mandujano et al. (2004) reported from 71 to 76 individuals in 92 fragments of the Mexican region of Los Tuxtlas. The

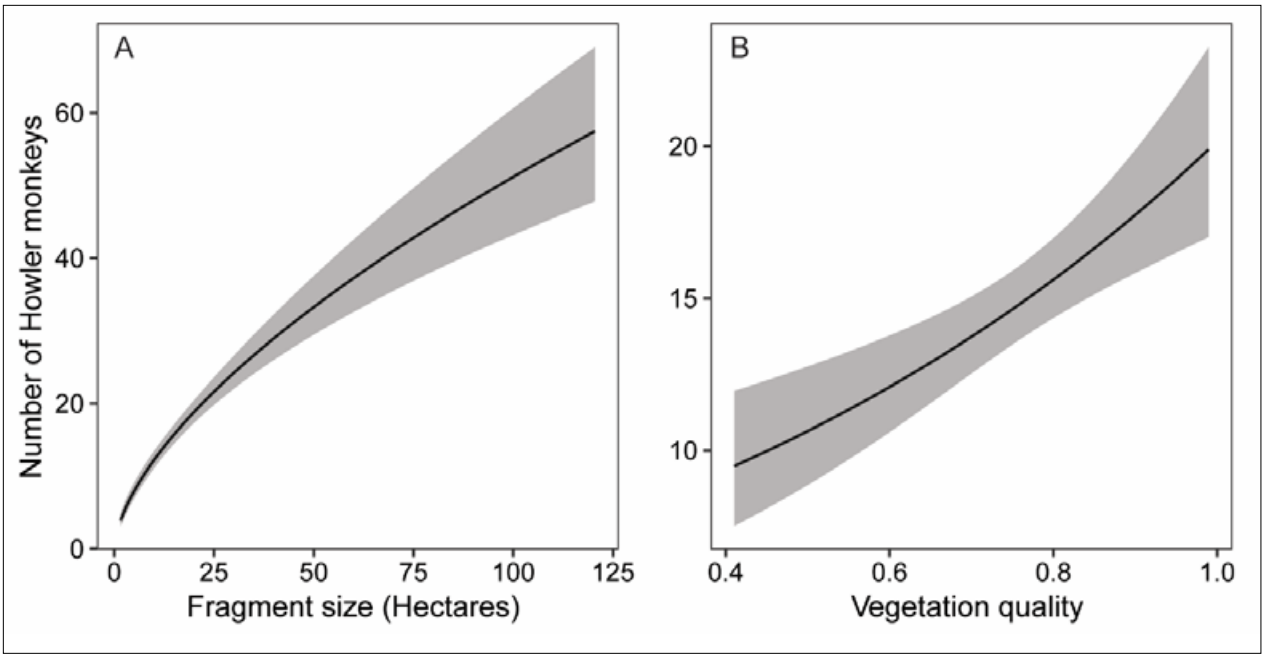

Figure 4. Relationship of (A) fragment size and (B) vegetation quality to number of howler monkeys (*Alouatta palliata*) using a GLM with Poisson distribution. The continuous lines indicate the predicted fit from the model and the dark areas are the 95% confidence intervals.

finding of 576 monkeys in a similar number of forest fragments in our study urges management actions to promote protection and connectivity in this region. The fragmentation and deterioration of the forest in the place of study is very likely to get worse if pineapple cultivation in San Carlos continues increasing as in recent years (Arguedas et al. 2021). Therefore, efforts to maintain that high number of individuals in the population are worth it, assuming that such land use changes would have a significant and negative impact on the survival of monkeys. The number of individuals in this landscape might be the result of a number of factors, such as the quality of forest cover or the proximity of native forest fragments. In addition, the absence of important predators in small patches (González-Solís et al. 2001) or in highly fragmented landscapes facilitates the settlement and persistence of monkey groups.

The proposed vegetation quality index showed that the number of individuals can increase as the quality of the habitat increases. In addition, some authors suggest that many species that are present in a rural landscape can only persist with the presence of native forests in its vicinity (Ranganathan and Daily 2008). In this regard, the area we studied borders the Maquenque Mixed Wildlife Refuge, which still conserves fragments of natural forest that connects with the forests of southern Nicaragua.

The average number of howler monkeys per group (9.76) in our study was on the lower end of reports for *A. palliata* in other locations. For example, Chapman and Balcomb (1998) reported an average of 10.7 individuals per group from a census of Guanacaste National Park, Costa Rica and a literature review characterizing 80 howler monkey populations. In Costa Rica, Zucker et al. (1996) reported an average group size of 14.9 at Hacienda La Pacífica, and Rosales (2008) reported an average group size of 18.0 ± 2.9 individuals per troop. In another Costa Rican dry forest site, Fedigan et al. (1998) revealed that group sizes may change over time showing that the average group size in her study site fluctuated from 10.9 to 17.6 individuals over 8 years of sampling. Estrada et al. (2001) reported an average troop size of 14 individuals for Yunká Park in Tabasco, Mexico.

The maximum (24) and minimum (2) numbers of howlers per group reported here are similar to those reported for the same species in different localities in the country – between 1 and 26 individuals in the Palo Verde National Park (Massey 1987); from 2 to 29 individuals in the Cahuita National Park (Perdomo 2003); and groups of 11 and 20 individuals in the La Selva Biological Station (Stoner 1996). In addition, Chapman and Balcomb (1998) reported that group sizes of *Alouatta* spp. vary between 2 and 23 members. We did not find any groups as large as those found by Fedigan et al. (1998, cited by Bezanson et al. 2008), who reported groups of up to 44 individuals in the dry forest of Costa Rica. Groups with a maximum of 15 individuals have been described in fragments of premontane forest (Sánchez 1991), and of 13 individuals in the humid forests of the lowlands (Rodríguez 2007).

Solitary individuals are common in populations of *Alouatta palliata* (Glander 1992; Estrada and Coates-Estrada 1996; Perdomo 2003; Mandujano et al. 2004). In Costa Rica, 79% of the males and 96% of the females of the species leave their native groups, and females and males can live solitarily for 1 and 4 years, respectively (Glander 1992). The extended period of time that males live as solitary individuals is consistent with our observations of more solitary males (6) than solitary females (1) encountered in the current investigation.

The estimates of Chapman and Balcomb (1998) for the density of individuals of the genus *Alouatta* in forested areas range from 0.008 to 1.5 individuals/ha, with an average of 0.49 individuals/ha. The average density calculated for Pital (1.23 individuals/ha) is on the higher end, and is also higher than figures reported for other populations, such as 0.069 individuals/ha on Ometepe Island, Nicaragua (Massey 1987), 0.15 individuals/ha in the Cahuita National Park, Costa Rica (Perdomo 2003), and 0.6 individuals/in Los Tuxtlas, Mexico (Escobedo-Morales and Mandujano 2008). Although density estimates similar to those in our study have also been reported, such as 1.67 individuals/ha in Yunká Park, Mexico (Estrada et al. 2001), a review of different populations of *A. palliata* by Treves (2001) mentions densities ranging from 0.012 to 5.16 individuals/ha, while densities as high as 6.87 or 7.11 individuals/ha are cited for a closed population on a Mexican lake island (Cristóbal-Azkarate and Arroyo-Rodríguez 2007). It is important to note that differences in density of individuals could be due to differences in the estimation methods used in each study, as well as due to calculations made in continuous forest or remnant fragments. However, the plasticity of the species is evident considering the wide range of population densities, therefore it is necessary to study other factors such as the quality of the vegetation of the fragments where the monkeys live. It would also be appropriate to investigate the relationship between population density and health of individuals, so that the estimates of population density may provide more accurate data for future management actions.

Less than half of the interviewees reported movements of the howler monkeys through areas without tree coverage, but when reported the distance was short. This is consistent with the findings of Mandujano et al. (2004), who reported that while movement of individuals between fragments as far as 656 m apart occurred, 70% of movements were of less than 100 m.

We observed a positive relationship between the number of monkeys and the Vegetation Quality Index in the occupied patches, which suggests that the number of individuals present would increase if vegetation quality is improved. The application of this model allows making suggestions about which fragments should be incorporated into a vegetation management and protection system to improve conditions for these groups in the area. Leighton and Leighton (1982) reported that the presence of monkeys has a positive proportional relationship with the abundance of fruits rather than with the fragment size, indicating that improving vegetation conditions can provide benefits for the well-being of this species. Likewise, Arroyo-Rodríguez et al. (2007) show that vegetation quality affected the presence of howler monkeys in small, isolated forest fragments (<10 ha). They also show that variables such as high densities of large trees (DBH > 60 cm), total basal area (sum of all calculated basal area variables), basal area of persistent tree species, and basal areas of species which frequently serve as food, favored the presence of monkeys.

A positive relationship between the size of a forest fragment and the number of howler monkeys living in it has also been reported by Estrada and Coates-Estrada (1996). However, in the area we studied in Pital, San Carlos, it is possible to find medium-sized fragments with high densities of individuals and larger fragments with lower densities. This suggests that other factors may explain the variation in group sizes, such as anthropic pressures or the capacity of the landscape to allow movement of individuals through the landscape matrix. Estrada and Coates-Estrada (1996), for example, reported a negative correlation between the number of monkeys in forest fragments and the distance to the closest forest fragment and isolation time, which can affect the number of individuals per unit of area.

Although some authors consider that exposure to direct conflicts between howler monkeys and people, dogs, or birds of prey may be greater in small patches (Estrada et al. 1994), these previous situations were not documented in our interviews to local people. It seems that the presence of monkeys does not represent a conflict to the types of productive activities in the area, and from the local people's point of view they are not a source of pressure on monkeys because they do not hunt, for example.

Considering the number of howler monkeys present in the study area, the consent of the majority of the owners to study them on their farms, and the fragmented landscape in Pital, we recommend to work together with farmers and landowners to maintain forest strips and/or corridors, which are important for the long-term survival of the howler monkeys, and other primates, in the area. In this regard, Horwich (1998) proposed designing forest areas which could be used for agriculture and silviculture by establishing functional corridors, and increasing the number of plant species that provide food for the howler monkeys, connecting isolated groups with forests, and improving the quality of their habitat.

Acknowledgments

We thank the owners and administrators of the farms who provided access. We also give thanks to the field coworkers: Cristina Arrieta, Michael Méndez, Josimar Estrella, David Villalobos and Saray Espinoza for their support. To Manuel Spinola for his statistical support. To the Vice-Rector for Research, Universidad Nacional, Costa Rica, for support with the translation.

References

Arguedas, C., Vargas, C. and Miller, C. 2021. Monitoreo del estado de la piña en Costa Rica para el año 2019, asociado con la pérdida y ganancia entre la cobertura forestal. Report. Proyecto Monitoreo del Cambio de Uso y Cobertura de la Tierra en Paisajes Productivos (MOCUPP). CONARE - CENAT, San José, Costa Rica.

Arroyo-Rodríguez, V. and Mandujano, S. 2003. Comparación de la estructura vegetal entre fragmentos desocupados y ocupados por *Alouatta palliata mexicana* en el sureste de México *Neotrop. Primates* 11(3): 168–171.

Arroyo-Rodríguez, V., Mandujano, S., Benítez-Malvido, J. and Cuende-Fanton, C. 2007. The influence of large tree density on howler monkey (*Alouatta palliata mexicana*) presence in very small rain forest fragments. *Biotropica* 39(6): 760–766.

Bezanson, M., Garber, P., Murphy J. and Premo, L. S. 2008. Patterns of subgrouping and spatial affiliation in a community of mantled howling monkeys (*Alouatta palliata*). *Am. J. Primatol.* 70: 282–293.

Chapman, C. A. and Balcomb, S. R. 1998. Characteristics of howlers: ecological conditions or group history. *Int. J. Primatol.* 19(3): 385–403.

Chassot, O., Mata, A. and Monge, G. 2006. Reporte de evaluación ambiental del Refugio Nacional de Vida Silvestre Mixto Maquenque. Centro Científico Tropical, San Pedro, Costa Rica.

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). 2017. Appendices I, II y III. Geneva, Switzerland. 19pp.

Cortés-Ortiz, L., Canales Espinosa, D., Cornejo, F. M., Guzman-Caro, D., Link, A., Moscoso, P., Méndez-Carvajal, P., Palacios, E., Rodríguez, V., Rosales-Meda, M., Solano, D., Williams-Guillén, K. and de la Torre, S. 2020. *Alouatta palliata*. The IUCN Red List of Threatened Species 2020: e.T39960A17925090. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T39960A17925090.en

Cristóbal-Azkarate, J. and Arroyo-Rodríguez, V. 2007. Diet and activity pattern of howler monkeys (*Alouatta palliata*) in Los Tuxtlas, México: effect of habitat fragmentation and implications for conservation. *Am. J. Primatol.* 69: 1013–1029.

Elkie, P., Rempel, S., and Carr, A. 1999. Patch Analyst User's Manual: A Tool for Quantifying Landscape Structure (NWST Technical Manual TM-002). https://www.yumpu.com/en/document/read/29088001/patch-analyst-users-manual

Escobedo-Morales, L. A. and Mandujano, S. 2008. Viabilidad metapoblacional del mono aullador (*Alouatta palliata mexicana*) en un paisaje altamente fragmentado de Los Tuxtlas, México. In*: Evaluación y Conservación de Biodiversidad en Paisajes Fragmentados de Mesoamérica,* A. Harvey, J. Sáenz. (eds.), pp.421–450. Instituto Nacional de Biodiversidad (INBio). Heredia, Costa Rica.

ESRI (Environmental System Research Institute). 2008. ArcGIS 9.3. ESRI, Redlands.

Estrada, A., Coates-Estrada, R. and Meritt, D. 1994. Non-flying mammals and landscape changes in the tropical rain forest region of Los Tuxtlas, Mexico. *Ecography* 17: 229–241.

Estrada, A. and Coates-Estrada, R. 1996. Tropical rain forest fragmentation and wild populations of primates at Los Tuxtlas, Mexico. *Int. J. Primatol.* 17(5): 759–783.

Estrada, A., García, Y., Muñoz, D. and Franco, B. 2001. Survey of the population of howler monkeys (*Alouatta palliata*) at Yunká Park in Tabasco, Mexico. *Neotrop. Primates* 9(1): 12–15.

Fedigan, L. M., Rose, L. M. and and Morera, R. 1998. Growth of mantled howler groups in a regenerating Costa Rican dry forest. *Int. J. Primatol.* 19(3): 405–432.

Field, R. and Carrillo, E. 2002. Asociaciones de Vida Silvestre y Hábitat en los Bosques de Costa Rica. Report. Universidad Nacional, Heredia, Costa Rica.

Glander, K. E. 1992. Dispersal patterns in Costa Rican mantled howling monkeys. *Int. J. Primatol.* 13(4): 415–436.

González-Solís, J., Guix, J. C., Mateos, E. and Llorens, L. 2001. Population density of primates in a large fragment of the Brazilian Atlantic rainforest. *Biodiv. Conserv.* 10: 1267–1282.

Harvey, A. and Sáenz, J. 2008. Evaluación y conservación de biodiversidad en paisajes fragmentados de Mesoamérica. Instituto Nacional de Biodiversidad (INBio), Heredia, Costa Rica.

Horwich, R. 1998. Effective solutions for howler conservation. *Int. J. Primatol.* 19(3): 579–598.

Juan, S., Estrada, A. and Coates, R. 2000. Contrastes y similitudes en el uso de recursos y patrón general de actividades en tropas de monos aulladores (*Alouatta palliata)* en fragmentos de selva en Los Tuxtlas, México. *Neotrop. Primates* 8(4): 131–135.

Leighton, M. and Leighton, D. R. 1982. The relationship of size of feeding aggregate to size of food patch: howler monkeys (*Alouatta palliata*) feeding in *Trichilia cipo* fruit trees on Barro Colorado Island. *Biotropica* 14(2): 81–90.

Mandujano, S., Escobedo-Morales, L. A. and Palacios-Silva, R. 2004. Movements of *Alouatta palliata* among forest fragments in Los Tuxtlas, Mexico. *Neotrop. Primates* 12(3): 126–131.

Massey, A. 1987. A population survey of *Alouatta palliata*, *Cebus capucinus* and *Ateles geoffroyi* at Palo Verde, Costa Rica. *Rev. Biol. Trop.* 53(2): 345–347.

Mostacedo, B. and Fredericksen, T. S. 2000. *Manual de Métodos Básicos de Muestreo y Análisis en Ecología Vegetal.* Bolfor. Santa Cruz, Bolivia.

Ochoa, S., Kampichler, C., De Jong, B., Hendricus, J., Hernández, S., Geissen, V. and Huerta, E. 2009. Página Web con un índice para la evaluación de la condición ecológica de los bosques tropicales en México. In: *Agricultura Sostenible, Vol. 5*, Aguilar, C.E., López, W., Pinto, R., Bahena, F. (eds.), pp.363–371. Universidad Autónoma de Chiapas, Sociedad Mexicana de Agricultura Sostenible, Tuxtla Gutiérrez, Chiapas, México.

Perdomo, L. 2003. Evaluación Clínica de una Población de Monos Congos *(Alouatta palliata)* en El Parque Nacional Cahuita, Costa Rica. Informe de avance final Área de Conservación La Amistad Caribe - Instituto Nacional de Biodiversidad (ACLAC-INbio) Programa Regional en Manejo de Vida Silvestre (PRMVS). Universidad Nacional, Heredia, Costa Rica.

Programa Estado de la Nación. 2009. Programa Estado de la Nación en Desarrollo Humano Sostenible (Costa Rica)/Decimoquinto Informe Estado de la Nación en Desarrollo Humano Sostenible. San José, Costa Rica.

Quan, C. L. 2008. Efecto de la fragmentación del hábitat sobre la variabilidad genética en tropas de mono aullador (*Alouatta palliata*) del Área de Conservación Tempisque, Costa Rica. In: *Evaluación y Conservación de Biodiversidad en Paisajes Fragmentados de Mesoamérica,* A. Harvey, J. Sáenz. (eds.), pp.475–509. Instituto Nacional de Biodiversidad (INBio), Heredia, Costa Rica.

Ranganathan, J. and Daily, G. 2008. La biogeografía del paisaje rural: oportunidades de conservación para paisajes de Mesoamérica manejados por humanos. In: *Evaluación y Conservación de Biodiversidad en Paisajes Fragmentados de Mesoamérica,* A. Harvey, J. Sáenz. (eds.), pp.15–30. Instituto Nacional de Biodiversidad (INBio), Heredia, Costa Rica.

Rodríguez, J. 2007. Efecto de la Fragmentacion del Habitat en la Estructura Poblacional del Mono Congo (*Alouatta palliata*) y del Mono Carablanca (*Cebus capucinus*) en el Refugio de Vida Silvestre Privado Nogal, Sarapiquí, Heredia, Costa Rica. Tesis de Licenciatura. Universidad de Costa Rica, San José, Costa Rica.

Rosales, M. 2008. Uso de Tipos de Cobertura Vegetal por Tropas del Mono Aullador (*Alouatta palliata*) y Carablanca (*Cebus capucinus*) y Conocimiento Local de Habitantes con Respecto a Estos Primates en un Agro Paisaje del Pacífico Central, Costa Rica. MA thesis, Universidad Nacional, Heredia, Costa Rica. 155pp.

R Development Core Team. 2012. *R: A Language and Environment for Statistical Computing.* R. Foundation for statistical computing, Vienna, Austria.

Sánchez, R. 1991. Utilización del Hábitat, Comportamiento y Dieta del Mono Congo (*Aloutta palliata*) en um Bosque Premontano Húmedo de Costa Rica. Master's thesis, Universidad Nacional, Heredia, Costa Rica.

Stoner, K. 1996. Habitat selection and seasonal patterns of activity and foraging of mantled howling monkeys (*Alouatta palliata*) in northeastern Costa Rica. *Int. J. Primatol.* 17(1): 1–30.

Treves, A. 2001. Reproductive consequences of variation in the composition of howler monkey (*Alouatta* spp.) groups. *Behav. Ecol. Sociobiol.* 50: 61–71.

Zucker, E., Clarke, M., Glander, K. and Scott, N. 1996. Sizes of home ranges and howling monkey groups at Hacienda La Pacífica, Costa Rica: 1972–1991. *Brenesia* 45–46: 153–156.

DOI: https://doi.org/10.62015/np.2022.v28.228

ESTADO DEL CONOCIMIENTO DEL GÉNERO *AOTUS* EN COLOMBIA: UN SIGLO DE EXPLORACIÓN

Lisa Carrillo-Chávez[1], Andrés Link[2], Nelsy Rocio Pinto-Sánchez[3]

[1] Semillero de Evolución y Conservación, Universidad Militar Nueva Granada. E-mail: <U0500926@unimilitar.edu.co>, ORCID: 0000-0003-0761-6361
[2] Departamento de Ciencias Biológicas, Universidad de los Andes. E-mail: <a.link74@uniandes.edu.co>, ORCID: 0000-0003-3125-249X
[3] Semillero de Evolución y Conservación, Programa de Biología Aplicada, Universidad Militar Nueva Granada. E-mail: <nelsy.pinto@unimilitar.edu.co>, ORCID: 0000-0001-7561-2982

Resumen

Los monos del género *Aotus* son los únicos primates de América que tienen hábitos principalmente nocturnos. Actualmente se reconocen 11 especies distribuidas en Panamá y gran parte de Suramérica, siendo Colombia el país que contiene la mayor riqueza de especies. A pesar de esto, la información sobre el género *Aotus* es relativamente escasa en Colombia. En este trabajo, hacemos una recopilación de las investigaciones realizadas durante los últimos 108 años sobre el género *Aotus* en Colombia, incluyendo artículos publicados en revistas indexadas y literatura gris (tesis de pregrado y posgrado, sin publicar). En total encontramos 143 publicaciones, donde se evidencia una alta representación de estudios biomédicos, en parte debido a los intentos fallidos de desarrollo de vacunas contra enfermedades como la malaria en Colombia. Las especies de monos nocturnos más estudiadas son *Aotus nancymaae* y *Aotus griseimembra*, las cuales se encuentran distribuidas en la región del Amazonas y Caribe respectivamente. Varios estudios han intentado esclarecer la compleja taxonomía del género, involucrando técnicas cariológicas, genéticas y morfológicas. En los últimos años ha habido un aumento en el número de investigaciones sobre la ecología de monos nocturnos que describen su densidad poblacional, uso de hábitat, conservación, y aspectos parasitológicos. Aunque el 36% de estas investigaciones se han realizado en *A. lemurinus,* aún existen grandes vacíos de información sobre las demás especies distribuidas en el país. Encontramos 10 trabajos enfocados en el tráfico de diferentes especies del género, y la distribución de especies en Colombia, y tan sólo un estudio sobre fisiología, uno sobre análisis moleculares y uno sobre aspectos etnobiológicos. A partir de esta revisión, se evidencia la necesidad de ampliar los estudios sobre el género *Aotus* en Colombia, en particular en sus poblaciones silvestres. De igual forma es necesario generar más investigaciones para aquellas especies menos conocidas en el país como son *A. vociferans, A. brumbacki, A. trivirgatus* y *A. jorgeherandezi*. Investigaciones de este tipo permitirían entender los requerimientos de las especies del género permitiendo no sólo llenar estos vacíos de información, sino también la posibilidad de desarrollar planes de conservación efectivos para las diferentes especies del género *Aotus*.

Palabras clave: mono nocturno, conservación, ecología, primates colombianos

Abstract

Night monkeys (genus *Aotus*) are the only primates in the Americas that are primarily nocturnal. Currently, 11 species are distributed in Panama and much of South America, and Colombia has the highest species richness. Despite having a large number of night monkey species, Colombia has relatively scarce information available about night monkeys of the genus *Aotus*. In this paper, we reviewed research on the genus *Aotus* carried out during the last 108 years in Colombia. We included scientific articles published in indexed journals and gray literature (unpublished undergraduate and graduate theses). We found 143 publications, including a large number of biomedical studies that were partly driven by unsuccessful attempts to develop vaccines against tropical diseases such as malaria. *Aotus nancymaae* and *A. griseimembra*, which are distributed in the Amazon and Caribbean regions, respectively, were the best studied species. Several studies have attempted to clarify the complex taxonomy of the genus, involving karyological, genetic and morphological approaches. In recent years, there has been an increase in ecological research of night monkeys, with studies focusing on population density, habitat use, conservation, pollination dynamics, and parasitology. Although 36% of these investigations were carried out on *A. lemurinus*, there are large gaps of information for this and the rest of *Aotus* species in the country. Ten studies focused on wildlife trafficking and the distribution of different species in Colombia. We identified a large information gap on physiological, molecular, and ethnobiological aspects of night monkeys, finding only one study in each of these topics. From this review, it is evident that there is a need to expand studies on behavior, ecology, molecular genetics, and traffic control of the genus *Aotus*. It is also necessary to generate more research on the less studied species in the country, such as *A. vociferans, A. brumbacki, A. trivirgatus* and *A. jorgehernandezi.* Research

on these topics and species would allow us to understand the basic requirements of each species, allowing not only to fill these information gaps but also to develop more effective conservation plans for the different species of the genus.

Key words: night monkey, conservation, ecology, Colombian primates

Introducción

Colombia es un país megadiverso ocupando el cuarto puesto a nivel de riqueza de especies de mamíferos y el tercero en Latinoamérica a nivel de primates (Henao-Díaz et al. 2015). El género *Aotus* es conocido por incluir a los únicos primates con patrones de actividad nocturnos de las Américas (Donati y Borgognini-Tarli 2006). Este género está conformado por al menos 11 especies (Rylands et al. 2012), incluyendo *A. lemurinus*, *A. griseimembra*, *A. zonalis*, *A. brumbacki*, *A. trivirgatus*, *A. vociferans*, *A. jorgehernandezi*, *A. miconax*, *A. nancymaae*, *A nigriceps*, *A. azarae*.

Según la UICN cinco de estas especies se encuentran en estado de amenaza (VU), cuatro en estado de menor preocupación (NT) y dos con datos insuficientes (DD) (Morales-Jiménez et al. 2008; Cuarón et al. 2008; Maldonado et al. 2017; Urbani et al. 2018; Morales-Jiménez y Link 2018; Rímoli et al. 2021; Link et al. 2019; Cornejo et al. 2020; Shanee et al. 2020). En Colombia se encuentran ocho de estas especies de *Aotus*, constituyéndose en el país con mayor diversidad de este género. Los monos nocturnos tienen una amplia distribución que abarca desde Panamá, Colombia, Venezuela, Ecuador, Perú, Brasil, Bolivia, Paraguay hasta Argentina y se encuentran en diferentes hábitats de bosques primarios y secundarios, desde el nivel del mar hasta los 3.200 msnm (Morales-Jiménez et al. 2008; Cuarón et al. 2008; Maldonado 2013; Maldonado et al. 2017; Urbani et al. 2018; Morales-Jiménez 2018; Rímoli et al. 2018; Link et al. 2019; Cornejo et al. 2020; Shanee et al. 2020).

El mayor número de investigaciones sobre el género *Aotus* se concentran en Argentina y Perú (Lau et al. 2004; Aquino y Encarnación 1994), evidenciando la necesidad de realizar más trabajos en otros países, y particularmente en Colombia. A nivel comportamental las especies de *Aotus* se caracterizan, entre otras cosas, por vivir en pareja y tener un alto cuidado paternal (Fernández-Duque 2016). A nivel ecológico, los monos nocturnos, así como otros primates, son fundamentales como dispersores de semillas (Chapman 1995) y polinizadores (Marín-Gómez 2008). Algunas especies del género se han visto afectadas por la extracción de individuos para la investigación biomédica principalmente *A. nancymaae, A. vociferans* y *A. griseimembra* provenientes del norte de Colombia y la frontera con Perú y Brasil (Herrera et al. 2002; Maldonado et al. 2009). Es necesario entender cuál es el estado del conocimiento del género *Aotus* en Colombia y de esta manera comprender los vacíos de información existentes en cuanto a su investigación en el país, con el fin de plantear proyectos futuros que se enfoquen en el estudio y la conservación de las especies.

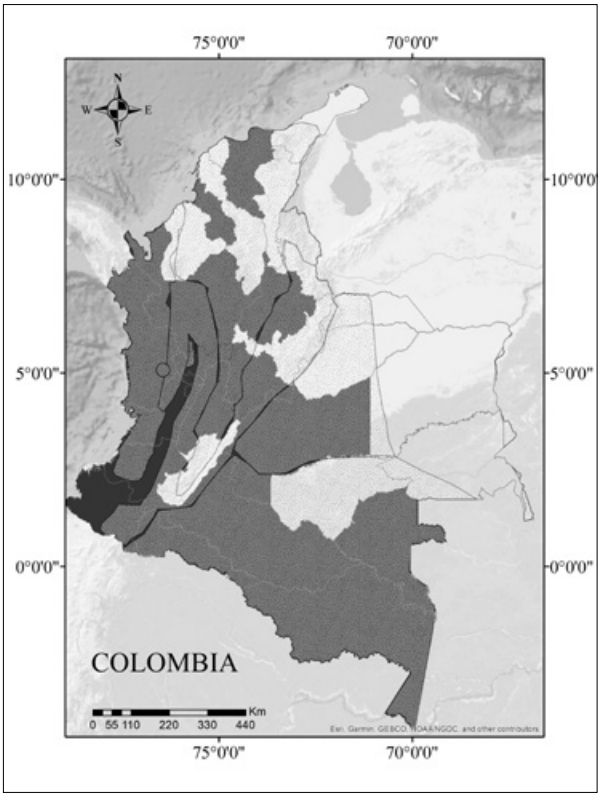

Figura 1. Mapa de Colombia mostrando en color gris obscuro donde hay trabajos de la especie, las zonas punteadas muestran la distribución del género *Aotus* en el país, y las áreas sin puntos ni color resaltan los lugares donde no se han reportado especimenes.

Métodos

Este estudio comprende los trabajos realizados sobre el territorio colombiano desde 1912 hasta agosto del 2020.

Revisión bibliográfica

Se realizó la búsqueda de literatura incluyendo, artículos científicos, capítulos de libros, informes no publicados, trabajos de pregrado y posgrado desde 1912 hasta agosto de 2020 que se encontraran relacionados con estudios de primates del género *Aotus* en Colombia. La información fue recolectada a través de buscadores como Google Scholar y las bases de datos Worldcat y Sciencedirect (ver Anexo 1 en un archivo complementario en la versión on-line). Además, para obtener información adicional

acerca de la literatura gris, se ingresó a las bases de datos de diferentes universidades colombianas, tales como la Pontificia Universidad Javeriana, Universidad de los Andes, Universidad del Valle, Universidad del Tolima, Universidad de Sucre, Universidad del Bosque, Universidad Incca y la Universidad Militar Nueva Granada.

Dos documentos no fueron incluidos en esta revisión porque fueron retirados de la revista que inicialmente los publicó o porque se encontraban en el repositorio de una universidad con acceso restringido. Se tuvo en cuenta que los trabajos publicados en revistas académicas no fueran los mismos encontrados dentro de literatura gris para evitar replicar la información sobre estos estudios. Los trabajos encontrados se organizaron en nueve categorías: 1) Ecología, 2) Medicina, 3) Tráfico, 4) Taxonomía, 5) Distribución, 6) Paleontología, 7) Comportamiento, 8) Genética molecular, 9) Otros (el Anexo 2, como un archivo complementario en la versión on-line, incluye todos los trabajos recolectados).

Para la categoría "Ecología" se tuvieron en cuenta subcategorías como: Densidad poblacional, uso de hábitat (patrones de actividad, rango de hogar y dieta), conservación, parasitología y polinización. Para el caso de la categoría "Medicina" se tuvo en cuenta trabajos de medicina veterinaria y trabajos en los que se usaron primates para investigación biomédica (por ejemplo, pruebas de vacunas en primates). En la categoría de "Taxonomía" se tuvieron en cuenta trabajos de filogenias basadas en datos morfológicos y/o moleculares y trabajos cariológicos. En la categoría de "Genética molecular" se incluyeron trabajos que estudiaran a nivel genético alguna de las especies sin fines médicos ni filogenéticos. Se tuvieron en cuenta trabajos de muestreo en campo de diferentes departamentos que registraron la presencia de alguna especie del género y se catalogaron como trabajos de distribución para la especie. En la categoría "Otros" se asignaron aquellos trabajos que fueron únicos en su tema o con sólo dos publicaciones: Fisiología, etnoprimatología y accidentes en redes eléctricas.

Se tuvieron en cuenta las actualizaciones taxonómicas para la presentación de los resultados de este trabajo. Por ejemplo, los trabajos que involucraban a *Aotus lemurinus griseimembra* y *Aotus brumbacki griseimembra* se clasificaron como *Aotus griseimembra* según su nueva clasificación (Defler et al. 2001). Además, se tuvo en cuenta el año de publicación y la nacionalidad de los autores considerándose como extranjero, nacional o colaboración internacional, según el caso.

Resultados

En total, consultamos 143 artículos publicados entre los años 1912 y 2020. Un gran número de estudios se realizaron a nivel de género (*Aotus* spp.), seguido por estudios sobre *Aotus nancymaae*, *A. lemurinus* y *A. griseimembra* (Figure 2). A nivel de investigaciones asociadas a la biomedicina, las especies con más del 50% de sus trabajos enfocados a esta categoría son *Aotus nancymaae* con 29 publicaciones y *A. vociferans* con16 publicaciones (Figure 2). Las especies menos estudiadas son *A. trivirgatus*, *A. zonalis* y *A. jorgehernandezi* (13% de los trabajos). De éstas, en las dos primeras especies el interés se ha centrado sobre su taxonomía, y en la última especie sólo presenta un trabajo donde se indica su posible distribución y el trabajo en el que se le cataloga como una nueva especie (Defler y Bueno, 2007). Los estudios de otras especies como *A. brumbacki, A. lemurinus, A. griseimembra* y los que sólo mencionan individuos a nivel genérico han tenido enfoques más variados (Figura 2).

Nuestro punto de partida de los trabajos sobre las especies del género *Aotus* en Colombia inicia en 1912 con trabajos basados en taxonomía (Elliot et al. 1912, 1913). Entre los años 1997 a 2011 hubo un incremento en el número de publicaciones de trabajos asociados a medicina. La tendencia muestra que las investigaciones asociadas a tráfico y a la categoría "otros" (ver metodología) se han publicado en los últimos 12 años, siendo las más recientes para el país. El mayor número de publicaciones sobre *Aotus* en Colombia tuvo lugar entre 2000 y 2020 aunque a partir de 2018 se aprecia un incremento más constante (Figura 3).

Se observa que el medio de divulgación más usado para los trabajos del género *Aotus* son las revistas científicas, teniendo un total de 113 artículos, seguido de literatura gris (tesis de pregrado y postgrado) con 13 trabajos, informes con 9 trabajos y libros/capítulos con 8. Los trabajos asociados con ecología se encuentran en un 53% en trabajos de tesis que aún no han sido publicados. Hacemos notar que puede haber información adicional en los repositorios de varias universidades del país que no fueron consultadas en este estudio.

En los últimos años se ha presentado un auge en estudios sobre ecología, con el mayor número de trabajos en esta categoría correspondiendo a temas como densidad poblacional y uso de hábitat, y el menor a polinización y parasitología (Figura 4).

Finalmente, se encontró que la mayoría de las publicaciones fueron realizadas por investigadores y/o estudiantes nacionales (62%), seguido de trabajos en colaboración en los que al menos uno de los autores es nacional (23%) y finalmente trabajos desarrollados por personas extranjeras (15%).

Discusión

En general, los trabajos sobre las ocho especies de *Aotus* en Colombia han sido realizados en su mayoría con fines biomédicos (34% del total de los trabajos), seguido por estudios sobre su distribución (18%), taxonomía (17%),

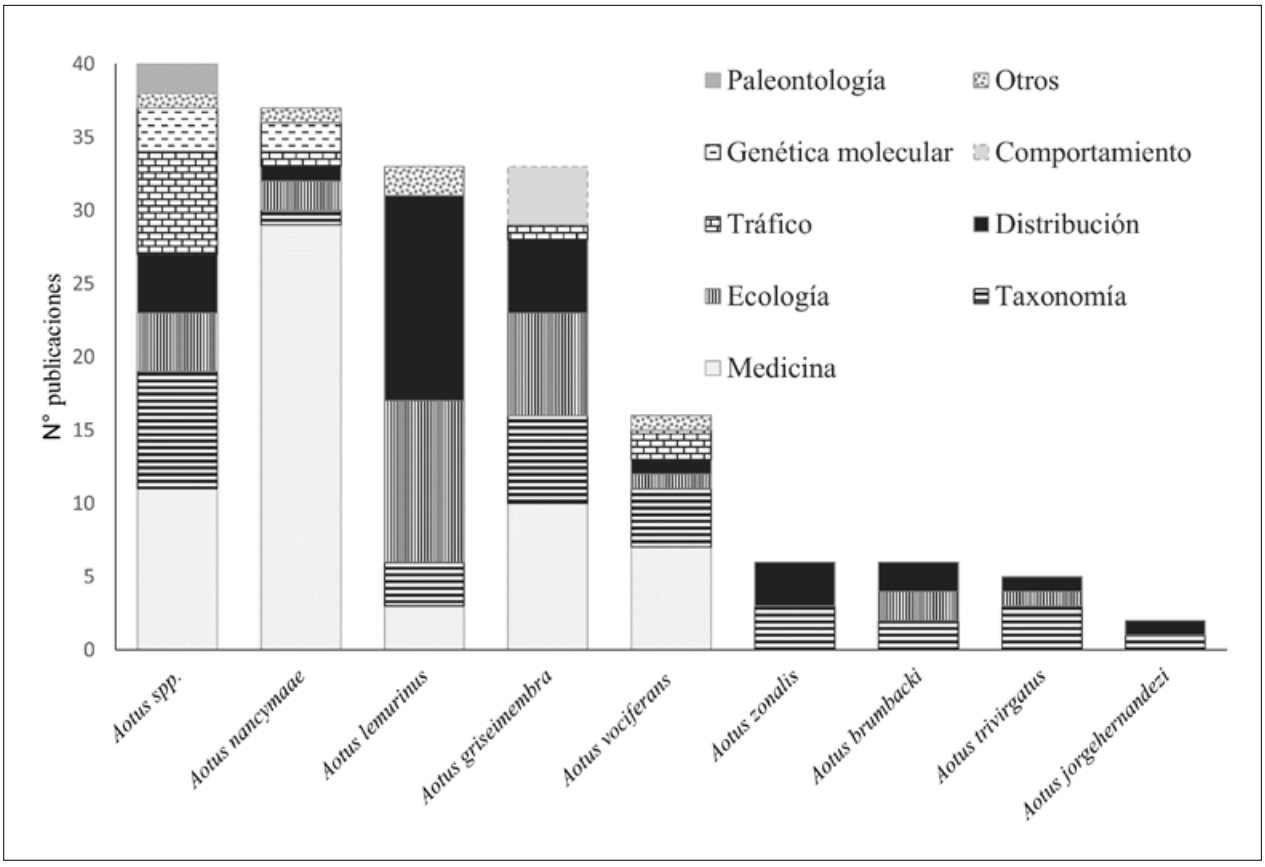

Figura 2. Número de publicaciones en cada categoría de estudio para cada una de las ocho especies del género *Aotus* en Colombia. Las categorías son explicitadas en la metodología.

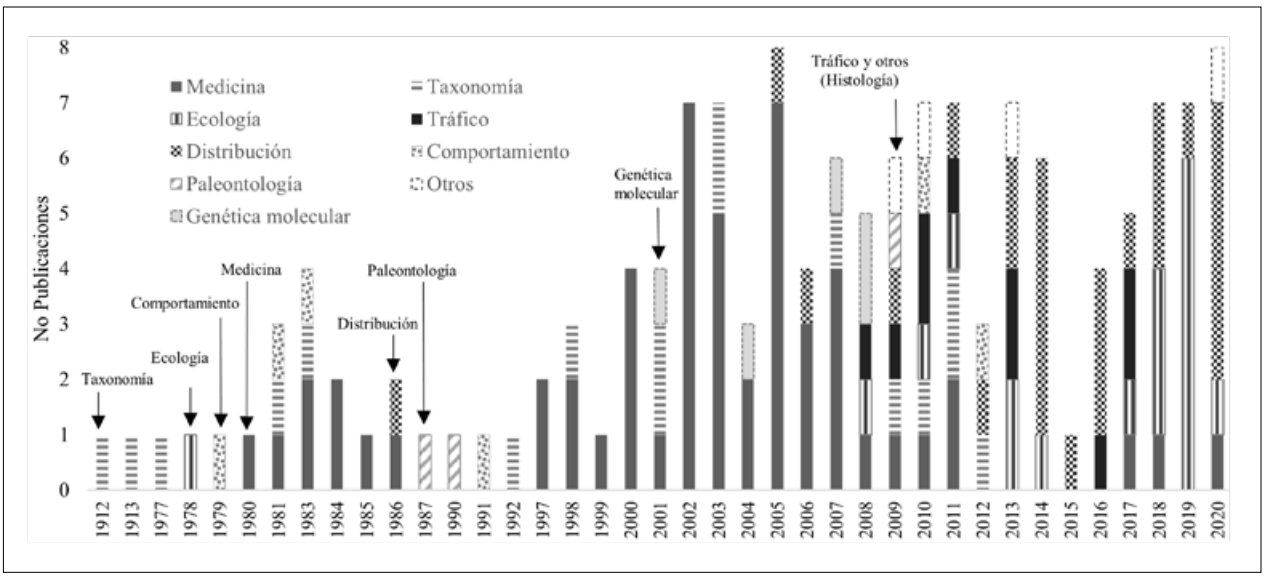

Figura 3. Número total de publicaciones por año de estudios realizados en Colombia sobre especies del género *Aotus*. Las flechas indican la presencia del primer trabajo reportado correspondiente a cada categoría.

ecología (16%), tráfico (6%), genética molecular y otros (3% cada uno), comportamiento (2%) y paleontología (1%) (Figura 2). La prevalencia de estudios biomédicos con *Aotus* está relacionada con características de su sistema inmune, que lo han sugerido cómo modelo para la investigación (Bunyard 2008). Por ende, los monos nocturnos han sido ampliamente utilizados en los intentos infructuosos sobre el desarrollo de vacunas para enfermedades como la malaria (Hernández et al, 2005). La mayoría de los monos nocturnos que eran utilizados en esos estudios no provenían de cautiverio, sino que eran directamente extraídos de su medio (Umaña et al. 1984),

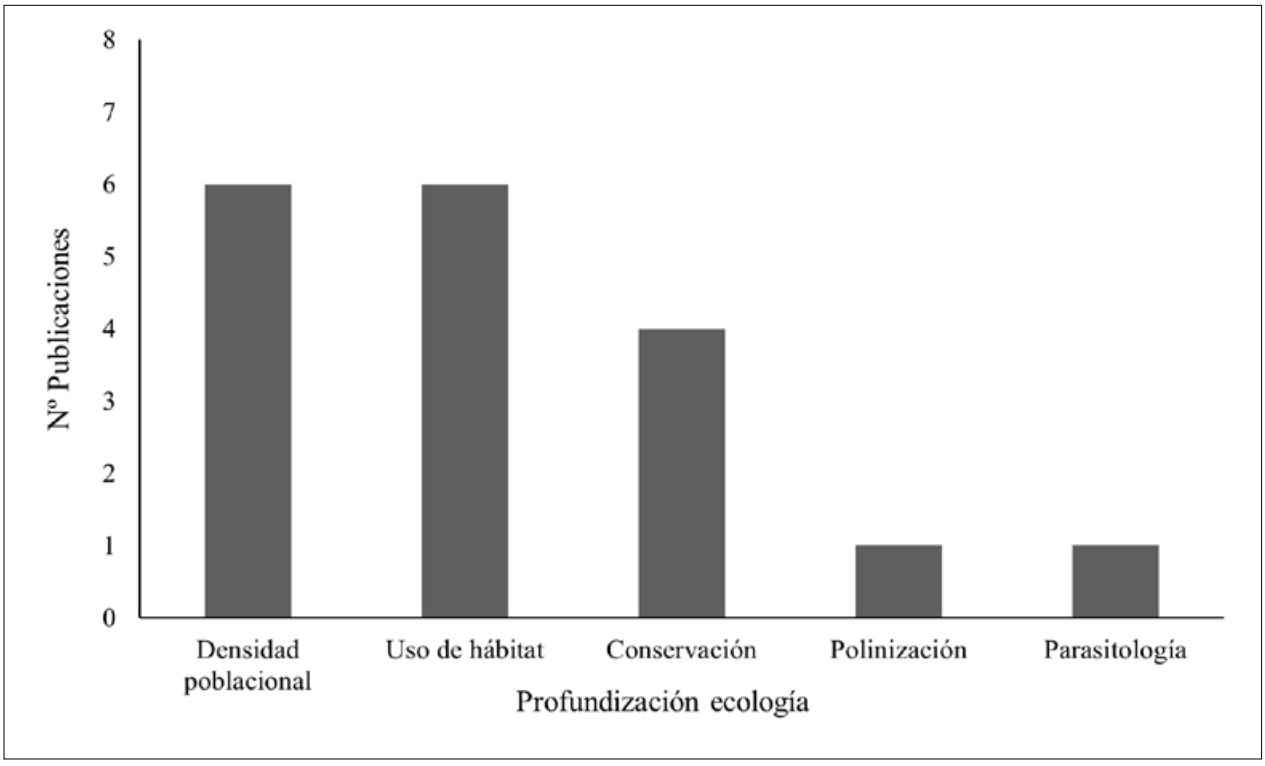

Figura 4. Número de publicaciones para cada una de las cinco subcategorías establecidas en la categoría de ecología asociadas a las especies de *Aotus* en Colombia durante los últimos 106 años.

con las potenciales implicaciones sobre sus poblaciones naturales. Esto debido a que Corpoamazonía, entidad encargada de administrar y conservar los recursos naturales del sur de la Amazonía, otorgó un permiso entre los años 1999 a 2008 a la Fundación Instituto de Inmunología de Colombia (FIDIC) (Maldonado 2011), principales autores de los trabajos con fines biomédicos que tuvieron un incremento en la publicación desde 1997 hasta 2011 (Figura 3). Asimismo, se muestra que la mayor cantidad de trabajos corresponden a varias especies en conjunto o no se especifica la especie tomando simplemente el nombre del género *Aotus* spp. La especie en la que más se han reportado este tipo de estudios es *A. nancymaae* (Maldonado et al. 2017), seguida de *A. griseimembra* (Link et al. 2019) (Figura 2). En parte debido a su amplio uso en estudios biomédicos, se ha sugerido que estas especies se encuentren actualmente en estado Vulnerable (Maldonado et al. 2017; Link et al. 2019).

La clasificación taxonómica del género *Aotus* ha sido históricamente polémica debido a la similitud morfológica entre las especies. Para resolver su clasificación, se han empleado caracteres fenotípicos (Elliot 1912, 1913), además de estudios cariológicos (Defler y Bueno 2003; 2007; Monsalve y Defler 2010; Arenas et al. 2012) y filogenéticos (Camargo 2009; Ruiz-García et al. 2011). Por lo tanto, la mayoría de los trabajos (26%) referentes a esta categoría se enfocan en varias especies del género (Figura 2) y no en una sola especie. Los trabajos basados en distribución se fundamentan en la observación directa (Escobar-Lasso et al. 2013; Montilla et al. 2018) y la revisión de literatura (García et al. 2018; Henao-Díaz et al. 2020). Lo anterior brinda información de localización de poblaciones específicas de una especie. Este tipo de trabajos (Distribución) incrementó en el 2014 representando un 90% de todos los estudios sobre *Aotus* en Colombia para ese año.

En la última década ha habido un aumento en los estudios sobre la ecología de los monos nocturnos en Colombia (Figura 3), principalmente en *A. lemurinus* (Hirche et al. 2017; Montilla et al. 2018; Ramírez-Chaves 2020) teniendo un total del 39% de los trabajos. Sin embargo, urge enfatizar la necesidad de más trabajos dentro de esta especie debido a la falta de conocimiento y a su estado de vulnerabilidad (Morales-Jiménez y de la Torre 2008). Una de las razones para la sobrerrepresentación de estudios sobre esta especie en Colombia puede deberse a que su distribución coincide con las áreas donde se encuentra la mayoría de la población e instituciones educativas en el país. Los proyectos de investigación de estas instituciones involucran trabajos de grado (licenciatura), los cuales han brindado la mayor cantidad de información recientemente (Figura 4). Dentro de la categoría "ecología" se ha observado un aumento en cuanto a la investigación del uso de hábitat que tienen estos primates, información que es bastante escasa si se compara con países como Argentina donde en los últimos 25 años se ha fomentado la investigación del mono nocturno por parte de la fundación ECO con el Proyecto Mirikiná (Fernandez-Duque y Huntington 2002; Fernandez-Duque y Marcelo Rotundo 2003; Fernandez-Duque 2003), siendo el país que ha

presentado la mayoría de los trabajos que han permitido ampliar nuestro conocimiento sobre el género, utilizando como objeto de estudio a *Aotus azarae* (Fernández-Duque et al. 2001). Sin embargo, trabajos como el de polinización debida al uso de néctar como recurso alimenticio (Marín-Gómez 2008) abren puertas a futuras investigaciones en campos no estudiados en el país para el género. La posible función de los monos nocturnos como polinizadores es especialmente interesante teniendo en cuenta que hay especies vegetales que sólo abren sus flores en la noche (Lambert y Rothman 2015).

Todos los trabajos que corresponden al control de tráfico se enfocan en la frontera trinacional entre Brasil, Perú y Colombia. Estos estudios han tenido un aumento reciente, generando diagnósticos sobre el estado de estos monos y documentando como años de extracción y la falta de control en la extracción de fauna no ha permitido que se tenga establecido el estado general de estas especies (Maldonado 2013).

Los trabajos paleontológicos estás relacionados al descubrimiento de fósiles pertenecientes a la especie *A. dindensis* en 1984, que evidencia la presencia de estos primates únicamente en el neotrópico (Setoguchi y Rosenberger 1987). Adicionalmente se muestra que en la categoría "Otros" (Figure 2), se incluye un trabajo a nivel fisiológico donde se enfoca en las características nocturnas del género, el cual proviene de un ancestro diurno, característica que lo diferencia de los demás primates de hábitos nocturnos como los lémures de Madagascar (Duque 2009; Fernández-Duque y Erkert 2006). Otro trabajo dentro de esta categoría aborda aspectos etnobiológicos donde se investiga la perspectiva que tienen acerca de la conservación de los primates, se evalúan las razones por las que se cazan estos animales en zonas del país donde se evidencia que es en gran medida por tradiciones religiosas y porque aún está muy arraigado el consumo de carne de primate (Parathian y Maldonado 2010). Por último, se muestran dos trabajos que presentan un panorama sobre la afectación de estos primates por accidentes con cercas eléctricas y su cercanía con las urbanizaciones (Saavedra-Rodríguez et al. 2013; Montilla et al. 2020).

Esta revisión muestra que hay grandes vacíos de información para algunas especies del género. Un caso puntual es el de la especie *A. jorgehernandezi* (DD) (Morales-Jiménez 2018) puesto que el espécimen tipo fue encontrado en cautiverio y no hay más información al respecto (Torres et al. 1998), los únicos trabajos presentes son el de su descripción propuesto por Defler y Bueno en 2007 y su posible distribución en el Atlas de biodiversidad para primates (Henao-Díaz et al. 2020). Razón por la cual esta especie aparece con datos deficientes en su estado de conservación (Morales-Jimenez 2018), resaltando la necesidad de realizar trabajos con esta.

A nivel del tipo de publicación, se obtuvo que la mayoría de los trabajos han sido publicados en revistas, esto permite que los trabajos realmente puedan ser visibles a nivel internacional. Asimismo se observa que gran parte de la información proporcionada proviene de literatura gris, por lo que es necesario que el esfuerzo invertido se materialice en publicaciones. Adicionalmente, la mayoría de los trabajos provienen de investigadores y estudiantes nacionales. Además, hay una gran proporción de publicaciones con colaboraciones y esto se debe a que normalmente se hacen asociaciones con otras universidades u organizaciones extranjeras. También está el caso de personas extranjeras que se establecen en Colombia y dan un gran aporte a la investigación.

Finalmente, este trabajo recopila la mayoría de los trabajos que se han realizado sobre el género *Aotus* en Colombia, evidenciando los vacíos que hay para este género en general y para cada una de las especies en particular, siendo las especies menos investigadas en el país *A. vociferans, A. brumbacki,* y *A. trivirgatus* (Figure 2), las cuales son especies con algún grado de vulnerabilidad y *A. jorgehernandezi* con datos insuficientes. Asimismo se encontraron muchos trabajos mostrando estudios con fines biomédicos, pero grandes vacíos en trabajos sobre categorías como comportamiento, genética molecular, tráfico y ecología, siendo estas dos últimas importantes y necesarias para generar planes de manejo.

Agradecimientos

Este trabajo hace parte de la tesis de pregrado del primer autor. Se agradece al semillero de Evolución y Conservación (SEC) a Estefany Acosta y a Nicolas Corredor por la retroalimentación realizada a este trabajo.

Referencias

Arenas, S., Giraldo, M., Bueno, M., Rivera Páez, F., y López, G. 2012. Caracterización cariológica de tres monos *Aotus griseimembra* (primates: Aotidae) mantenidos en cautiverio. *Bol. Cient. Mus. Hist. Nat.* 16: 120–132.

Aquino, R. y Encarnacion, F. 1994. Owl monkey populations in Latin America: field work and conservation. En: *Aotus*: *The Owl Monkey,* Baer, J. F., Weller, R. E., Kakoma, I. (eds.), pp.60–64. Academic Press, San Diego, California.

Bunyard, P. 2008. Monkey Business–a brutal Amazonian trade in Owl Monkeys. Ecologist, informed by nature. EEUU. Website: https://theecologist.org/2008/apr/01/monkey-business-brutal-amazonian-trade-owl-monkeys. Cnsultado el 1 de Octubre de 2022.

Camargo, E. 2009. Análisis filogenético de diferentes especies del género *Aotus* utilizando el gen mitocondrial citocromo II oxidasa. Tesis de pregrado. Universidad Javeriana, Bogotá.

Chapman, C. A. 1995. Primate seed dispersal: coevolution and conservation implications. *Evol. Anthrop.* 4: 74–82.

Cornejo, F. M., Guzmán-Caro, D., Lynch Alfaro, J., Maldonado, A., Moscoso, P., Shanee, S., Stevenson, P. R. y de la Torre, S. 2020. *Aotus vociferans. The IUCN Red List of Threatened Species* 2020. Website: https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T41544A166609000.en. Consultado el 24 de Abril 2020.

Cuarón, A. D., Palacios, E., Morales, A., Shedden, A., Rodríguez-Luna, E. y Grammont, P. C. 2008. *Aotus zonalis.* The IUCN Red List of Threatened Species 2008. Website: https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39953A10297100.en. Consultado el 25 de Abril 2020.

Defler, T. y Bueno, M. 2003. Karyological guidelines for *Aotus* taxonomy. En la conferencia número 26 de American Society of Primatology. Resumen. *Am. J. Primatol.* 60: 134–135.

Defler, T. y Bueno, M. 2007. *Aotus* diversity and the species problem. *Primate Conserv*. 22: 55–70.

Defler, T., Bueno, M. y Hernández-Camacho, J. 2001. Taxonomic status of *Aotus hershkovitzi*: its relationship to *Aotus lemurinus lemurinus*. *Neotrop. Primates* 9: 37–52.

Donati, G. y Borgognini-Tarli, S. 2006. From darkness to daylight: cathemeral activity in primates. *Folia Primatol*. 84: 7–32.

Duque, J. F. 2009. Descripción de la estructura interna del mesencéfalo de *Aotus* (primates: Simiiformes: Aotidae) con referencia a *Homo* (Primates: Simiiformes: Hominidae): posibles implicaciones en la evolución de los ciclos circadianos de mamíferos. *Rev. Acad. Colomb. Cienc.* 33: 425–444.

Elliot, D., Chapman, F., Miller, L. y Fuertes, L. 1913. Descriptions of new species of monkeys of the genera *Seniocebus* and *Aotus* from Colombia, South America. *Bull. Am. Mus. Nat.*59: 82–86.

Elliot, D., Kerr, E. Dollman, J. y Armstrong Carriker, M. 1912. New species of monkeys of the genera *Seniocebus*, *Alouatta*, and *Aotus*. *Bull. Am. Mus. Nat.* 31: 31–33.

Escobar-Lasso, S. Cerón-Cardona, J. y Castaño-Salazar, J. 2013. Los mamíferos de la cuenca del río Chinchiná, en la región andina de Colombia. *Therya* 4: 139–155.

Fernández-Duque, E., Rotundo, M., y Sloan, C. 2001. Density and population structure of owl monkeys (*Aotus azarai*) in the Argentinean Chaco. *Am. J. Primatol.* 53: 99–108.

Fernández.Duque, E. y Huntington, C. 2002. Disappearances of individuals from social groups have implications for understanding natal dispersal in monogamous owl monkeys (*Aotus azarai). Am. J. Primatol.* 57: 219–225.

Fernández-Duque, E. y Rotundo, M. 2003. Field methods for capturing and marking Azarai Night Monkeys. *Int. J. Primatol.* 24: 113–1120.

Fernández-Duque, E., y Erkert, H. G. 2006. Cathemerality and lunar periodicity of activity rhythms in Owl Monkeys of the Argentinean Chaco. *Folia Primatol.* 77: 123–138.

Fernández-Duque, E. 2016. Social monogamy in wild owl monkeys (*Aotus azarai azarai*) of Argentina: the potential influences of resource distribution, ranging patterns and competition. *Am. J. Primatol.* 78: 355–371.

García, S., Montilla, S., Bustamante, B. y Bustamante, S. 2018. Estado de la investigación primatológica en el Eje Cafetero y Antioquia, Colombia. *Neotrop. Primates* 24: 56–63.

Henao-Díaz, F. et al. 2020. Especies de *Aotus* spp. En: *Atlas de la Biodiversidad de Colombia: Primates*. Henao-Díaz, F. et al. (eds.), pp.11–15. Instituto de investigación Alexander Von Humboldt, Colombia.

Henao Díaz F., Stevenson P., Carretero-Pinzón X., Castillo-Ayala C., Chacón Pacheco J., Defler T., García--Villalba J., Guzmán Caro D. C., Link A, Maldonado A. M., Moreno M. I., Palacios E., Rodríguez Rodríguez A., Roncancio Duque N. J., Soto Calderón I. D., Soto L., Velásquez-Tibatá J., Olaya-Rodríguez M. H., Cruz--Rodríguez C., Noguera-Urbano E., Galvis Ramírez N. F. and Valencia L. M. (2020). *Atlas de la Biodiversidad de Colombia: Primatas.* Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. pp.51. Bogotá DC, Colombia.

Herrera, S., Perlaza, B., Bonelo, A., y Arévalo-Herrera, M. 2002. *Aotus* monkeys: their great value for anti-malaria vaccines and drug testing. *J. Parasitol.* 32: 1625–1635.

Hernández, E., Suárez, C., Parra, C., Patarroyo, M. E. y Patarroyo, M. E. 2005. Identification of five different IGHV gene families in owl monkeys (*Aotus nancymaae*). *Tissue Antigens* 66: 640–649.

Hirche, A., Jiménez, A., Roncancio-Duque, N. y Ansorge, N. 2017. Population density of *Aotus* cf. *lemurinus* (Primates: Aotidae) in a subandean forest patch on the eastern slopes of the western Andes, region of Dapa, Yumbo, Valle del Cauca, Colombia. *Primate Conserv.* 31: 1–7.

Lambert, J. E. y Rothman, J. M. 2015. Fallback foods, optimal diets and nutritional targets: primate responses to varying food availability and quality. *Annu. Rev. Anthropol*. 44: 493–512.

Lau, J., Fernández-Duque, E., Evans, S., Dixson, A. F. y Ryder, O. A. 2004. Heterologous amplification and diversity of microsatellite loci in three owl monkey species (*Aotus azarai, A. lemurinus, A. nancymaae*). *Conserv. Genet.* 5: 727–731.

Link, A., Mittermeier, R. A. y Urbani, B. 2019. *Aotus griseimembra. The IUCN Red List of Threatened Species* 2019. Website: https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T1807A17922228.en. Consultado el 25 de Abril 2020.

Maldonado, A. Nijman, V. y Bearder, S. 2009. Trade in night monkeys *Aotus* spp. in the Brazil–Colombia–Perú tri-border area: international wildlife trade regulations are ineffectively enforced. *Endanger. Species Res.* 9: 143–149.

Maldonado, A. M. 2013. Diagnóstico sobre el comercio de monos nocturnos *Aotus* spp. en la frontera entre Colombia, Perú y Brasil. En: *Primates Colombianos en Peligro de Extinción*. Defler, T. R., Stevenson, P. R., Bueno, M. L., Guzmán-Caro, D. C. (eds.), pp.39–67. Editorial Panamericana, Colombia.

Maldonado, A., Guzmán-Caro, D., Shanee, S., Defler, T. R. y Roncancio, N. 2017. *Aotus nancymaae. The IUCN Red List of Threatened Species* 2017. Website: https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41540A115578713.en. Consultado el 24 de Abril 2020.

Maldonado, A. M. 2011. Tráfico de monos nocturnos *Aotus* spp. en la frontera entre Colombia, Perú y Brasil: efectos sobre sus poblaciones silvestres y violación de las regulaciones internacionales de comercio de fauna estipuladas por CITES. *Rev. Acad. Colomb. Cienc.* 35: 225–242.

Marín-Gómez O. 2008. Consumo de néctar por *Aotus lemurinus* y su rol como posible polinizador de las flores de *Inga edulis* (Fabales: Mimosoideae). *Neotrop. Primates* 15: 30–32.

Morales-Jiménez, A. L. y de la Torre, S. 2008. *Aotus lemurinus. The IUCN Red List of Threatened Species* 2008. Website: https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T1808A7651803.en. Consultado el 24 de Abril 2020.

Morales-Jiménez, A. L. y Link, A. 2018. *Aotus jorgehernandezi. The IUCN Red List of Threatened Species* 2018. Website: https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T136211A17922981.en. Consultado el 24 de Abril 2020.

Morales-Jiménez, A. L., Link, A. y Stevenson, P. 2008. *Aotus brumbacki. The IUCN Red List of Threatened Species* 2008. Website: https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T39915A17923405.en. Consultado el 24 de Abril 2020.

Monsalve, M. y Defler, T. 2010. An *Aotus* karyotype from extreme eastern Colombia. *Primate Conserv.* 25: 21–26.

Montilla, S. Cepeda-Duque, J. y Bustamante-Manrique, S. 2018. Distribución del mono nocturno andino *Aotus lemurinus* el departamento del Quindío, Colombia. *Mammalogy Notes* 4: 6–10.

Montilla, S., Ríos-Soto, J., Mantilla-Castaño, J., Patiño-Siro, D., Bustamante-Manrique, S., Botero-Henao, N., Ruiz, S., Arias-Monsalve, H., Link, A. y Ramírez-Chaves, H. E. 2020. Electrocution events of *Aotus lemurinus* (Primates: Aotidae) in the Central Andes of Colombia. *Mammalogy Notes* 6: 183–187.

Parathian, H. E., y Maldonado, A. M. 2010. Human–nonhuman primate interactions amongst Tikuna people: Perceptions and local initiatives for resource management in Amacayacu in the Colombian Amazon. *Am. J. Primatol.* 72: 855–865.

Ramírez-Chaves, H., Carvajal-Agudelo, J. D., Hoyos, M., Bustamante-Manrique, S., Castaño-Rivera, A., Rivillas-Carmona, M., Ossa-López, P. y Rivera-Páez, F. 2020. New records and confirmation of the presence of three species of primates (Mammalia, Primates) in southwestern Colombia. *Check List* 16: 811–819.

Rímoli, J., Pinto, T., Romero-Valenzuela, D., Rumiz, D. I., Lynch Alfaro, J. W. y Ravetta, A. L. 2021. *Aotus azarae*. The IUCN Red List of Threatened Species 2021: Website: https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T41539A190450485.en. Consultado el 23 Septiembre 2022.

Rylands, A., Mittermeier, R. y Silva, J. 2012. Neotropical primates: taxonomy and recently described species and subspecies. *Int. Zoo. Yb.* 46: 11–24.

Ruiz-García, M., Vásquez, C., Camargo, E., Leguizamón, N., Gálvez, H., Vallejo, A., Pinedo, M., Castellanos-Mora, L., Shostell, J. y Álvarez, D. 2011. Molecular phylogenetics of *Aotus* (Platyrrhini, Cebidae). *Int. J. Primatol.* 32: 1218–1241.

Saavedra-Rodríguez, C., Lizcano, A. y Corrales, J. 2013. Incidentes de fauna silvestre en líneas de energía en zona rural del Valle del Cauca, Colombia. *Revista Biodiversidad Neotropical* 3: 85–89.

Setoguchi, T., y Rosenberger, A. L. 1987. A fossil owl monkey from La Venta, Colombia. *Nature* 326: 692-694.

Shanee, S., Cornejo, F. M. y Mittermeier, R. A. 2020. *Aotus miconax.* The IUCN Red List of Threatened Species 2020. Website: https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T1802A164046186.en. Consultado el 23 de Septiembre 2022

Torres, O. M., Enciso, S., Ruiz, F., Silva, E. y Yunis, I. 1998. Chromosome Diversity of the Genus *Aotus* From Colombia. *Am. J. Primatol.* 44: 255–275.

Urbani, B., Lynch, Alfaro. J. y de Azevedo, R. 2018. *Aotus trivirgatus*. The IUCN Red List of Threatened Species 2018. Website: https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T41543A17923788.en. Consultado el 24 de Abril 2020.

Umaña, A. Ramírez, C. Espinal T. y Sabogal, M. 1984. Establishment of a colony of nonhuman primates (*Aotus lemurinus griseimembra*) in Colombia. *Pan American Journal of Public Health* 18: 221–229.

Anexos 1 y 2 son disponibles como un archivo complementario en la versión on-line.

DOI: https://doi.org/10.62015/np.2022.v28.350

DISTRIBUIÇÃO ESPACIAL DE GRUPOS FAMILIARES E PREFERÊNCIA DE HABITAT DE *PLECTUROCEBUS BERNHARDI* EM REMANESCENTE FLORESTAL NO SUDOESTE DA AMAZÔNIA BRASILEIRA

Odair Diogo da Silva[1], Eder Correa Fermiano[1] , Thatiane Martins da Costa[1], Dionei José da Silva[2], Manoel dos Santos Filho[2], Derli Rodrigues Diogo[3], Emerson Moreira de Almeida[4], Almério Câmara Gusmão[5]

[1] Programa de Pós-Graduação em Ciências Ambientais, Universidade do Estado de Mato Grosso, Centro de Pesquisa de Limnologia, Biodiversidade, Etnobiologia do Pantanal, Av. Santos Dumont, s/nº, Cidade Universitária (Bloco II), CEP 78200-000, Cáceres, Mato Grosso. <Email: odair_diogo@hotmail.com>.
[2] Centro de Pesquisa de Limnologia, Biodiversidade, Etnobiologia do Pantanal – CELBE.
[3] Secretaria de Estado da Educação do Estado de Rondônia, Seduc.
[4] Faculdade de Ciências Biomédicas de Cacoal (FACIMED), Cacoal, Rondônia.
[5] Instituto Estadual de Desenvolvimento da Educação Profissional de Rondônia, IDEP/Centec Abaitará.

Resumo

Populações de *Plecturocebus bernhardi* estão sobre fortes pressões de redução de habitat, decorrente do protagonismo do agronegócio e crescimento de áreas urbanas no sudoeste da Amazônia brasileira. E o comportamento da espécie no uso desses tipos de habitats são desconhecidos. Compreender os efeitos da modificação de habitat nos motivou em estudar a distribuição espacial de grupos familiares e preferência de habitat da espécie em um remanescente de floresta no centro-sul do estado de Rondônia. Empregamos a metodologia de transecção linear utilizando playback com vocalização da espécie. Verificou-se a composição dos grupos, em diferentes locais (interior ou borda de parte do bloco de floresta da confluência dos rios Jí-Parana/Machado e São Pedro), fitofisionomia e estrato vertical de vegetação ocupado. Durante o estudo foram registrados 26 grupos de *P. bernhardi* em um esforço de amostragem de 29,9 km percorridos. Os grupos estavam estruturados com até quatro indivíduos, encontrados principalmente em estratos verticais intermediários, com maior registro de grupos em borda de floresta. A alta taxa de encontro de grupos registrados não atenuam nos cuidados de conservação da espécie, considerando que é cada vez menor a área de habitat para a espécie nessa porção da Amazônia.

Palavras-chave: Zogue-zogue do Príncipe Bernhardi; arco do desmatamento; conservação; Rondônia

Abstract

Populations of *Plecturocebus bernhardi* are under strong pressure from habitat reduction due to the dominance of agribusiness and growth of urban areas in the southwest of the Brazilian Amazon. At the same time, the behavioral ecology of this species is unknown. Interest in understanding the effects of habitat modification on species ecology motivated us to study the spatial distribution of family groups and species habitat preference in a forest remnant in south-central Rondônia state, Brazil. We used linear transect methodology, including playback with the species' vocalizations. We verified group composition in different locations (interior or edge of the forest block at the confluence of the Ji-Paraná and Machado rivers), phytophysiognomy and vertical stratum of vegetation occupied. During the study, 26 groups of *P. bernhardi* were recorded in a sampling effort of 29.9 km covered. The groups were structured with up to four individuals, found mainly in intermediate vertical strata, with a greater number of groups at forest edges. The high rate of encounters of recorded groups does not indicate a reduction in conservation priority for the species, considering that the habitat area for the species in this part of the Amazon is decreasing.

Keywords: Prince Bernard's titi monkey; arc of deforestation; conservation; Rondônia

Introdução

As espécies de primatas distribuídas no sudoeste da Amazônia brasileira vêm sofrendo com fortes pressões de perda de habitats decorrente da modificação da paisagem natural, tornando-as áreas devastadas para atender as atividades do agronegócio e crescimento de áreas urbanos (Gusmão et al. 2021; Silva et al. 2022). Essas ameaças tem se intensificado nos últimos anos, haja vista que a negligência devido a flexibilização das políticas púbicas de proteção ambiental brasileiras (ver Agapito et al. 2021; Ruaro et al. 2022). O resultado disso foi a elevação de espécies de primatas dessa região ao status de ameaçados de extinção da natureza, nas principais entidades dedicados avaliação do estado de conservação das espécies da fauna silvestre (por exemplo Silva et al. 2022). *Plecturocebus*

bernhardi é uma das espécies que vem sobrevivendo em pequenos remanescentes florestais na região. Sobretudo àquelas populações da porção sul do rio Jí-Paraná/Machado (Monção et al. 2008), onde a perda de vegetação nativa foi mais acentuada (Khanna e Medvigy 2014). As quais foram conferidas como fenotipicamente variante das encontradas no norte desse interflúvio (Silva-Diogo et al. 2018). O comportamento dessas populações frente a essas alterações são desconhecidas, desse modo, fomos motivados a estudar sobre como é encontrado os grupos familiares de *P. bernhardi* na distribuição espacial e suas preferências pelos micro habitats em um dos principais remanescentes florestais da drenagem sul do alto rio Ji-Parana/Machado, confluência com o rio São Pedro, um afluente de segunda ordem da porção centro-sul do estado de Rondônia, Brasil.

Material e Métodos

O estudo foi conduzido em um remanescente de floresta formado por um bloco de vegetação nativa preservada localizado em áreas particulares. O trecho estudado pertence a denominada Reserva Água Doce (11°25'8.51"S, 61°44'7.58"W) no município de Cacoal (Figura 1). Cujo a área possui 700 ha de floresta composta por Reserva Legal (RL) e Área de Preservação Permanente (APP) do rio São Pedro, contigua a RL e APP de outros pequenos rios em outras propriedades, formando um mosaico de vegetação nativa >10.000 ha. A fitofisionomia é do tipo Floresta Ombrófila Aberta (RadamBrasil 1978) de terra firme, com enclaves de Cerrado e área longitudinal de área de igapó nas proximidades dos rios. O clima da região é do tipo Tropical AW (clima tropical, com inverno seco), com temperatura média de 26° C, período de estiagem entre os meses de junho a outubro e chuvosa entre novembro e abril, com pluviosidade média anual de 2.300 mm (Alvares et al. 2014).

O método empregado foi o de transecção linear adaptada a partir do estudo de Peres (1999) consistindo em caminhadas em trilhas no interior e borda do remanescente de floresta a uma velocidade média de 1 km/h. A fim de localizar os animais foi utilizado um gravador Sony ICD-PX312 acoplado a uma caixa de som amplificadora, com vocalização do *Plecturocebus bernhardi* obtidas diretamente no campo. As emissões da vocalização foram a cada 100 m, durante caminhada nas trilhas no período de julho a setembro de 2016, totalizando 29,9 km de

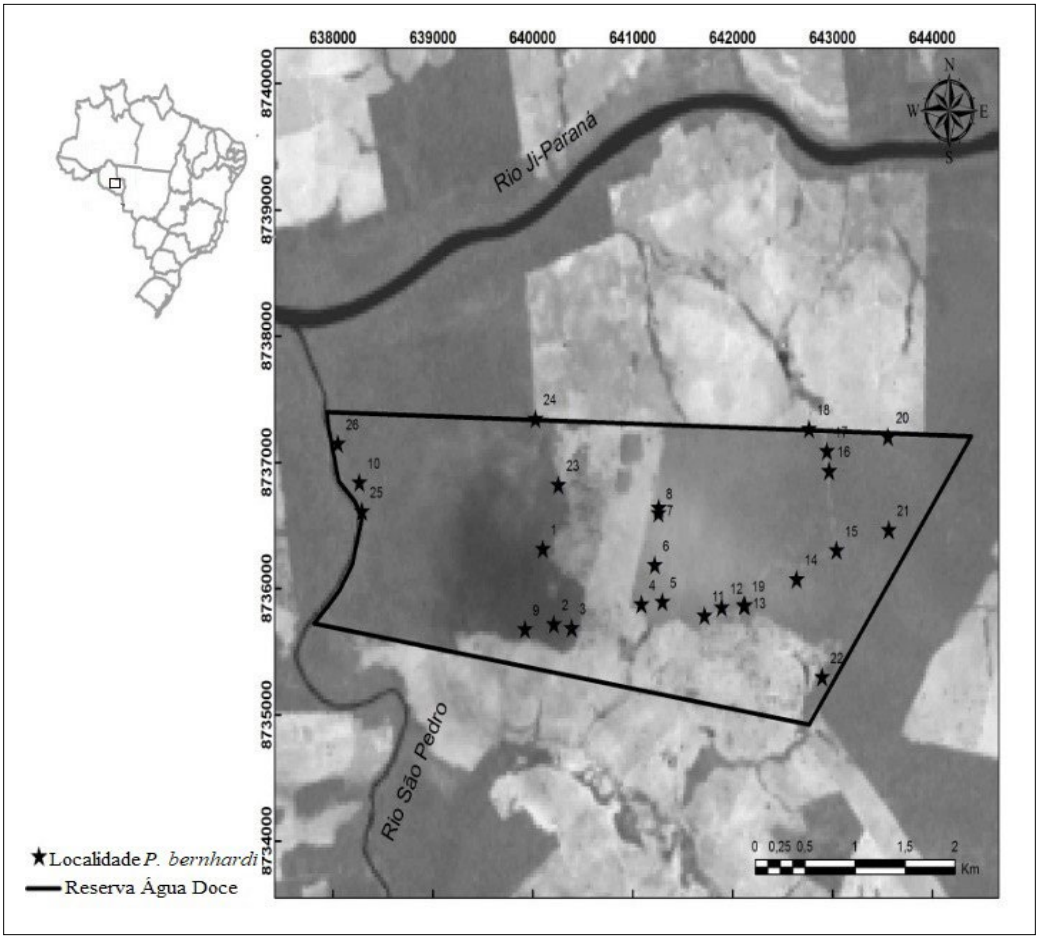

Figura 1. Localização da área estudada em polígono e com os pontos dos grupos de *P. bernhardi* encontrados representado por pontos; Cinza claro: pastagens antrópicas; Cinza escuro; vegetação nativa.

Tabela 1. Grupos de macaco Zogue-zogue registrados na fazenda Água Doce pelo método de procura em trilhas e estímulo por *playback*.

Grupos	Adulto Macho	Adulto Fêmea	Sub-adulto	Juvenil	Infante	Extrato arbóreo/ Altura do chão (M)	Tipo de Registro
01	01	01	01	-	-	05-10	VI
02	01	01	-	-	01	15-20	VI
03	01	01	-	-	-	10-15	VI
04	01	01	-	-	-	10-15	VI
05	01	01	01	-	-	15-20	VI
06	01	01	01	01	-	10-15	VI
07	01	01	-	-	-	05-10	VI
08	01	01	01	-	-	15-20	VI
09	01	01	-	-	-	10-15	VI
10	01	01	-	-	-	05-10	VI
11	01	01	-	01	-	15-20	VI
12	01	01	-	-	-	15-20	VI
13	-	-	-	-	-	-	VO
14	01	01	01	01	-	15-20	VI
15	01	01	01	-	-	10-15	VI
16	01	01	-	-	-	15-20	VI
17	01	01	-	-	-	10-15	VI
18	01	01	-	-	-	10-15	VI
19	01	01	01	-	01	20-25	VI
20	01	01	01	01	-	10-15	VI
21	01	01	-	-	-	10-15	VI*
22	-	-	-	-	-	-	VO
23	-	-	-	-	-	-	VO
24	01	01		01		05-10	VI
25						10-15	VI
26	01	01	-	-	-	-	VI

esforço de amostragem. Na ocasião todos os estratos da vegetação foram inspecionados com intuito de localizar os animais.

Durante as observações dos grupos foi anotado a presença de machos e fêmeas adultas, subadultos, juvenis e infantos, utilizando o modelo de Speld et al. (2017) (Tabela 1). Por sua vez, os machos e fêmeas foram considerados indivíduos adultos que participaram de vocalizações. Os juvenis foram considerados como individuos visivelmente menores que os adultos e não participavam das vocalizações. Os infantos foram os individuos carregados no dorso e subadultos foram os individuos intermediarios entre adultos e juvenis.

Na análise de estrato vertical utilizado pela espécie foi observado a altura em que se encontrava o grupo em relação ao solo. Considerando que a vegetação possuía estrato mínimo de 0 m (Solo) e floresta com máximo 35 m (Dossel), foram categorizados em sete porções de

altitude da floresta, ou seja, intervalo de altura a cada 5 m. Conforme registrado o grupo no percurso foi anotada as coordenadas geográficas e avaliada as características da vegetação do local, quando borda ou interior do remanescente de floresta, se igapó ou cerradão. A taxa de encontro de grupos foi calculada com base na observação a cada 10 km percorridos. Para evitar a replicação na amostragem desconsideramos os grupos com composição semelhantes em intervalos curtos de 500 m e no mesmo dia de observação.

Resultados

Durante o estudo obtivemos 26 grupos de *Plecturocebus bernhardi*. Os quais variaram de 2 a 4 indivíduos na sua composição de grupos (= 2,69 [± 0,764]), ind/grupo e taxa de 8,6 grupos a cada 10 km percorrido. Em todos os grupos foram observados machos e fêmeas adultas, enquanto subadultos foram observados em 30,76% dos grupos, seguidos por juvenis e infantes em 21,74% e 13,04% respectivamente (ver Tabela 1). Por outro lado, não ocorreu de forma concomitante a presença de indivíduos infantes e juvenis no mesmo grupo. No entanto, houve sobreposição destes com subadultos. A maioria dos grupos (80,77%) foram encontrados em áreas de bordas do remanescente florestal, independentemente da fitofisionomia cerradão ou de floresta. *P. bernhardi* teve baixa preferência por área de igapó era inexistente em área de Cerrado (Figura 2). A espécie foi encontrada com maior frequência entre 10 m e 15 m de altura, seguido por 15 a 20 m e em menor frequência na altura de 5 a 10 m, seguido por 20 a 25 m (Figura 3). Não registramos grupos nos estratos inferiores a 5 m e nem nos extratos superiores a 25 m.

Discussão

Nossos dados contribuem para entender como as populações de *Plecturocebus bernhardi* tendem a utilizar os remanescentes florestais do sudoeste da Amazônia Brasileira, principalmente no conhecimento da estrutura da população e preferência de uso de habitats. Pois, observa-se que os grupos estão estruturados com até quatro indivíduos, que quase sempre, além do casal, a presença de subadultos, juvenis ou infantos. Indicando, portanto, que as populações estão se reproduzindo periodicamente.

Figura 2. Grupo de *Plecturocebus bernhardi,* avistado durante as observações de campo. Foto: Odair Diogo da Silva.

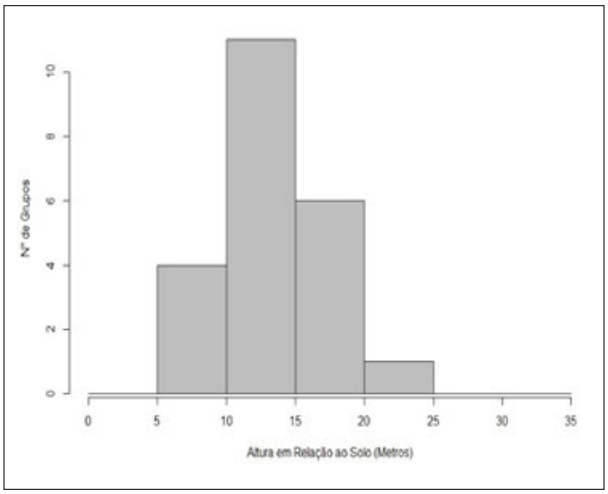

Figura 3. Altura do estrato arbóreo utilizado pelos grupos de *P. bernhardi* amostrados durante período de coleta de dados.

Esse padrão de abundância foi semelhante ao observado em áreas próximas (Alves 2013; Gusmão et al. 2014).

Nossos dados indicam que a composição dos grupos foi menor que a esperada, haja vista que, Gusmão et al. (2014) observaram grupos com até sete indivíduos em um remanescente a 12 km de distância da área por nós estudada. Padrão comum inclusive as espécies simpatricas como *P. parecis*, *P. miltoni* e *P. brunneus* conforme observado na literatura (Ferrari 2001; Alvares et al. 2014; Dalponte et al. 2014, Gusmão et al. 2019).

Acreditamos que *Plecturocebus bernhardi* possui forte preferência por área florestada em vez de vegetação baixa como de Cerrado. Essa tendência tem chamado atenção quando comparado a outras espécies vizinhas. Estudos em andamento apontam que os enclaves de Cerrado limitam a ocorrência da *P. bernhardi* em zonas de simpatria com a espécie *P. parecis* (Gusmão et al., em vias de publicação), onde *P. bernhardi* foi observado ocupando floresta de maior porte em relação a sua espécie simpatrica. No nosso estudo foi observado que a espécie ocupava preferencialmente os estratos da vegetação entre 10 m e 15 m de altura, com menor frequência acima de até 20 m, independentemente se borda ou interior da floresta.

É possível que as espécies de primatas da região exploram diferentes estratos da vegetação, assim como observamos em *Plecturocebus bernhardi*. Pois, exemplo disso, foram os registros em campo de compartilhamento da floresta entre *P. bernhardi* e a espécie *Ateles chamek*. As duas espécies foram vistas consumindo concomitantemente frutos, onde a estratégia de coleta do recurso esteve relacionada à altura dos frutos na floresta, onde *P. bernhardi* explorava o sub-bosque enquanto que *A. chamek* a porção superior. Acreditamos que isso seja uma tendência, pois reforça a opinião de Peres (1993), que duas espécies de primatas ecologicamente similares ocupam o mesmo habitat a partição do espaço vertical da floresta.

Acreditamos que este número relativamente alto de registros de grupos, em comparação com os dados disponível em estudos realizados em áreas próximas (Gusmão et al. 2014; Cavalcante et al. 2018), tenha relação com particularidades ambientais/temporais. Essa reflexão vai de encontro aos argumentos de Kasecker (2006), onde nós concordamos com a ideia que fatores como disponibilidade de alimento, composição florística, estratificação florestal, altura da floresta e insolação podem ser a inferência no aumento de abundância de uma determinada espécie. Deste modo, o aumento da luminosidade, aceleram a dinâmica da vegetação (Murcia 1995), aumentando a quantidade de folhas novas e presença de plantas pioneiras, como as embaúbas (*Cecropia* sp.) nas bordas da floresta, o que pode explicar a elevada taxa de encontro de *Plecturocebus bernhardi* nessa porção do remanescente florestal. Destacamos também que o método de estimulo de vocalização utilizado tenha colaborado no sucesso de encontro, haja vista que os zogue-zogues são primatas difíceis de serem detectados em campo, já que são de pequeno porte e silenciosos (Costa et al. 2009; Silva-Diogo et al. 2016). Mesmo assim, a ressalva foi que os grupos não responderam aos estímulos por vocalização por *playback* às tardes.

No presente estudo foi detectado que os grupos de *Plecturocebus bernhardi* são bem distribuídos no remanescente florestal estudado, onde é rico em estratos arbóreos intermediários, com significativa preferência a posições perimetrais da floresta. A alta abundância de grupos registrados não implica em relaxamento nos cuidados de conservação da espécie, pois o número de remanescentes florestais potenciais de permanência da espécie são reduzidos nessa matriz antropizada do "arco do desmatamento" da Amazônia brasileira.

Agradecimentos

A Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) pela bolsa de mestrado de ODS, TMC e ECF e de doutorado de ACG. Ao Sr. Jorge A. Cavalleti pela autorização de acesso a área e apoio logístico. A Antônio Miguel Olivo Neto pela produção do mapa da área amostrada.

Referências

Agapito, L. S., Miranda, M. M. A. e Xavier Januário, T. F. 2022. A political agenda in conflict with environmental protection: a critical policy essay from Brazil. *International Criminology* 2: 206–218. https://doi.org/10.1007/s43576-021-00041-y.

lves, S. L. 2013. Efeitos do tipo de floresta e da estrutura de habitat em assembleias de primatas no sudoeste da Amazônia. Dissertação de Mestrado em Zoologia – Universidade Federal do Pará e Museu Paraense Emílio Goeldi, Belém, Pará.

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. M. e Sparovek, G. 2014. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22(6): pp.711–728. http://doi.org/10.1127/0941-2948/2013/0507

Cavalcante, T., Gusmão, A. C. e Ferrari, S. F. 2018. Unexpected diversity: the potential role of privately-owned forest remnants in the conservation of the primates of the highly-impacted Rondônia center of endemism, southwestern Brazilian Amazonia. *Neotrop. Primates* 24(2): pp.36–39.

Costa, M. D., Bonillo-Fernandes, F. A. e Gonçalves, A. V. 2009. Densidade e tamanho populacional de sauás *Callicebus nigrifrons* em fragmento de mata atlântica em Pouso Alegre, MG. In: IX Congresso de Ecologia do Brasil, 1–3. Anais. São Lourenço, Minas Gerais.

Dalponte, J. C., Silva, F. E. e Júnior, S. 2014. New species of titi monkey, genus *Callicebus* Thomas, 1903 (Primates, Pitheciidae), from southern Amazonia, Brazil. *Papéis Avulsos de Zoologia* (São Paulo) 54(32): 457–472. http://dx.doi.org/10.1590/0031-1049.2014.54.32.

Ferrari, S. F. 2001. A Fauna de Mamíferos Não-Voadores da Reserva Biológica do Traçadal – RO. Relatório técnico não publicado.

Gusmão, A. C., Crispim, M. A., Ferronato, M. L., Sousa. J. e Junior, S. 2014. Primatas da Reserva Particular do Patrimônio Natural Água Boa, Cacoal, Rondônia, Brasil. *Neotrop. Primates* 21(2): 207–209. http://doi.org/10.1896/044.021.0212.

Gusmão, A. C. Evangelista-Vale, J. C. Pires-Oliveira, J. C. P. Barnett, A. A. e Silva, O. D. 2021. New records and modelling the impacts of climate change on the black-tailed marmosets. http://doi.org/10.1371/journal.pone.0256270.

Gusmão, A. C., Messias, M. R., Carneiro, J., Shineider, H., Alencar, T. B., Calouro, A. M., Dalponte, J. C., Mattos, F. S., Ferrari, S. F., Bus, G., Azevedo, R. B., Santos Junior, E. M., Nash, S. D., Rylands, A. B. e Barnett, A. A. 2019. A new species of Titi Monkey, *Plecturocebus* Byrne et al., 2016 (Primates, Pitheciidae), from southwestern Amazonia, Brazil. *Primate Conservation* 33(1): 15–15.

Gusmão, A. C., Silva, O. D., Silva, A. M. e Barnett, A. A. 2023. Contact zone between two species of *Plecturocebus* (Pithecidae, Primates) titi along the upper Rio Roosevelt, South-western Amazonia, Brazil. *Neotrop. Primates*. No prelo.

Khanna, J. e Medvigy, D. 2014. Strong control of surface roughness variations on the simulated dry season regional atmospheric response to contemporary deforestation in Rondônia, Brazil. *Journal of Geophysical Research: Atmospheres* 119(23): 13.067–13.078. https://doi.org/10.1002/2014JD022278

Kasecker, T. P. 2006. Efeito da estrutura do hábitat sobre a riqueza e composição de comunidades de primatas da RDS Piagaçu-Purus, Amazônia Central, Brasil. Dissertação de Mestrado em Biologia Tropical e Recursos Naturais – Universidade Federal do Amazonas, Manaus, Amazonas.

Monção, G. R. e Selhorst, V. 2008. Expansão da distribuição geográfica de *Callicebus bernhardi* a oeste do Rio Ji-Paraná, estado de Rondônia, Brasil. *Neotrop. Primates* 15: 67–68.

Murcia, C. 1995. Edges effects in fragmented forests: implications for conservation. *Trends in Ecology and Evolution* 10: 58–62. https://doi.org/10.1016/S0169-5347(00)88977-6.

Peres, C. A. 1993. Structure and spatial organization of an Amazonian terra firme forest primate community. *J. Trop. Ecol.* 9(3): 259–276.

Peres, C. A. 1999. General guidelines for standardizing line-transect surveys of tropical forest primates. *Neotrop. Primates* 7: 11–16.

RadamBrasil. 1978. *Geologia, geomorfologia, pedologia, vegetação e uso potencial da terra.* Departamento Nacional de Produção Mineral, Vol. 1–34. Brasília, Distrito Federal.

Ruaro, R., Alves, G. H. Z., Tonella, L., Ferrante, L. e Fearnside, P. M. 2022. Loosening of environmental licensing threatens Brazilian biodiversity and sustainability. *Die Erde* 153(1): 60–64.

Silva, F., Pacca, L., Lemos, L., Gusmão, A., Silva-Diogo, O., Dalponte, J., Franco, C. L. B., Santana, M. I., Buss, G. e El Bizri, H. R. 2022. Using population surveys and models to reassess the conservation status of an endemic Amazonian titi monkey in a deforestation hotspot. *Oryx* 56(6): 846–853. http://doi.org/10.1017/S0030605322000655

Silva-Diogo, O., Costa, T. M., Almeida, E. M. e Fermiano, E. C. 2018. Atualização do conhecimento e padrões de pelagem distintos em grupos de zogue-zogue dentro da distribuição geográfica de *Plecturocebus bernhardi* Van Roosmalen et al. (2002). *Neotrop. Primates* 24(2): 29–33.

Silva-Diogo, O., Costa, T. M. e Gusmão, A. C. 2016. Eficácia no uso do playback para registro de *Callicebus brunneus* na floresta nacional do Jamari, RO. *In. VIII Simpósio de iniciação cientifica FACIMED*, 51. Anais. Cacoal, Rondônia.

Speld, R. F. V. D., Bello, R. e Hebard, L. 2017. Activity budget and ranging of a group of Madidi titis (*Plecturocebus aureipalatii*) in Reserva Ecólogica Taricaya, with preliminary notes on diet composition, habitat usage and additional sightings. *Neotrop. Primates* 23(2): 33–40.

DOI: https://doi.org/10.62015/np.2022.v28.347

ACTIVITY BUDGETS OF BLACK AND GOLD HOWLER MONKEYS LIVING IN URBAN AND NATURAL HABITATS IN SOUTHWEST PARAGUAY

Victoria Overbeck[1,2], Pamela Gonzalez[1], Wing Man Lau[1], Erica DesJardins[1,] Marco Alesci[1], Jake Wellian[1], John Kane[1,3], Melissa Henderson[1], Rachel Blood[1] and Rebecca L. Smith[1]

[1] Fundación Para La Tierra, Centro IDEAL, Pilar, Ñeembucú, Paraguay, Email: <rebecca@paralatierra.org>
[2] Swarthmore College, 500 College Ave, Swarthmore, Pennsylvania 19081, USA
[3] Department of Bacteriology, University of Wisconsin-Madison, Wisconsin, USA

Abstract

As urbanisation continues to encroach upon the natural habitats of wild primates, it is important to understand how species adapt to these anthropogenic changes by observing how they allocate time to different activities. This study investigated whether activity budgets of black and gold howler monkeys (*Alouatta caraya*) living in an urban habitat (located in the city of Pilar, Ñeembucú, southwest Paraguay) differed from black and gold howler monkeys living in the surrounding natural environment of the Ñeembucú Wetland Complex. We recorded 404.32 h of observation over 73 days – 360.07 h of observation in the Urban habitat over 67 days and 44.25 h of observation in the Natural habitat over 6 days. When comparing activity budgets across habitat types, there was no difference in time allocated to any of the four behavioural categories, which could suggest that the black and gold howler monkeys are adapting well to increased urbanisation. Among all age-sex classes and habitats, resting was the most prevalent activity (67.51%), followed by feeding (13.05%), travelling (12.74%), socialising (6.17%), and other (0.53%). Overall, adult males spent significantly more time resting (mean= 71.14%) and less time travelling (mean=8.86%) compared to immature males (mean = 46.10%, P = 0.038 for resting; mean=17.83%, P=0.026).

Key words: *Alouatta caraya*, behaviour, Central and South American primates, time budgets, urbanisation

Resumen

Mientras la urbanización continúa invadiendo los hábitats naturales de los primates silvestres, es importante entender cómo los primates se adaptan a estos cambios antropogénicos por observar cómo asignan sus tiempos a las diferentes actividades. Este estudio investigó si los presupuestos de actividad de los caraya (*Alouatta caraya*) que viven en un hábitat urbano (ubicado en la ciudad de Pilar, Ñeembucú, suroeste de Paraguay) difieren de los caraya que viven en el entorno natural circundante entorno del Complejo de Humedales de Ñeembucú. Anotamos 404,32 h de observación durante 73 días - 360,07 h de observación en el hábitat urbano durante 67 días y 44,25 h de observación en el hábitat natural durante 6 días. Al comparar los presupuestos de actividad entre los tipos de hábitat, no hubo una diferencia en el tiempo asignado a ninguna de las cuatro categorías de comportamiento, lo que podría insinuar que los caraya se están adaptando bien al crecimiento de la urbanización. Entre todas las categorías de edad-sexo y hábitats, a descansar fue la actividad más prevalente (67,51%), seguida de alimentarse (13,05%), translocar (12,74%), socializar (6,17%) y otras (0,53%). En general, los machos adultos pasaron significativamente más tiempo descansando (media = 71,14%) y menos tiempo viajando (media = 8,86%) en comparación con los machos inmaduros (media = 46,10%, P = 0,038 para descansar; media = 17,83 %, P = 0,026).

Palabras claves: *Alouatta caraya*, comportamiento, primates de Centro- y Sudamérica, presupuestos de actividad, urbanización

Ñemombyky

Urbanización oñemotenonde ohóvo umi ka'aguy ka'ikuera oikoha, tuicha mba'e oñentende mba'éichapa umi ka'i oikokuaa umi cambio antropogénico ndive rohecha chaicha mba'éichapa oiporu ijactividakuera. Ko estudio oinvestiga umi presupuesto actividad orekóva umi caraya (*Alouatta caraya*) oikóva peteî hábitat urbanope (Pilar, Ñeembucú, suroeste Paraguay) iñambuépa umi caraya oikóva ka'aguyhare pe estero tiuchakue Ñeembucúpe. Roregistra 404,32 aravo 73 árape - 360,07 aravo cuidape (67 árape) ha 44,25 aravo ka'aguype (6 árape). Oñembojojávo umi presupuesto caraya activida rehegua umi hábitat apytépe, ndaipóri diferencia umi tiempo oñeme'ẽvape ni peteĩva umi irundy categoríape hekove kuera rehegua, ikatúva ohechauka oiha diferencia, umi caraya ohechauka ojeadapta porãha la urbanización

ndive okakuaa haguã. Opaitechagua hábitat ha edad-sexo apytépe, opytu'u haẽ pe actividа ojeipysóva (67,51%), hapykuéri katu jekaru (13,05%), guata katu (12,74%), hapicha kuera apytepe (6,17%) ha ambue (0,53%). Opaiteicha umi machokuera kakuaáva hetave ohasa itiempo opytu'úvonde (media = 71,14%) ha sa'ive tiempo oguata (media = 8,86%) oñembojojávo machokuera inmaduros ndevi katu (media = 46,10%, P = 0,038 opytu'u haguã; media = 17,83%, P = 0,026).

Ñe›ê clave: *Alouatta caraya*, Teko rehegua; Ka'ikuera Mbyteamérika ha Ñembyamérikagua, Actividа rehegua, Táva okakuava rehegua

Introduction

More than 60% of primate species are threatened with extinction and habitat loss that is driven by anthropogenic activities, including increasing urbanisation (Estrada 2009; Sol et al. 2013; Bicca-Marques 2017). The wide-scale alteration and fragmentation of natural habitats can lead to a decrease in natural food sources, an increase in noise, light, and chemical pollution, and increased opportunities for human-wildlife contact and potential conflict (Sol et al. 2013). To survive in this rapidly changing world, primate species must adapt to habitat alterations or risk becoming locally extirpated (Bicca-Marques 2017; Back et al. 2019).

Activity budgets are a measure of how primates allocate their time (Strier 1987) and are influenced by both environmental constraints (e.g., availability of food sources, sleeping sites, and water sources) and physiological constraints (e.g., individual energy requirements and thermoregulation) (Agetsuma and Nakagawa 1998; Hanya 2004; Doorn et al. 2010; El Alami et al. 2012). Behavioural flexibility in activity budgets could increase a population's chance of survival in these changing environments (El Alami et al. 2012). Examining the effect of urbanisation on a population's activity budget is the first step to understanding whether a given population (or species as a whole) can adapt to an increasingly anthropogenic world.

Age and sex are critical factors affecting primates' activity budgets as a result of the different energetic demands required at each stage of development (Strier 1987; Yanhong et al. 2014). For instance, adult black and gold howler monkeys (*Alouatta caraya*) in a seminatural forest located in Estância Casa Branca, Argentina allocated a greater proportion of time to resting (Bicca-Marques and Calegaro-Marques 1994), whereas subadult and juvenile black and gold howler monkeys socialised more often than other age classes, and infants spent the most time travelling (Prates and Bicca-Marques 2008).

Sociodemographic factors, such as group size, can influence primates' activity budget (Agostini et al. 2012). A large group of brown howlers (*Alouatta guariba clamitans*) in Misiones, Argentina spent more time moving, feeding, and less time resting than those in the smaller group; at the same site, in contrast, a larger group of black and gold howlers spent a significantly greater proportion of time travelling and socializing, and less time feeding than individuals in the smaller group (Agostini et al. 2012).

Howler monkeys (genus *Alouatta*) are folivorous-frugivorous primates found throughout Central and South America (Prates and Bicca-Marques 2008). The black and gold howler (*Alouatta caraya*) is found in Paraguay, Brazil, Bolivia, Argentina, and potentially northwestern Uruguay (Bicca-Marques et al. 2020). Activity budgets of black and gold howler monkeys in Argentina (Bravo and Sallenave 2003; Agostini et al. 2012; Pavé et al. 2016) and Brazil (Bicca-Marques and Calegaro-Marques 1994; Prates and Bicca-Marques 2008; Rímoli et al. 2008) have been conducted, but very few studies have looked at the ecology or activity budgets of black and gold howler monkeys in Paraguay (Stallings 1985; Pinkowski and Smith 2018; Kane and Smith 2020; Alesci et al. 2022; Duffy et al. 2022). Though previous studies of black and gold howler monkeys have shown that they are capable of coping with habitat alteration (Bicca-Marques 2003), no studies have examined the effects of living in an urban habitat on the activity budgets of black and gold howler monkeys. This study investigates whether black and gold howler monkeys living in a natural habitat allocate time differently compared to those living in an urban habitat in Ñeembucú Department, southwest Paraguay.

Methods

Study site

The study was conducted across two habitats (urban and natural) in Ñeembucú Department, southwest Paraguay. The City of Pilar (-26.85726, -58.30753)–the urban habitat in our study–is the capital of the Ñeembucú Department, with a population of about 33,000 people (DGEECC, 2020). The natural habitat, Estancia Santa Ana (-26.83612, -58.02426), is a 700-ha cattle ranch located 30 km east of Pilar in the Ñeembucú Wetland Complex. This habitat is a natural mosaic of humid Chaco, grassland, and gallery forest, that naturally exists in island-like fragments that have not been altered from this natural state despite the presence of low-impact cattle ranching.

Table 1. Average rainfall (mm) and temperatures (°C) in Ñeembucú Department, southwest Paraguay during the study observation periods (https://www.worldweatheronline.com/).

Month & Year	Temperature (°C)	Rainfall (mm)
August 2017	22	75.4
September 2017	25	59.9
October 2017	25	297.6
November 2017	26	177.2
June 2018	16	55.06
July 2018	17	30.1
August 2018	18	50
August 2019	19	18.4
January 2020	32	115.7
February 2020	30	61.6
March 2020	30	33.2

Data Collection

Data were collected from 25th August to 28th November 2017, from 26th June to 6th August 2018, 20th – 27th August 2019, and from 20th January to 2nd March 2020 from 5:45am-10:45am and 13:45pm-17:45pm by 12 different observers (typically, 1-4 observer(s) collected data on a single group per day) (Table 3). The minimum time spent per day with a given group over the entire study period was 15 minutes, and the maximum time spent per day with a given group over the entire study period was 10 hours. On average, an observer spent about 4.4 hours with one group per day over the entire study period. We recorded 404.32 h of observation (170.06 h with Factory group, 190.01 h with Police group, 22.50 h with Roadside group, and 21.75 h with Swamp group) over 73 days. We excluded records with insufficient behavioural

Table 2. Demographics of the black-&-gold howler monkeys by habitat and groups within each habitat. Numbers varied through immigrations, emigrations, births and deaths during the observation period; all individuals observed in the groups during the study period are included here in the tally. Subadult, juvenile, and infant males and females were classified as 'Immature' males and females.

	Habitat & Groups				
	Urban		Natural		
Age-Sex	Factory	Police	Swamp	Roadside	TOTAL
Adult male	2	5	2	2	11
Adult female	2	6	2	4	14
Immature male	4	5	3	1	13
Immature female	1	11	1	1	14
TOTAL	**9**	**27**	**8**	**8**	**52**

Paraguay has inconsistent rainfall that varies greatly each year throughout its "Wet and Dry" and "Hot and Cold" seasons (Hill et al. 1984; Duffy et al. 2022). Average rainfall (mm) and temperature (°C) for the study observation periods are shown in Table 1.

Study Subjects

Four groups of black and gold howler monkeys were sampled across the two different habitats. Within the urban habitat, we observed two groups (Factory and Police) of black and gold howler monkeys with highly fragmented, small home ranges (1.01 - 3.07 ha) that consist of a matrix of roads, buildings, and powerlines (Kane and Smith 2020; Duffy et al. 2022). Within the natural habitat, we observed two different groups (Swamp and Roadside) of black and gold howler monkeys with home ranges that are limited to the small areas of undisturbed gallery forest where there was little to no human interaction.

Across all four groups, there were 52 individuals. Individuals were identified by age and sex following the descriptions in Rumiz (1990). Demographics of the study groups are provided in Table 2.

Table 3. Observation months/years for each study group over the entire study period.

Study Group	Observation Period
Factory	August – October 2017 June – August 2018
Police	October – November 2017 June – August 2018 August 2019 January – February 2020
Swamp	January & March 2020
Roadside	August 2018 January & March 2020

Table 4. Number of behavioural records observed for each age-sex class in the urban and natural habitats over the entire study period.

	Habitat		
Age-Sex	Urban	Natural	Total
Adult male	961	412	1373
Adult female	1209	767	1976
Immature male	806	423	751
Immature female	841	266	586
TOTAL	**3817**	**1868**	**5685**

description, and/or that were missing age/sex information, leaving a total of 5685 behavioural records (Table 4).

We used scan sampling (Altmann 1974) to record the behaviour of all visible individuals every 30 minutes. We reduced the potential for bias in the sampling effort by randomly sampling when doing visual scans in the field. In each scan, we recorded: (a) the time and area location of the group; and for the visible black and gold howler monkeys, we recorded: (b) identity, (c) sex, (d) age, (e) behaviour, and when applicable, (f) tree location, (g) height above the ground, (h) proximate individuals, and (g) any other relevant information. The behaviour was classified into one of the following categories, using similar definitions as Rímoli et al. (2012) and Schreier et al. (2021): feeding (i.e., when the animal was observed biting, chewing, ingesting, and/or manipulating food or water with its hands, feet, mouth), resting (i.e., when the animal remained in one location, was inactive, lying down, or asleep), social (i.e., when the animal was observed engaged in social interactions including grooming, playing, aggression, submission), travelling (i.e., moving any sort of distance) and other (i.e., any behaviour not mentioned above).

Data analysis

We pooled data for the different age-sex classes into four total classes to provide sufficient data for analysis (Table 2; similar to Rímoli et al. 2012 and Jaman and Huffman 2013). Similar to Prates and Bicca Marques, (2008), we did not include behaviours accounting for <1.5% of records among any of the age-sex classes in our analyses. Activity budgets were calculated similarly to Agostini et al. (2012). First, we combined all data for each day of observation for each age-sex class. We then calculated the time allocated to each activity for each day of observation and each age-sex class as the proportion of scanned individuals engaged in each activity type. Using these proportions, we calculated an overall activity budget and activity budgets for each age-sex class within each group and habitat. Activity budgets were expressed as the time allocated to each activity divided by the total amount of time sampled overall, for each age-sex class, and within each group and habitat. One-way ANOVA was used to compare the time allocated to each of the behavioural activities for the four age-sex classes, the groups within each habitat, and the two habitats. Tukey's *post hoc* test was used for the pairwise comparisons of the respective proportions. All statistical analyses were done using RStudio 2022.07.1+554. Each analysis was 2-tailed with significance set at $p < 0.05$.

Results

Overall, resting was the most prevalent activity (67.51%), followed by feeding (13.05%), travelling (12.74%), socialising (6.17%), and other (0.53%).

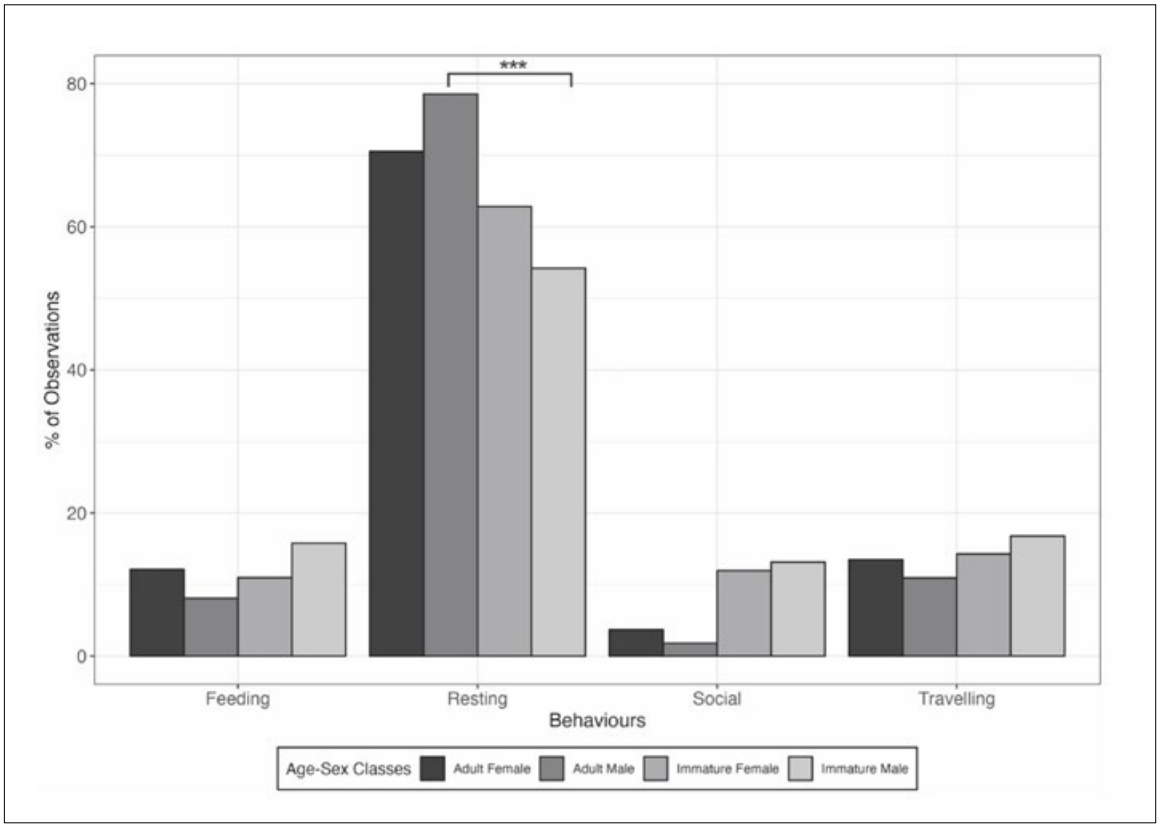

Figure 1. Activity budgets between the different age-sex classes.

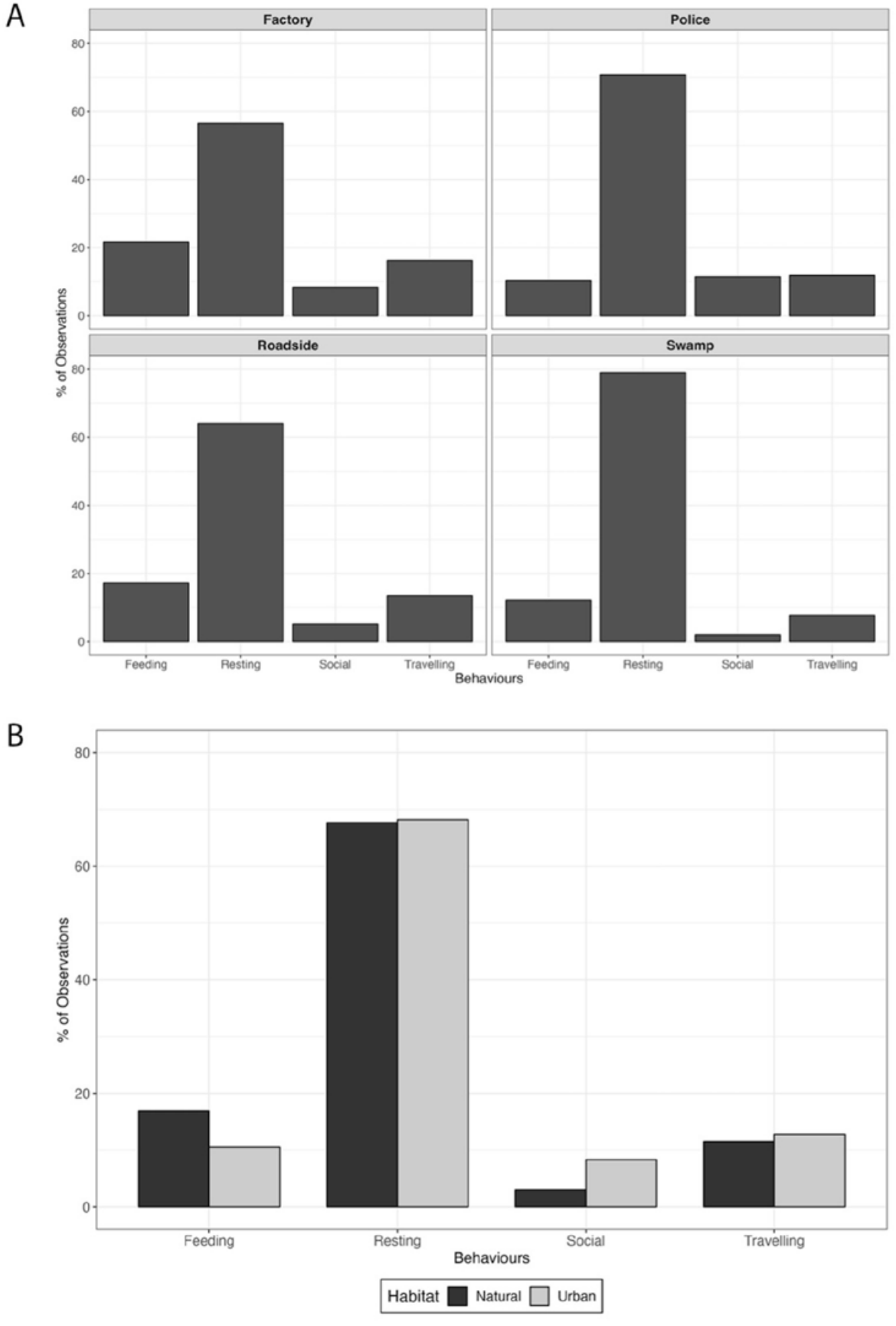

Figure 2. (A) Activity budgets between the different groups within each habitat (Urban = Factory and Police; Natural = Roadside and Swamp). (B) Activity budgets between the different habitats.

Table 5. Comparison of activity budgets across the genus *Alouatta*.

Species	Location	% of Time Allocated to Each Activity					Reference
		Resting	Feeding	Travelling	Social	Other	
Alouatta caraya	Ñeembucú Wetland Complex, Paraguay	66.65	16.60	11.34	4.28	1.12	This Study
Alouatta caraya	Pilar, Paraguay	67.93	11.32	13.41	7.10	0.24	This Study
Alouatta caraya	Estabelecimento Nossa Senhora da Conceição, Alegrete, Rio Grande do Sul, Brazil	56.5	14.9	23.4	3.9	-	Prates and Bicca-Marques (2008)
Alouatta caraya	Flooded forest, Brasilera Island, Northeastern Argentina	56.5	18.9	16.5	8.0	-	Bravo and Sallenave (2003) (Mean annual values)
Alouatta caraya	Aquidana River, Mato Grosso do Sul, Brazil	64.7	10.1	18.5	4.4	2.3	Rímoli et al. (2012)
Alouatta caraya / Alouatta guariba clamitans	El Piñalito Provincial Park, Misiones, northeastern Argentina	57.0-65.0	12.0-15.0	11.0-15.0	3.0-5.0	1.0-2.0	Agostini et al. (2012)
Alouatta seniculus	Colombian Andes	63.0	22.0	10.0	-	4.0	Palma et al. (2011)
Alouatta seniculus	Colombian Andes	78.5	12.7	6.2	2.0	0.5	Gaulin and Gaulin (1982)
Alouatta palliata	Los Tuxtlas, Mexico	80.0	17.0	3.0 (includes traveling and social behavior)		-	Estrada et al. (1999)
Alouatta palliata	Los Tuxtlas, Mexico	61.9	26.4	10.5	-	1.2	Asensio et al. (2007)
Alouatta belzebuth	Paranata, MT, Brazil	58.7	20.0	18.2	2.1	-	Pinto (2002)
Alouatta guariba	Araucaria Pine Forest, southern Brazil	57.6	19.0	18.8	-	-	De Marques (1996)

Variation in Activity Budgets between Age-Sex Classes

There was no difference in time allocated to feeding or socialising between any of the age-sex classes ($F_{[3,27]} = 1.504$, $P = 0.24$ for feeding; $F_{[3,27]} = 0.358$, $P = 0.784$ for socialising). There was a difference in time allocated to resting and travelling between at least two of the age-sex classes ($F_{[3,27]} = 3.274$, $P = 0.036$ for resting; $F_{[3,27]} = 3.61$, $P = 0.026$ for travelling). Adult males allocated significantly more time to resting (mean= 71.14%) and significantly less time to travelling (mean=8.86%) compared to immature males (mean = 46.10%, $P = 0.038$ for resting; mean=17.83%, $P=0.026$). There was no difference in time allocated to resting or time allocated to travelling between any other age-sex classes (Figure 1).

Variation in Activity Budgets between Groups within each Habitat

There was no difference in time allocated to any of the behavioural categories between the two groups (Factory and Police) in the urban habitat ($F_{[1,6]}=1.713$, $P=0.238$ for feeding; $F_{[1,6]}=2.515$, $P=0.164$ for resting; $F_{[1,6]}=2.02$, $P=0.205$ for travelling; $F_{[1,6]}=0.996$, $P=0.357$ for socialising) or between the two groups (Roadside and Swamp) in the natural habitat ($F_{[1,2]}=0.345$, $P=0.616$ for feeding; $F_{[1,2]}=1.212$, $P=0.386$ for resting; $F_{[1,2]}=1.65$, $P=0.328$ for travelling; $F_{[1,2]}=14.95$, $P=0.0609$ for socialising) (Figure 2A).

Variation in Activity Budgets between Habitats

There was no difference in time allocated to any of the behavioural categories between the two habitats ($F_{[1,7]}=3.402$, $P=0.108$ for feeding; $F_{[1,7]}=0.149$, $P=0.711$ for resting; $F_{[1,7]}=0.016$, $P=0.903$ for travelling; $F_{[1,7]}=1.718$, $P=0.231$ for socialising) (Figure 2B).

Discussion

The differences between age-sex classes in both habitats were consistent with previous observations of this species, with older individuals spending more time resting and less time socialising (Bicca-Marques and Calegaro-Marques 1994). In our study, adult males spent more time resting than immature males. This could be because adult male black and gold howler monkeys tend to eat at a faster rate than others in the group, and are capable of monopolising food sources, which means less time required for travelling to get food sources. Less time required for travelling and feeding allows for more time for resting. Another possible explanation for why adult male black and gold howler monkeys spent more time resting compared to younger, more active males is due to their limited energetic requirements (Bicca-Marques and Calegaro-Marques 1994).

The amount of time spent feeding is inversely related to the nutrient content of the food consumed (Strier 1987). Even though black and gold howlers in the urban and natural habitats spent similar times feeding (11.32% vs. 16.6% respectively; Figure 2A), there are differences in the diets of the primates between these two habitats. Black and gold howler monkeys in the urban habitat have access to higher quality food sources from neighbouring gardens or rubbish piles scattered throughout their home range. The urban black and gold howler monkeys were observed consuming fewer leaves and had easier access to high energy fruit, including mangoes and avocadoes (Para La Tierra, unpublished data), which could enable them to spend less time feeding, while still fulfilling their energetic needs. Compared to previous studies of *Alouatta* species, the black and gold howler monkeys in the urban habitat spent a higher proportion of time engaged in social activities (7.1%; Table 5). Further studies of the diets and activity budgets in other areas where howler monkeys have colonised urban habitats are required to confirm whether the low level of social interactions once thought to be characteristic of this genus are related to diet or habitat quality.

Habitat can impact the behaviour of different age-sex classes differently (Li and Rogers 2003). However, this did not appear to be the case with the howler monkeys in the two habitats in Ñeembucú, which supports previous findings of the phenomenal adaptability of black and gold howler in other areas (Bicca-Marques 2003). Behavioural flexibility to changing habitats may increase a species' chance of survival, but not all behaviours are necessarily beneficial. Primates' use of agricultural crops and other behaviours can negatively impact their coexistence with people, and lead to people perceiving the primates as pests (McLennan et al. 2017). The long-term survival of the Pilar black and gold howler monkeys not only depends on their ability to adapt behaviourally, but also on the humans' tolerance of their presence. Fortunately, in Pilar, the black and gold howler monkeys are not considered a pest to people (Alesci et al. 2022); the local people's tolerant attitudes towards the black and gold howler monkeys may be due to their high levels of daily inactivity.

This study provides this first evidence that living in the urban habitat does not significantly alter how black and gold howler monkeys in southwest Paraguay allocate their time in different activities. These results provide the foundation for future research into the extent of the adaptability of this species, which is essential to understand as urbanisation continues to alter Paraguay's last remaining wild areas.

Acknowledgments

All authors are grateful to the staff, interns and volunteers of Fundación Para La Tierra. We express our immense gratitude to the Pilar community for their incredible hospitality and friendliness that made this research possible. R. L. Smith is grateful to the PRONII program of Conacyt. Thanks to Dr. David Lusseau for guidance with data analysis. Thanks to Jorge Damián Ayala Santacruz and Paul Smith for checking the grammar of the Guaraní and Spanish abstracts. Fundación Para La Tierra is grateful to the estate of Don Julio Contreras for their continued support of PLT's activities. Special thanks to Don Oberon Barrios for allowing the team to use his property of Estancia Santa Ana. V. Overbeck is grateful for the Natural Sciences Summer Research Grant (2020) from Swarthmore College, which funded her research opportunity with Fundación Para La Tierra. Thanks to Jessica Lynch and the anonymous reviewers for their efforts and helpful comments.

References

Agetsuma, N. and Nakagawa, N. 1998. Effects of habitat differences on feeding behaviors of Japanese monkeys: Comparison between Yakushima and Kinkazan. *Primates* 39: 275–289.

Agostini, I., Holzmann, I. and Di Bitetti, M. S. 2012. Influence of seasonality, group size, and presence of a congener on activity patterns of howler monkeys. *J. Mammal.* 93: 645–657.

Altmann, J. 1974. Observational Study of Behavior: Sampling Methods. *Behaviour* 49: 227–267.

Asensio, N., Cristobal-Azkarate, J., Dias, P. A. D., Vea, J. J. and Rodríguez-Luna, E. 2007. Foraging habits of *Alouatta palliata mexicana* in three forest fragments. *Folia Primatol.* 78: 141–153.

Back, J. P., Suzin, A. and Aguiar, L. M. 2019. Activity budget and social behavior of urban capuchin monkeys, *Sapajus* sp. (Primates: Cebidae). *Zoologia* 36: 1–10.

Bicca-Marques, J. C. and Calegaro-Marques, C. 1994. Activity budget and diet of *Alouatta caraya*: an age-sex analysis. *Folia Primatol.* 63: 216–220.

Bicca-Marques, J. C. 2003. How do howler monkeys cope with habitat fragmentation? In: *Primates in Fragments*, L. K. Marsh (ed.), pp.283–303. Springer, Boston.

Bicca-Marques, J. C. 2017. Urbanization (and primate conservation). In: *The International Encyclopedia of Primatology*, A. Fuentes, M. Bezanson, C. J. Campbell, A. F. Di Fiore, S. Elton, A. Estrada, J. Yamagiwa (eds.), pp.1-5. Wiley, New York.

Bicca-Marques, J., Alves, S. L., Boubli, J., Cornejo, F. M., Cortes-Ortíz, L., Jerusalinsky, L., Ludwig, G., Martins, V., de Melo, F. R., Messias, M., Miranda, J., Rumiz, D. I., Rímoli, J., Talebi, M., Wallace, R., da Cunha, R. and do Valle, R. R. 2020. *Alouatta caraya*. The IUCN Red List of Threatened Species 2020.

Bravo, S. P. and Sallenave, A. 2003. Foraging behavior and activity patterns of *Alouatta caraya* in the northeastern Argentinean flooded forest. *Int. J. Primatol.* 24: 825–846.

De Marques, A. A. B. 1996. Ecology and behavior of brown howlers in Araucaria Pine Forest, southern Brazil. *Neotrop. Primates* 4: 90–91.

DGEEC 2020. Dirección General de Estadística, Encuestas y Censos. Website: https://www.ine.gov.py/publicacion/2/poblacion. Accessed 5th December 2020.

Doorn, A. C., O'Riain, M. J. and Swedell, L. 2010. The effects of extreme seasonality of climate and day length on the activity budget and diet of semi-commensal chacma baboons (*Papio ursinus*) in the Cape peninsula of South Africa. *Am. J. Primatol.* 72: 104–112.

Duffy, P. X., Wellian, J. and Smith, R. L. 2022. Use of space by black and gold howler monkeys (*Alouatta caraya*) in an urban environment in Paraguay. *Urban Ecosyst.* 25: 1777–1786.

El Alami, A., Van Lavieren E., Rachida, A. and Chait, A. 2012. Differences in activity budgets and diet between semiprovisioned and wild-feeding groups of the endangered barbary macaque (*Macaca sylvanus*) in the central high Atlas Mountains, Morocco. *Am. J. Primatol.* 74: 210–216.

Estrada, A. 2009. Primate conservation in South America: the human and ecological dimensions of the problem. In: *South American Primates.* P. A. Garber, A. Estrada, J. C. Bicca-Marques, E. W. Heymann, K. B. Strier (eds.), pp.463–505. Springer, New York.

Estrada, A., Juan-Solano, S., Martínez, T. O. and Coates-Estrada, R. 1999. Feeding and general activity patterns of a howler monkey (*Alouatta palliata*) troop living in a forest fragment at Los Tuxtlas, Mexico. *Am. J. Primatol.* 48: 167–183.

Gaulin, S. and Gaulin, C. 1982. Behavioral ecology of *Alouatta seniculus* in Andean cloud forest, Colombia. *Int. J. Primatol.* 3: 1–32.

Hanya, G. 2004. Seasonal variations in the activity budget of Japanese macaques in the coniferous forest of Yakushima: effects of food and temperature. *Am. J. Primatol.* 63: 165–177.

Jaman, M. F. and Huffman, M. A. 2013. The effect of urban and rural habitats and resource type on activity budgets of commensal rhesus macaques (*Macaca mulatta*) in Bangladesh. *Primates* 54: 49–59.

Kane, J. and Smith, R. L. 2020. *Bertiella* sp. (Meyner, 1895) infection of *Alouatta caraya* (Humbolt, 1812) in urban and natural environments in Ñeembucu, southwest Paraguay. *Am. J. Primatol.* 82: e23166.

Li, Z. and Rogers, E. 2003. Habitat quality and activity budgets of white-headed langurs in Fusui, China. *Int. J. Primatol.* 25: 41–54.

McLennan, M. R., Spagnoletti, N. and Hockings, K. J. 2017. The implications of primate behavioral flexibility for sustainable human-primate coexistence in anthropogenic habitats. *Int. J. Primatol.* 38: 105–121.

Palma, A. C., Vélez, A., Gómez-Posada, C., López, H., Zárate D. A. and Stevenson, P. R. 2011. Use of space, activity patterns, and foraging behavior of red howler monkeys (*Alouatta seniculus)* in an Andean Forest fragment in Colombia. *Am. J. Primatol.* 73: 1062–1071.

Pavé, R., Kowalewski, M. M., Zunino, G. E. and Leigh, S. R. 2016. Sex differences in the behavior of wild *Alouatta caraya* infants. *Primates* 57: 521–532.

Pinkowski, D. and Smith, R. L. 2018. Activity Budgets of Urban Dwelling Paraguayan Howler Monkeys in Pilar, Paraguay. Poster Presentation, International Primatological Society Conference, Nairobi, Kenya. DOI: 10.13140/RG.2.2.22808.14083

Pinto, L. P. 2002. Diet, activity, and home range of *Alouatta belzebuth discolor* (Primates: Atelidae) in Paranaíta, northern Mato Grosso. *Neotrop. Primates* 10: 98–99.

Prates, H. M. and Bicca-Marques, J. C. 2008. Age-sex analysis of activity budget, diet, and positional behavior in *Alouatta caraya* in an orchard forest. *Int. J. Primatol.* 29: 703–715.

Rímoli, A. O., Valdivino, E. M., Rímoli, J., and Ferrari, S. F. 2008. Behavior patterns of a group of black howler monkeys *Alouatta caraya* (Humboldt, 1812) in a forest

fragment in Terenos, Mato Grosso do Sul: a seasonal analysis. *A Primatologia no Brasil* 9: 179–191.

Rímoli, J., dos Santos Nantes, R. and Júnior, A. É. L. 2012. Diet and activity patterns of black howler monkeys *Alouatta caraya* (Humboldt, 1812, Primates, Atelidae) in ecotone Cerrado-Pantanal in the left bank of Aquidauana River, Mato Grosso do Sul, Brazil. *Oecologia Australis*. 16: 933–948.

Rumiz, D. I. 1990. *Alouatta caraya*: Population densities and demography in Northern Argentina. *Am. J. Primatol*. 21: 279–294.

Schreier, A. L., Bolt, L. M., Russell, D. G., Readyhough, T. S., Jacobson, Z. S., Merrigan-Johnson, C. and Coggeshall, E. M. 2021. Mantled howler monkeys (*Alouatta palliata*) in a Costa Rican Forest fragment do not modify activity budgets or spatial cohesion in response to anthropogenic edges. *Folia Primatol*. 92: 49–57.

Sol, D., Lapiedra, O. and González-Lagos, C. 2013. Behavioural adjustments for a life in the city. *Anim. Behav.* 85: 1101–1112.

Stallings, J. 1985. Distribution and status of primates in Paraguay. *Primate Conserv*. 6: 51–58.

Strier, K. 1987. Activity budgets of woolly spider monkeys, or muriquis (*Brachyteles arachnoides*). *Am. J. Primatol*. 13: 385–395.

Yanhong L., Li, D., Ren, B., Hu, J., Li, B., Krzton, A. and Li, M. 2014. Differences in the activity budgets on Yunnan snub-nosed monkeys (*Rhinopithecus bieti*) by age-sex class at Xiangguqing in Baimaxueshan nature reserve, China. *Folia Primatol.* 85: 335–342.

DOI: https://doi.org/10.62015/np.2022.v28.223

"SAUINS" ON TOUCHSCREENS: SOCIAL MEDIA AS A TOOL FOR PIED TAMARIN CONSERVATION AWARENESS

Tainara Venturini Sobroza[1,2,3], Aline Souza de Menezes Medeiros[2], Raiclicia Nayara Morais Batista[2], Marcelo Gordo[2]

[1] Centro de Estudos Integrados da Biodiversidade Amazônica, Instituto Nacional de Pesquisas da Amazônia, Av. André Araújo 2936, C.P. 2223, Petrópolis, 69067-375, Manaus, Amazonas. E-mail: <tv.sobroza@gmail.com>. +55 92 36433302\ 55-92-981729591. ORCID: https://orcid.org/0000-0003-4081-276X

[2] Projeto Sauim-de-Coleira, Departamento de Biologia/ICB, Universidade Federal do Amazonas (UFAM), Av. General Rodrigo Otávio Jordão Ramos, 6200, Coroado, 69080-900, Manaus, Amazonas

[3] Grupo de Pesquisa de Mamíferos Amazônicos, Instituto Nacional de Pesquisas da Amazônia, Av. André Araújo 2936, C.P. 2223, Petrópolis, 69067-375, Manaus, Amazonas

Abstract

Conservation is only possible when conservation thinking and awareness permeate people's lives. Communication is key to informing and sensitizing people to conservation issues. In this sense, social media may be a communication facilitator. Here we addressed people's engagement with and perceptions of the content created by the Pied Tamarin Project on the Facebook webpage. We found an increase in the number of "likes" across the years and received numerous messages expressing willingness to help. Further, people engaged more with posts related to published scientific papers. In general, we found a good atmosphere with positive attitudes toward collaboration for the conservation of the pied tamarin, as evidenced by the high number of "likes" and positive content of direct messages on the Pied Tamarin Project social media.

Keywords: Science outreach, Amazon, primates, Callitrichidae, *Saguinus bicolor*

Resumo

A conservação só é possível quando o pensar conservação permeia a vida e decisão das pessoas diariamente. Nesse sentido, a comunicação é fundamental para informar e sensibilizar pessoas e as mídias sociais podem ser um facilitador dessa comunicação. Aqui quantificamos o engajamento e a percepção das pessoas sobre o conteúdo criado na página do Facebook pelo Projeto Sauim-de-Coleira. Constatamos um aumento no número de "curtidas" ao longo dos anos e recebemos um grande número de mensagens expressando vontade de ajudar na conservação da espécie. Além disso, as pessoas se envolveram mais com postagens relacionadas a artigos científicos publicados. Em geral, encontramos um bom clima com atitudes de colaboração para a conservação do sauim-de-coleira, o que foi evidenciado pelo alto número de "likes" e conteúdo positivo das mensagens diretas recebidas nas redes sociais do Projeto Sauim-de-Coleira.

Palavras chave: divulgação científica, Amazônia, primatas, Callitrichidae, *Saguinus bicolor*

Introduction

Conservation is only possible when conservation thinking and awareness permeate people's lives. In this sense, science literacy and interpersonal communication may lead to attitude and behavioral changes that hopefully will help to reduce wildlife threats and enhance the chances of conservation success (Wright et al. 2015; Nilsson et al. 2020). Social media, an umbrella term for internet platforms that facilitate communication between users (Loom 2017), has the potential power to reach a large number of people and communicate ideas that might inspire them to act and influence policy (Vries 2020). For any successful conservation strategy, it is important to constantly evaluate its outcomes and feedback, so we can address whether our goals are being accomplished, and, if not, how we could adapt them to be more effective (Padua 2010). In Brazil, internet access is relatively widespread and smartphones are the main equipment used to access it (IBGE 2018). Using social media, conservation messages can be on the touchscreens in everyone's hands.

The pied tamarin (*Saguinus bicolor*), or *sauim* as it is locally known, has a narrow geographic range in central Brazilian Amazonia. Past and ongoing habitat loss have restricted tamarin groups to isolated forest fragments in the city of Manaus, where urbanization has expanded rapidly in the last decades (Gordo et al. 2013). In

addition to habitat loss, fragmentation also leads to the loss of tamarins through roadkill, electrocution, and attacks by domesticated animals. The pied tamarin is Critically Endangered (Gordo et al. 2019) and a national plan has been developed for its conservation (PAN Sauim, Brasil 2018). Among the suggestions for securing viable populations of pied tamarins is the creation of ecological corridors to connect urban forest fragments and reserves (BRASIL 2018). Such an urban matrix inevitably provokes close contact between people and tamarins (Santos et al. 2017). Thus, the Pied Tamarin Project (or Projeto Sauim-de-Coleira) was created in 2022 to increase knowledge about pied tamarin and its habitats through research, monitoring, and education actions. In 2014, we created profiles on social media platforms to facilitate the outreach of our activities and to call people for actions that would benefit pied tamarin survivorship. Here, we evaluate people's perceptions and propensity to engage in conservation actions directed toward pied tamarins and their habitat in and around the city of Manaus. To do so, we investigated the Pied Tamarin Project Facebook profile metrics and the content of people's comments and "likes" directed to posts as an indirect measure of people's engagement with the content.

Methods

We carried out a manual search on our Facebook page (Projeto Sauim-de-Coleira 2020) categorizing and accounting for the content of posts and people's reactions (number of likes and direct messages) from November 2014 to August 2019. During this period, the social media publications were created by a team of three biologists (TVS, ASMM, RNC). We checked for demographic aspects such as sex and municipal origin of the followers using Facebook's own statistics. We also estimated the average internet quality (download speed) of our followers using a free database about internet quality in the cities of Brazil (https://qualidadedainternet.nic.br/ accessed on 31/05/2022).

We categorized our publications according to their content in: Pied Tamarin Project daily activities (N=38), Pied Tamarin Biology (N=37), messages for celebrating holidays (N=18), invitations for conservation events (N=18), Information about reserves (N=15), forest nursery activities and group planting (N=11), published articles (N=8), ongoing research (N=8), and activities of the PAN Sauim (N=7). We also analyzed 70 direct messages (N=70) with variable content, including 1) Willingness to help, 2) Admiration, 3) Reports of environmental crimes, 4) Suggestions of research topic and partnerships, 5) Requests for internships, 6) Reports of pied tamarin occurrences and their behavior, 7) Requests for educational material, 8) Demonstration of concern for the pied tamarin, 9) Disbelief in conservation actions or institutions and 10) Other. The "Other" category included a) suggestions of posts, b) suggestions of granting agencies, c) requirements of seedlings to plant in gardens, and d) expressions of desire to observe wild tamarins. We tested for the variation in the number of posts and likes per year using linear regression and report the distribution of likes and posts visually in graphics that we produced. Further, we briefly discuss our social media impact on Facebook and Instagram from 2019 to 2021.

Results

By August 2019, our Facebook page had 1540 followers (i.e. people that accompany the content) and 111 posts. We found that the Projeto Sauim-de-Coleira Facebook page had followers from 39 countries, but the great majority of our followers were Brazilians. These included users from 45 different cities, Manaus being the most numerous (N=878). The internet quality of our followers was on average 53.34 mbps (sd=22), while cities from Amazonas, the state where pied tamarins occur, had on average 10.47 mbps (sd=16.25). Until August 2019, we had no followers from Rio Preto da Eva and Itacoatiara, the two other cities where pied tamarins naturally occur in addition to Manaus. Followers were mainly young (25-34 years old) women (61%). The average number of posts per month was 1.5, which did not vary across the years ($t=0.44$, $r^2=0.04$, $p=0.68$) (Figure 1). On the other hand, the number of "likes" significantly increased across the years ($t=3.45$, $r^2=0.74$, $p=0.026$) (Figure 1), and the number of posts and "likes" were not correlated (cor=0.24). Proportional to the number of posts, followers engaged more with the posts about published articles and ongoing research (Figure 2).

We received 70 direct messages, "Willingness to help" being the most common content, followed by "Other" (Figure 3). From the 70 messages, 31 people spontaneously reported their occupation, of which 12 related to some natural sciences (undergraduate students or professionals from biology, veterinary, and self-claimed environmentalists). The remaining occupations included police, architects, historians, teachers, high-school students, visual communicators, and journalists. From 2019 to 2021, we mostly changed our activities to other social media (Instagram) keeping an average of 1.9 posts/month. On this platform, we obtained nearly 10 times more engagement from the followers. During this time period, the annual number of likes on our Facebook page was about 370 while on Instagram 3064.

Discussion

As shown by the high number of "likes" and positive content of direct messages at the Projeto Sauim-de-Coleira social media, we found a positive atmosphere with attitudes towards cooperation for the pied tamarin conservation. We did not track the number of followers per year; thus, it is possible that there is a positive correlation between the increase in the number of followers per year

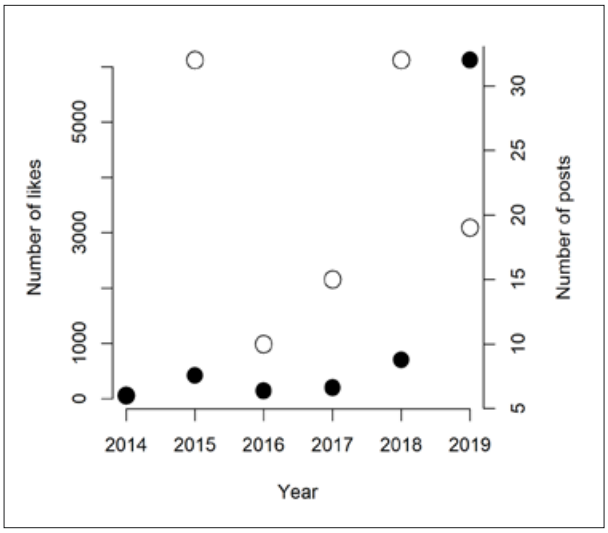

Figure 1. Correlation between the number of posts (open dots) and the number of "likes" (closed dots) of the Pied Tamarin Project (Projeto Sauim-de-Coleira) Facebook page across the years (N=6).

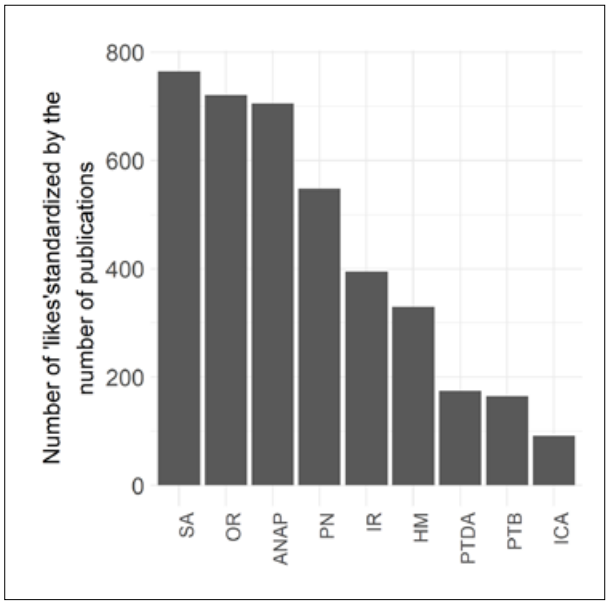

Figure 2. Number of "likes" proportional to the number of posts across different post topic content on the Pied Tamarin Project (Projeto Sauim-de-Coleira) Facebook page between 2014 and 2019. Ordered by topic (N=111). SA= Scientific articles; OR= Ongoing research; ANAP= Activities of the National Action Plan (PAN) for the pied tamarin conservation; PN= Plant nursery and group planting activities; IR= Information about reserves; HM= holiday messages; PTDA= Pied tamarin project daily activities; PTB= Pied tamarin biology; ICA= Invitation for conservation actions.

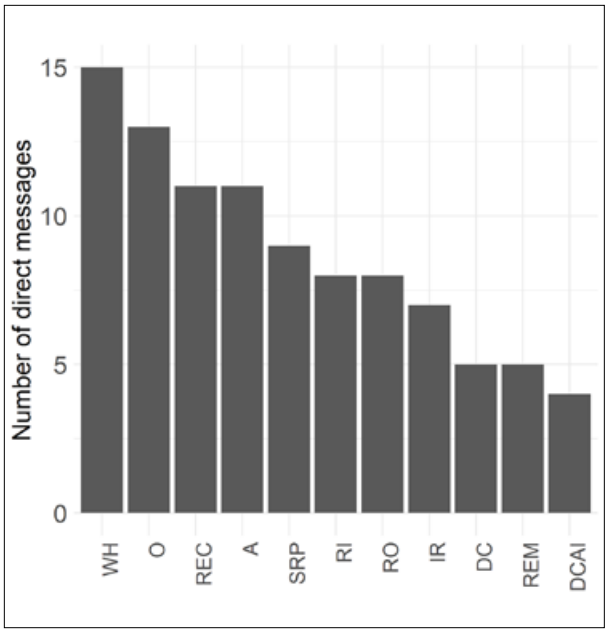

Figure 3. Content from direct messages received on Pied Tamarin Project (Projeto Sauim-de-Coleira) Facebook page between 2014 and 2019 (N=70). WH= Willingness to help; O=Other; REC= Reports of environmental crimes; A= Admiration; SRP= Suggestions of research topics and partnership; RO= Reports of pied tamarin occurrences; RI= Request for internships; IR= Interview requests; DC= Demonstration of concern with the pied tamarin; REM= Requests for educational material; DCAI= Disbelief in conservation actions or institutions.

and the increase in the number of likes. If so, we consider this a positive outcome as more people are consuming the content from the page. The "Willingness to help" and "Other", the most common content in the messages that we received, were generally positive (see Methods). Some of the students that contacted us volunteered to work in our plant nursery, though we are not aware of "how far" this willingness to help goes regarding the other followers. This feedback from the community is in line with previous studies, which found that people that live near forest fragments with pied tamarins are likely to show affection for the species and want to cooperate with conservation actions (Santos et al. 2017; Coelho et al. 2018). Such willingness to engage is extremely important, as foreseen wildlife crossings of the urban ecological corridor planned for the pied tamarin, ideally include citizens' gardens and, consequently, close contact between humans and pied tamarins may occur (Santos et al. 2017; Coelho et al. 2018). People from Manaus that are not necessarily close neighbors of forest fragments share such perceptions and 47% of them affirmed that TV and internet content contributed to their knowledge about the species and its conservation status (Guimarães et al. 2019). It is worth mentioning that we do not know the proportion of local people that share their gardens with pied tamarins among our followers. Regardless, it seems that we have a positive context that would facilitate conservation measures in the urban area of Manaus.

In our study, we detected that our posts attracted mostly Manaus citizens (N=878), but not people from Rio Preto da Eva city and Itacoatiara; these are the only three municipalities where the pied tamarin naturally occurs. A possible reason for that is that our research and educational actions mostly occur in Manaus. From 2014 to 2019, we conducted only four non-intensive research projects and no education initiatives in these

areas. Therefore, we are failing to publicize our material in these two municipalities. This is also true for other educative initiatives that focus on pied tamarin conservation (Lagroteria et al. 2017). They also focused mainly on Manaus but agree that it is important to extend the activities to the rural area of its distribution (Lagroteria et al. 2017). The quality of internet access in rural areas in the region is among the worst in Brazil (IBGE, 2018), which reduces social accessibility to the content. In terms of conservation, such areas are truly important, as they account for 42% of the pied tamarin range and comprise a great amount of forested area that, if protected, could guarantee the survival of viable populations of pied tamarins (Coelho et al. 2018). If internet social media is not reaching these areas, complementary activities of scientific outreach that use mainstream communication media such as local TV and, especially, radio are crucial. Regarding the characteristics of our public, most of our followers were women, which aligns with a global trend of feminine engagement with environmental behavior and digital activism (Hunter et al. 2004).

Additionally, some messages that we received had a direct impact and utility in conservation efforts such as the reporting of the occurrence of pied tamarins in urban forest fragments. The city of Manaus has more than 900 forest fragments and with the current human and monetary resources it is almost impossible to survey all of them to track pied tamarin groups (Coelho et al. 2018). Therefore, such user-provided information is valuable, considering the ongoing efforts to establish an ecological urban corridor for the species (Barr 2016). Citizen science-based research was successful in assessing a small ape population (Mohd Rameli et al. 2020) and this must also be the case for the pied tamarin. Additionally, we received several reports of criminal activities, mainly associated with deforestation, but also illegal trade. In such cases, we immediately contacted the government sector responsible for dealing with the situation. Fortunately, pied tamarins are not frequently kept illegally in captivity, but we did receive a direct message with such content, thus social media can continue helping us to track such activities, as is the case for lemurs (Reuter and Schaefer 2017).

Based on our analysis, we noted some aspects that could be improved, and we received some requests that may be considered in the future. First, people enjoy posts about published scientific articles, therefore we should put more effort into producing such kind of content. Secondly, we received some messages that show the lack of confidence in environmental governmental agencies and their capacity for surveillance of criminal activities. Thus, it would be interesting to publish more stories with a message of hope, which is more likely to motivate people to keep engaged in conservation actions (Kelsey 2012; Vries 2020). We also detected in "disbelief" messages that some people do not think that the *National Plan for the Pied Tamarin Conservation* (PAN Sauim) (Jerusalinsky et al. 2017; Decree 281/2018) would be effective without considering the human population's values and needs. We agree with such a statement and indeed a human dimension is part of the objectives and goals of the PAN. Hence, it is recommended that we clarify what those goals are to a broader audience. Finally, we received requests for didactic material from educators, an important request that should be fulfilled, as teachers are key stakeholders and multipliers of knowledge, which is pivotal to long-term behavioral changes in human populations.

Digital culturomics (i.e. the field that aims to analyze digital data to get insights on human–nature interactions) are inherently biased, especially because people have different levels of internet access which can lead to geographic bias (Correia et al. 2021). Further, social media data can contain gender, age, and educational differences in representativeness (Correia et al. 2021). Other limitations include the fact that negative experiences and perspectives are not necessarily reported by the followers (Di Minin et al. 2015). Also, people often use social media platforms to engage with content that they are already interested in (Nikolov et al. 2015). Nevertheless, conservation messages in social media can burst such bubble filters and achieve new conservation actors. This is especially likely when the message spread is repeated different times by different platforms/actors (Wu et al. 2018), which may be our case since many other initiatives using pied tamarin as a flagship species exist in Manaus (e.g. "Salve o Sauim", "SOS Fragmentos Florestais e Sauim"). One example of this may be the peak in 2015's number of posts (Figure 1). In that year, several actors for pied tamarin conservation (researchers, employees from the environmental agency, and politicians) made a symbolic action calling 2015 "The Year of the Pied Tamarin" and organized events such as lectures, planting trees, theater performances in public spaces, etc. (Lagroteria et al. 2017). The Pied Tamarin Project page was one of the channels to promote such events that achieved hundreds of participants. Despite the bias in using social media as a conservation awareness tool, we still believe it should be encouraged. By adding together all the efforts of these and further initiatives, we hope to create an effective web of popular actors for the conservation of pied tamarins and their habitat, as these actors are one of the most important allies for species' conservation success.

Acknowledgments

We thank Daniel Ferraz, Julio Cesar Bicca-Marques and Luis Paulo Ferraz for the invitation and sharing experiences in the round-table "Para além dos artigos científicos: o papel das redes sociais na comunicação e divulgação científica" at the XVIII Brazilian Congress of Primatology; our discussion with colleagues encouraged this publication. In the timespan of the study TVS received a FAPEAM scholarship (062.01758/2018),

and MG received resources from FAPEAM/Universal 006/2019.

References

Barr, S. 2016. Conservation efforts for pied tamarins (*Saguinus bicolor*)—evaluating ecological corridors for restoring the forest fragments of urban Manaus, Brazil. Master's thesis, Lund University, Lund, Sweden.

BRASIL, 2018. Decree 281, 06 April 2018. Plano de Ação Nacional para a Conservação do Sauim-de-Coleira. Diário Oficial da União. Available at: https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/pan-sauim-de-coleira/1-ciclo/pan-sauim-de-coleira-livro.pdf

Coelho, L., Barr, S., Silva dos Santos, L., Rohe, F., Monteiro-Neto, B. D., Raseira, M., Lagroteria, D. and Gordo, M. 2018. Conservação de *Saguinus bicolor* (Callitrichidae) em paisagens fragmentadas na Amazônia Central, Brasil. In: *La Primatología en Latinoamérica 2,* B. Urbani, M. M. Kowalewski, R. G. T. da Cunha, S. de La Torre, and L. Cortés-Ortiz (eds.), pp.187–197. Instituto Venezolano de Investigaciones Científicas, Miranda.

Correia, R. A., Ladle, R., Jarić, I., Malhado, A. C., Mittermeier, J. C., Roll, U., Soriano-Redondo, A., Veríssimo, D., Fink, C., Hausmann, A., Guedes-Santos, J., Vardi, R. and Di Minin, E. 2021. Digital data sources and methods for conservation culturomics. *Conserv. Biol.* 35: 398–411.

Di Minin, E., Tenkanen, H. and Toivonen, T. 2015. Prospects and challenges for social media data in conservation science. *Front. Environ. Sci.* 3: 63.

Gordo, M., Calleia, F. O., Vasconcelos, S. A., Leite, J. J. F. and Ferrari, S. F. 2013. The challenges of survival in a concrete jungle: conservation of the pied tamarin (*Saguinus bicolor*) in the urban landscape of Manaus, Brazil. In: *Primates in Fragments: Complexity and Resilience,* L. Marsh and C. A. Chapman (eds.), pp.357–370. Springer. https://doi.org/10.1007/978-1-4614-8839-2_23.

Guimarães, V. Y., Costa, V., Henicka, T. da S., Range, C. H., and Martinez, R. 2019. "Esse manauara merece respeito": percepção dos habitantes de Manaus sobre o sauim-de-coleira (*Saguinus bicolor*). *Bol. Soc. Bras. Mastozool.* 80: 7–15.

Hunter, L. M., Hatch, A., and Johnson, A. 2004. Cross-national gender variation in environmental behaviors. *Soc. Sci. Q.* 85(3): 677–694. https://onlinelibrary.wiley.com/doi/10.1111/j.0038-4941.2004.00239.x

IBGE. 2018. Acesso à internet e à televisão e posse de telefone móvel celular para uso pessoal. https://biblioteca.ibge.gov.br/. Accessed in 29 December 2020.

Jerusalinsky, L., Azevedo, R. B. de, and Gordo, M. 2017. *Plano de Ação Nacional para a Conservação do Sauim-de-Coleira*. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília.

Kelsey, E. 2012. Ecologists should learn to look on the bright side. *New Scientist* 2846: 24–25. https://www.newscientist.com/article/mg21328460-200-ecologists-should-learn-to-look-on-the-bright-side/#ixzz6RW4O2aU4. Accessed 29 December 2020.

Lagroteria, D. F., Campista, D., and Lima, N.A.S. 2017. Programa de Educação para a Conservação do *Saguinus bicolor*. In: *Plano de Ação Nacional para a Conservação do Sauim-de-Coleira,* L. Jerusalinsky, R. B. Azevedo, and M. Gordo (eds.), pp.131–145. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília.

Loom, M. 2017. *Designing and Developing Digital and Blended Learning Solutions*. Kogan Page, London and NYC.

Mohd Rameli, N. I. A., Lappan, S., Bartlett, T. Q., Ahmad, S. K. and Ruppert, N. 2020. Are social media reports useful for assessing small ape occurrence? A pilot study from Peninsular Malaysia. *Am. J. Primatol.* 82(3): e23112. https://doi.org/10.1002/ajp.23112

Nikolov, D., Oliveira, D. F. M., Flammini, A. and Menczer, F. 2015. Measuring online social bubbles. *PeerJ Comput. Sci.* 1:e32. https://doi.org/10.7717/peerj-cs.38

Nilsson, D., Fielding, K., and Dean, A. J. 2020. Achieving conservation impact by shifting focus from human attitudes to behaviors. *Conserv. Biol.* 34(1): 93–102. https://doi.org/10.1111/cobi.13363

Padua, S. M. 2010. Primate conservation: integrating communities through environmental education programs. *Am. J. Primatol.* 72: 450–453. https://onlinelibrary.wiley.com/doi/10.1002/ajp.20766

Reuter, K. E., and Schaefer, M. S. 2017. Illegal captive lemurs in Madagascar: comparing the use of online and in-person data collection methods. *Am. J. Primatol.* 79. e22541. https://doi.org/10.1002/ajp.22541

Santos, L. S., dos Santos Pereira, H. and Gordo, M. 2017. Simpatria entre populações humanas e de sauim-de-coleira (*Saguinus bicolor*) em fragmentos florestais de Manaus, Amazonas. *Neotrop. Primates* 23(2): 25–30.

Vries, G. 2020. Public communication as a tool to implement environmental policies. *Soc. Issues Policy Rev.* 14(1): 244–272. https://doi.org/10.1111/sipr.12061

Wright, A. J., Veríssimo, D., Pilfold, K., Parsons, E. C. M., Ventre, K., Cousins, J., Jefferson, R., Koldewey, H., Llewellyn, F. and McKinley, E. 2015. Competitive outreach in the 21st century: why we need conservation marketing. *Ocean Coast. Manag.* 115: 41–48. https://doi.org/10.1016/j.ocecoaman.2015.06.029

Wu, Y., Xie, L., Huang, S. L., Li, P., Yuan, Z. and Liu, W. 2018. Using social media to strengthen public awareness of wildlife conservation. *Ocean Coast. Manag.* 153: 76–83. https://doi.org/10.1016/j.ocecoaman.2017.12.010

Short Articles

FIRST CASE OF ALBINISM REGISTERED FOR *ATELES CHAMEK* (HUMBOLDT, 1812)

Liselot R. Lange
Sean Glynn

DOI: https://doi.org/10.62015/np.2022.v28.224

Abstract

Albinism is rarely documented amongst Neotropical mammals, especially in primates, for which only a few cases have been reported. In this paper, we report the first case of albinism in a wild black-faced black spider monkey (*Ateles chamek*) found on the Las Piedras River in south-eastern Peru. The individual, a juvenile female, was sighted in a group in primary forest between 2017 and 2020.

Keywords: Albinism, spider monkey, genetics, Neotropics, mammal

Resumen

El albinismo raras veces se documenta en los mamíferos neotropicales, especialmente en los primates, de los cuales, solo se han reportado algunos casos. En este artículo, reportamos el primer caso de albinismo en un mono araña negro (*Ateles chamek*) silvestre encontrado a lo largo del río Las Piedras en el sur-este de Perú, Madre de Dios. El individuo, una hembra juvenil, fue avistado en su grupo en bosque primario entre los años 2017 y 2020.

Palabras claves: Albinismo, mono araña, genética, mamíferos, neotrópicos

Albinism is a rare genetic condition found in vertebrates, invertebrates and plants (Uieda 2000). The term albinism refers to the absence of pigmentation within an individual (Uieda 2000), causing it to have pale, pinkish skin and white fur or hair. Anomalous pigmentation is a recessive and rare phenomenon (Uieda 2000; Hofreiter and Schöneberg 2010; Espinal et al. 2016) and can take on different forms: albinism, leucism and piebaldism (Brito and Valdivieso-Bermeo 2016). Albinism is more recognizable for the complete lack of pigmentation throughout the body including the iris causing a red colouration (Uieda 2000), whereas in leucism and piebaldism there is still some pigmentation found in patches of fur, irises, and nails (Uieda 2000; Abreu et al. 2013).

In captivity, albinism is often selectively bred, for instance, rodents that are used in labs (Romero et al. 2018). There have also been many records of albino animals in zoos, where small gene pools and limited breeding opportunities have been shown to increase the frequency of albinism (Abreu et al. 2013; Prado-Martinez et al. 2013; Marçon and Maia 2019). This suggests that albinism may be more common in captive populations than in the wild.

Anomalous pigmentation has been recorded for a large variety of mammal species, including whales, tapirs, peccaries and primates (Gross 1965; Bicca-Marques 1988; Watkins-Colwell 2002; Mahabal et al. 2012; Abreu et al. 2013; Prado-Martinez et al. 2013; Duquette et al. 2015; National Geographic 2015; Espinal et al. 2016; Landis et al. 2020; Aximoff et al. 2021; López-Platas et al. 2021; Montilla and Link 2022; Ramos-Luna et al. 2022), and new cases in the wild are being reported more frequently. Wild albino individuals are more vulnerable to predation, as their natural camouflage is lost and the individual can be physically impaired, e.g. reduction in visual acuity, an impairment that is frequently recorded amongst albino vertebrates (Oetting et al. 1994; Abreu et al. 2013). Furthermore, in some vertebrate communities, albino individuals have been found to be ostracised due to their difference in appearance, causing an even higher predation risk (Slavík et al. 2015; Espinal et al. 2016). These consequences of albinism could explain the small number of reports of wild individuals because due to the lowered survival rate, levels of prevalence are minimised.

In a literature review of anomalous pigmentation within Neotropical mammals by Abreu et al. (2013), 198 cases of anomalous pigmentation were found, 23 of which were cited as albinism. Within this survey, no albino primates were reported. However, Ramos-Luna et al. (2022), have since reported 13 records of anomalous pigmentation in Neotropical primates in a total of 44 individuals, including specimens of the genera *Alouatta*, *Ateles*¸ *Callithrix*, *Cebus*, and *Saimiri*.

Here, we report the first record of albinism for *Ateles chamek* (Figure 1).

The black-faced black spider monkey (*Ateles chamek*) is recognised as Endangered throughout its range in Peru, Brazil and Bolivia (Alves et al. 2020). They are large primates with long limbs and a prehensile tail (Campbell 2008). Normally, their fur is completely black with no distinguishing colours on any of their limbs except for slightly light pink genitals and lighter spots in the face (Campbell 2008).

The albino individual was first sighted in March 2017 by a staff member of the ecotourism lodge Las Piedras Amazon Tours (12°2'41.067"S, 69°40'12.493"W). The sighting occurred within an ecotourism concession of 1,016 ha situated along the Las Piedras River in the Madre de Dios department of south-eastern Peru. The individual was sighted on the banks of an oxbow lake situated in floodplain forest. At the time, the individual was an infant and

travelled on the mother's back. This sighting was then confirmed by photographic evidence by resident scientist Suze Lewis-Amable on the 14th of August 2017 (Figure 2). From these photos, the individual was identified as a female. Over a 3-year period, from March 2017 to February 2020, there have been multiple sightings of the same albino individual by staff members of the lodge, the first author and community members. Initial observations of the individual (by the first author) indicate that her group has not ostracised her, as she was seen foraging and travelling in a subgroup of four individuals, the mother and two other females that all stayed in close proximity of the albino.

There have only been a few confirmed cases of non-human primates with albinism reaching adulthood. The captive-held albino Western Gorilla 'Snowflake', that reached adulthood, presented poor visual acuity and was also diagnosed with squamous cell carcinoma, a type of skin cancer, likely developed due to the reduced protection from UV light (Prado-Martinez et al. 2013). Observations of two spider monkeys (*Ateles hybridus*) with leucism in Colombia suggest that these large primates can survive in the wild and reach adulthood with no obvious physical impairments (National Geographic 2015). In another case, a wild albino infant male chimpanzee was killed by group members in a case of infanticide (Leroux et al. 2011). Initially the group members reacted with fear upon seeing the albino infant, a reaction not usually seen with other infants. The group members then took the infant from the mother's arms and killed it. Whether this infanticide was triggered by its albinism or other reasons remains uncertain, however, due to the chimps' initial fear response it is suggested by the authors that this reaction could have been due to the albinism (Leroux et al. 2011).

Genetic research has shown that albinism can be caused by inbreeding (Prado-Martinez et al. 2013). Inbreeding often occurs due to decreasing populations caused by habitat loss, habitat fragmentation and hunting. Inbreeding is known to reduce a population's fitness and can even lead to population extinction (Reed et al. 2002). The albino individual recorded along the Las Piedras River is, however, found in continuous protected primary rainforest and there is no direct evidence of habitat loss, habitat fragmentation, or hunting (personal observations 2020).

The causes and effects of anomalous pigmentation on wild vertebrates remain largely unknown. Further studies are recommended on wild individuals with anomalous pigmentation to gain a better understanding on consequences on population level (genetics) as well as on individual level (social and physical).

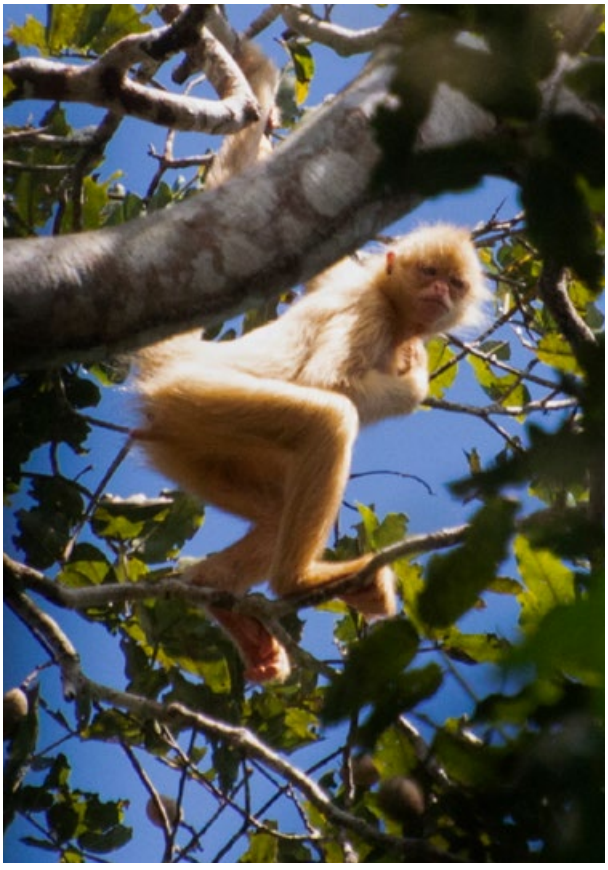

Figure 1. Albino *Ateles chamek* as a subadult in early 2019. Photograph by Liselot Lange.

Figure 2. The albino individual when first sighted, still an infant at the time, clinging to her mother's back. Photograph by Suze Lewis de Amable.

Acknowledgements:

We would like to express our gratitude to Jose Luis Moscoso Garces for allowing us to enter his ecotourism concession and observe the albino individual. Furthermore, we would like to thank Suze Lewis-Amable for kindly providing us with photographic evidence and more information on the albino individual. Lastly, we would like to thank Holly O'Donnell and Lauren Young, and an anonymous reviewer for thoroughly proofreading our short paper.

Liselot R. Lange, Jr. Libertad 646, Puerto Maldonado, Tambopata, Tambopata, Madre de Dios, Perú. E-mail: <liselotlange@gmail.com>, +51 914 281 252, MAQUISAPA E.I.R.L.
https://orcid.org/0000-0003-1382-3850. **Sean Glynn**, 177 Merryhill Road, Bushey, Hertfordshire, United Kingdom E-mail: <Glynn476@gmail.com>, +447716667686 Durrell Institute of Conservation and Ecology (DICE), School of Anthropology and Conservation, University of Kent. https://orcid.org/0000-0002-3071-1415.

References*:*

Abreu, M. S. L., Machado R., Barbieri F., Freitas N. S. and Oliveira L. R. 2013. Anomalous colour in Neotropical mammals: a review with new records for *Didelphis* sp. (Didelphidae, Didelphimorphia) and *Arctocephalus australis* (Otariidae, Carnivora). *Braz. J. Biol.* 73: 185–194.

Alves, S. L., de Melo F. R., Boubli J., Rylands A. B., Messias M. et al. 2020. *Ateles chamek*. The IUCN Red List of Threatened Species 2020: e.T41547A17928789. Website: https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T41547A17928789.en. Accessed 10 August 2020.

Aximoff, I., Neto E. P., de Paula, W., Hofmann, G. S., Keuroghlian, A., et al. 2021. Sticking out in a herd? Records of anomalous pigmentation in a social herd-forming ungulate (*Tayassu pecari*). *North West J. Zool.* 17: 288–293.

Brito, J. and Valdivieso-Bermeo K. 2016. First records of leucism in eight species of small mammals (Mammalia: Rodentia). *Therya* 7: 83–489.

Bicca-Marques, J. C. 1988. Albino capuchin at Sapucaia do Sul zoo. *Primate Conserv.* 9: 37.

Campbell, C. J. 2008. *Spider Monkeys, Behaviour, Ecology and Evolution of the Genus* Ateles. The Edinburgh Building, Cambridge.

Duquette, J. F., Ureña L., Ortega J., Cisneros I., Moreno R., et al. 2015. Evidence of albinism in the white-faced monkey *Cebus capucinus imitator* on Coiba Island, Republic of Panama. *Neotrop. Primates* 22: 97–99.

Espinal, M., José M. M., Ruedas L. A., López LIand Marineros, L. 2016. A case of albinism in the Central American spider monkey, *Ateles geoffroyi*, in Honduras. *Mastozool. Neotrop.* 23: 63–69.

Gross, A. 1965. The incidence of albinism in North American birds. *Bird-Banding* 36: 67–71.

Hofreiter, M. and Schöneberg T. 2010. The genetic and evolutionary basis of colour variation in vertebrates. *Cell. Mol. Life Sci*. 67: 2591–2603.

Landis, M., Candisani, L., Munhões, L., Gebin J., Rezende F., et al. 2020. First record of albino lowland tapirs (*Tapirus terrestris* Linnaeus 1758) in an important Brazilian Atlantic forest hotspot. *Mammalia* 84: 601–604

Leroux, M., Monday G., Chandia B., Akankwasa J. W., Zuberbühler K., et al. 2021. First observations of a chimpanzee with albinism in the wild: social interactions and subsequent infanticide. *Am. J. Primatol*. e23305.

López-Platas, J. A., Vivas-Lindo, R. and Serna-Lagunes, R. 2021. Abnormal pelage colour in mantled howler monkey (*Alouatta palliata mexicana*) in Veracruz, México. *Therya Notes* 2: 26–28.

Mahabal, A., Rane, P. D., and Pati, S. K. 2012. A case of total albinism in the Bonnet Macaque *Macaca radiata* (Geoffroy) from Goa. *Zoo's Print J*. 27: 22–23.

Marçon, C. and Maia, M. 2019. Albinism: epidemiology, genetics, cutaneous characterization, psychosocial factors. *An. Bras. Dermatol*. 94: 503–520.

Montilla, S. O. and Link, A. 2022. Albinism in a wild Caribbean night monkey (*Aotus griseimembra*) in a fragmented landscape in Colombia. *Therya Notes* 3 14–17.

National Geographic. 2015. Website: https://www.nationalgeographic.com/animals/article/150417-ghost-monkey-albino-bear-elephant-animals-science. Accessed 14 January 2020.

Oetting, W. S., Summers C. G. and King R. A. 1994. Albinism and the associated ocular defects. *Metab. Pediatr. Syst. Ophthalmol.* 17: 5–9.

Prado-Martinez, J., Hernando-Herraez I., Lorente-Galdos B. et al. 2013. The genome sequencing of an albino Western Lowland Gorilla reveals inbreeding in the wild. *BMC Genomics* 14: 363.

Ramos-Luna, J., Alvarez-Velazquez M. F., Chapman C. A., and Serio-Silva J. C. 2022. Anomalous pigmentation in American primates: review and first record of a leucistic black howler monkey in southeast Mexico. *Folia Primatol*. 2 : 26–28.

Reed, D. H., Briscoe D. A. and Frankham R. 2002. Inbreeding and extinction: the effect of environmental stress and lineage. *Cons. Gen*. 3: 301–307.

Romero, V., Racines-Márquez C. and Brito J. 2018. A short review and worldwide list of wild albino rodents with the first report of albinism in *Coendou rufescens* (Rodentia: Erethizontidae). *Mammalia* 82: 509–515.

Slavík, O., Horký P. and Maciak M. 2015. Ostracism of an albino individual by a group of pigmented catfish. *PloS one* 10, e0128279. https://doi.org/10.1371/journal.pone.0128279

Uieda, W. 2000. A review of complete albinism in bats with new cases from Brazil. *Acta Chiropt*. 2: 97–105.

Watkins-Colwell G. 2002. A partial albino Northern Red-Bellied snake from Vermont. *Northeast. Nat.* 9(2): 221.

NOVA LOCALIDADE DE OCORRÊNCIA DE *CALLITHRIX AURITA* (É. GEOFFROY SAINT-HILAIRE, 1812) NO ESTADO DE SÃO PAULO, BRASIL

Paulo de Tarso Zuquim Antas
Igor Pfeifer Coelho
José Roberto Matos
Saulo R. Lima

DOI: https://doi.org/10.62015/np.2022.v28.221

Introdução

O sagui-da-serra-escuro (*Callithrix aurita*) é endêmico da Mata Atlântica do sudeste do Brasil, habitando florestas ombrófilas densas e estacionais semidecíduas especialmente nas regiões montanhosas dos estados de Minas Gerais, Rio de Janeiro e São Paulo (Melo et al. 2018). Embora a espécie já tenha sido registrada em baixas altitudes (165 m in Angra dos Reis, RJ; Brandão e Develey 1998) a maioria dos registros conhecidos são em áreas acima de 800 m de altitude (Melo et al. 2018), e a adequabilidade de ambientes para *C. aurita* foi relacionada a maiores altitudes no Parque Estadual da Serra do Mar (Norris et al. 2011). Grupos de 2 a 11 indivíduos já foram registrados para essa espécie (estudos compilados em Melo et al., 2018), tendo áreas de vida estimadas entre 11,0 ha, na Fazenda Monte Alegre - MG (Muskin 1984), e 39,9 ha, na Estação Ecológica de Bananal – SP (Brandão 1999). Estimativas populacionais indicam densidades entre 0,02-0,08 indivíduos/km² no Parque Estadual do Rio Doce, MG (Stallings e Robinson 1991) e 20-23 indivíduos/km² no Parque Estadual da Serra do Mar, SP (Corrêa 1995).

Com base na inferência de que a espécie está sofrendo uma redução populacional de pelo menos 50% em um intervalo de 18 anos, ou três gerações, o sagui-da-serra-escuro é considerado Em Perigo de Extinção pelas listas de espécies ameaçadas da IUCN (Melo et al. 2021) e do Brasil (Melo et al. 2018). As ameaças reconhecidas a *Callithrix aurita* são a perda e fragmentação de habitat e, principalmente, a competição e hibridação com espécies invasoras de calitriquídeos (*Callithrix penicillata* e *C. jacchus*). As principais recomendações para a conservação da espécie incluem pesquisas para o registro de populações em áreas sem a ocorrência dos calitriquídeos invasores (Melo et al. 2018). Nesse trabalho apresentamos uma nova área de ocorrência para *C. aurita* no estado de São Paulo decorrente de levantamentos populacionais e monitoramento de mamíferos e aves.

Métodos

A observação de *Callithrix aurita* foi realizada na Fazenda Montes Claros (2698 ha), município de São José dos Campos, SP (Figura 1). A fazenda é uma propriedade da empresa de papel e celulose Suzano S.A. e foi reconhecida pela empresa como uma Área de Alto Valor de Conservação, dentro do conceito da *Forest Stewardship Council* (https://br.fsc.org/pt-br/fsc-brasil). Os limites da Montes Claros se localizam entre um conjunto de áreas protegidas. A cerca de 300 m a leste e 700 m ao sul da fazenda ficam áreas da Área de Proteção Ambiental Bacia do Paraíba do Sul (federal). A cerca de 9 km de distância ao norte da fazenda estão os limites meridionais da Área de Proteção Ambiental São Francisco Xavier (estadual) e a cerca de 6 km a oeste fica a Área de Proteção Ambiental Piracicaba/Juqueri-Mirim (estadual). Por fim, a cerca de 7 km a sudeste está a unidade de conservação de proteção integral mais próxima, o Parque Natural Municipal Augusto Ruschi (PNMAR).

Calculamos a proporção de cada tipo de classe de cobertura da terra na Fazenda Montes Claros a partir da classificação do Mapbiomas para o ano de 2019 (Souza et al. 2019). Cerca de 71% da fazenda possui cobertura de floresta estacional semidecídua montana da Serra da Mantiqueira (Morelli et al. 2003) com dossel a 21 m de altura, 24% são plantações de *Eucalyptus* sp., 4% são brejos de altitude (classificados como "pastagem" ou "mosaico de agricultura e pastagem" pelo Mapbiomas) e córregos cobrem 0,01 % da área (Figura 1). A altitude na fazenda varia entre 660 e 890 m e o clima da região é mesotérmico úmido com estação seca no inverno (Cwa conforme a classificação climática de Köppen; Ruziska e Suguio, 2008).

Levantamentos de espécies e monitoramento da riqueza de mamíferos e/ou aves foram realizados na Fazenda Montes Claros nos anos de 2004, 2005, 2009, 2010, 2011, 2015 e 2019 (Schunck et al. 2022; Suzano S.A. dados inéditos). Em 2019 foram avaliados nove pontos de censo para aves, instaladas 10 armadilhas fotográficas e realizados sete pontos de *playback* para saguis (Figura 1). Cada ponto de censo para aves foi amostrado em duas ocasiões, de 12 a 13 de março e de 8 a 9 de maio, por um observador. Cada amostragem nos pontos de censo teve duração de 20 min, com início 30 min após o nascer do sol. Percursos a pé pelas estradas e trilhas da fazenda foram realizados após a finalização dos censos, até cerca de 16:00. O mesmo ocorreu nos dias de instalação e retirada das armadilhas fotográficas, as quais permaneceram em funcionamento entre 12 de março e 5 de abril, e de 8 a 25 de maio. Os pontos de *playback* para saguis foram realizados entre 07:00 e 10:30 do dia 9 de maio. Em cada ponto, foi tocada uma gravação do chamado longo de *C. aurita* por três vezes, com um intervalo de 5 min entre cada, usando um megafone SK66 25 W em todas as direções.

Resultados

Às 15:00 do dia 13 de março de 2019 avistamos um grupo de *Callithrix aurita* composto por seis indivíduos (quatro adultos e dois juvenis) em um bambuzal (685 m; -23,0455°, -46,0326°; Figura 1). Todos os indivíduos tinham o fenótipo escuro da espécie, sem variação notável de cores entre eles. Inicialmente detectados por seus chamados curtos de alarme, mantiveram-se arredios na parte alta do bambuzal e após cerca de 3 min de observação, todos afastaram-se rapidamente pela copa das árvores em direção leste. A mancha de floresta onde o grupo foi avistado se estende da fazenda até a APA Bacia do Paraíba do Sul, chegando a cerca 1200 m de altitude e com uma área total de 5431 ha. Nenhum outro grupo de saguis (*Callithrix* spp.) foi registrado nos pontos de censo, armadilhas fotográficas e pontos de *playback*.

Discussão

O registro de *Callithrix aurita* aqui apresentado representa uma nova localidade de ocorrência da espécie no estado de São Paulo, em uma área sem registros de calitriquídeos invasores. O ponto onde o grupo foi detectado está a cerca de 5 km do registro mais próximo da espécie (Santos 2018), em outra extremidade da mesma mancha florestal, sendo indicada a Fazenda Montes Claros como área de ocorrência. Porém, as coordenadas apresentadas para esse registro estão na Fazenda Lavras, vizinha à atual Fazenda Montes Claros. Até 2015 pelo menos, a Fazenda Lavras pertencia à Cia. Suzano de Papel e Celulose, predecessora da Suzano S.A. Outros registros de *C. aurita* na região próxima incluem o PNMAR (São José dos Campos 2014) e a APA de São Francisco Xavier (São José dos Campos 2021).

Considerando o esforço de campo que vem sendo empregado por mastozoólogos e ornitólogos na Fazenda Montes Claros, acreditamos que *Callithrix aurita* ocorra em baixa densidade na área. Estudos com método direcionado para *C. aurita* (e.g. pontos de *playback*) e desenho amostral apropriado (com réplicas espaciais e temporais para estimativa de detecção) são necessários para estimar a densidade da espécie com maior precisão.

Além da perda e fragmentação de habitat, a hibridização com *Callithrix penicillata* e *C. jacchus* tem sido apontada com ameaça à conservação de *C. aurita* (São Paulo 2015; Melo et al. 2018). Enquanto *C. penicillata* ainda não foi registrada na região da Serra da Mantiqueira do município de São José dos Campos, *C. jacchus* já foi encontrada na localidade de Água Soca II (Santos 2018; considerando

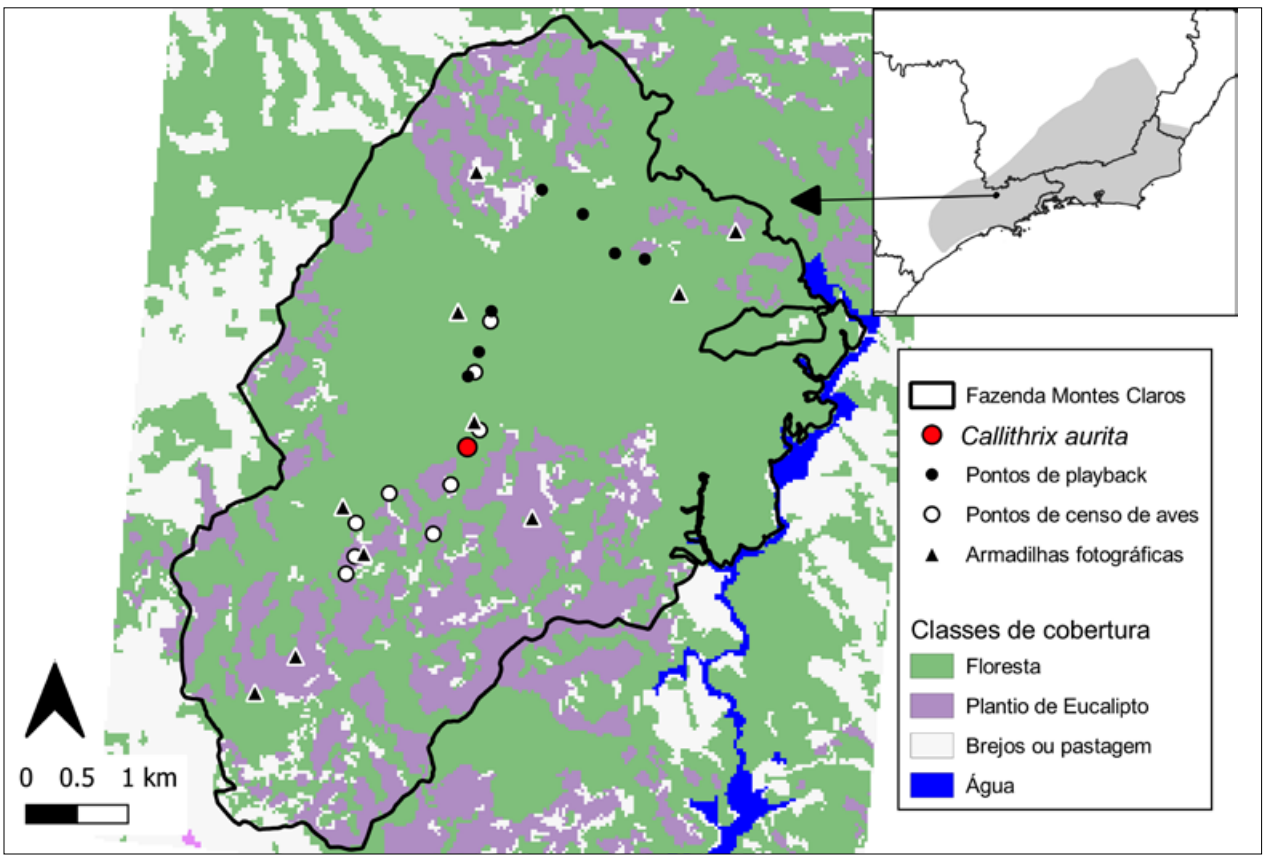

Figura 1. Localização do novo registro de *Callithrix aurita* na Fazenda Montes Claros, SP. No canto superior direito, em cinza, a distribuição geográfica da espécie de acordo com a IUCN (Melo et al. 2020).

as coordenadas dessa publicação, que cita o local como Vila dos Fazendeiros) a 685 m de altitude e a cerca de 13 km a leste do ponto onde *C. aurita* foi observado nesse estudo. A localidade é dominada por pastagens e áreas de cultivo e possui poucos remanescentes florestais. Embora a densidade de calitriquídeos invasores pareça ser baixa na região, não podemos descartar o risco de hibridação com *C. aurita* na região no futuro.

A Fazenda Montes Claros e seu entorno podem ser uma importante área para *Callithrix aurita* em um contexto regional dada a sua localização entre um conjunto de grandes áreas protegidas de uso sustentável e algumas pequenas unidades de conservação de proteção integral. A região da Serra da Mantiqueira foi indicada como prioritária para a conservação da biodiversidade do estado de São Paulo e *C. aurita* foi identificada como uma das principais espécies do *Plano de Ação para a Conservação dos Primatas do Estado de São Paulo* (São Paulo 2015). Uma importante ação para a conservação da espécie na região é o restabelecimento da conectividade entre os grandes fragmentos na encosta da Serra da Mantiqueira entre si e com o PNMAR. As superfícies aplainadas dos fundos dos vales montanhosos são, atualmente, ocupadas por meios de produção econômica rural com áreas abertas contínuas. A introdução e promoção de sistemas agroflorestais, cujos produtos tenham valor de mercado superior ou semelhante aos hoje cultivados, pode ser efetiva na criação de corredores de conexão em locais prioritários. A criação de um selo de qualidade vinculando a produção nesses sistemas agroflorestais à conservação de *C. aurita* poderia alcançar mais consumidores de grandes centros, impulsionando uma economia local que favoreça áreas de floresta e a persistência da espécie na região.

Agradecimentos

Agradecemos à então Companhia Suzano de Papel e Celulose S.A., atual Suzano S.A., pelo apoio para a realização do estudo, em especial a João Carlos Augusti, Giovana Bruns, Flávio Dechechi, Maria Sebastian Rangel Gregorio e Paulo Groke (Instituto Ecofuturo). À Fundação Pro-Natureza - FUNATURA, pelo gerenciamento e apoio institucional ao estudo para a realização dos monitoramentos de aves e mamíferos na Fazenda Montes Claros em 2004, 2005 e 2019. Igualmente, ao Fabio Schunck, Carlos Candia-Gallardo, Giulyana Althmann Benedicto e Regina de Souza Yabe pelo desenvolvimento das atividades de campo em 2004 e 2005. A dois revisores anônimos pelas contribuições na primeira versão do texto.

Referências

Brandão, L. D. 1999. Distribuição altitudinal e ambiente preferencial de *Callithrix aurita* (Primates: Callitrichidae) na Estação Ecológica de Bananal, Serra da Bocaina, São Paulo. Em: *Livro de Resumos do IX Congresso Brasileiro de Primatologia*, S. L. Mendes (ed.), 87pp. Santa Teresa, Espírito Santo.

Brandão, L. D. e Develey, P. F. 1998. Distribution and conservation of the buffy-tufted-ear marmoset, *Callithrix aurita*, in lowland coastal Atlantic forest, southeast Brazil. *Neotropical Primates* 6(3): 86–88.

Corrêa, H. K. M. 1995. Ecologia e comportamento alimentar de um grupo de saguis-da-serra-escuros (*Callithrix aurita* E. Geoffroy, 1812) no Parque Estadual da Serra do Mar, Núcleo Cunha, São Paulo, Brasil. Tese de Doutorado. Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais.

Melo, F. R., Ferraz, D. S., Valença-Montenegro, M. M., Oliveira, L. C., Pereira, D. G., e Port-Carvalho, M. 2018. *Callithrix aurita* (É. Geoffroy Saint-Hilaire, 1812). Em: *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção: Volume II – Mamíferos*, ICMBio/MMA, pp.206–213. Brasília, Distrito Federal.

Melo, F. R., Port-Carvalho, M., Pereira, D. G., Ruiz-Miranda, C. R., Ferraz, D.S., Bicca-Marques, J. C., Jerusalinsky, L., Oliveira, L. C., Valença-Montenegro, M. M., Valle, R. R., da Cunha, R. G. T., e Mittermeier, R. A. 2021. *Callithrix aurita* (amended version of 2020 assessment). The IUCN Red List of Threatened Species 2021: e.T3570A191700629. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T3570A191700629.en.

Morelli, A. F., Cavalheiro, F., Alves, M., e Fantini, M. 2003. Representação espacial da cobertura vegetal natural original do município de São José dos Campos. *Geoambiente On-line* 1: 1–15.

Muskin, A. 1984. Field notes and geographical distribution of *Callithrix aurita* in eastern Brazil. *Am. J. Primatol.* 7: 377–380.

Norris, D., Rocha-Mendes, F., Marques, R., Almeida Nobre, R., e Galetti, M. 2011. Density and spatial distribution of buffy-tufted-ear marmosets (*Callithrix aurita*) in a continuous Atlantic Forest. *Int. J. Primatol.* 32(4): 811–829.

Ruziska, A. A. e Suguio, K. 2008. Impactos ambientais sobre os recursos hídricos para abastecimento público em São José dos Campos (Estado de São Paulo, Brasil). *Revista UnG – Geociências* 1: 5–30.

Santos, G. F. 2018. Levantamento e diagnóstico de *Callithrix aurita* (É. Geoffroy, 1812) e congêneres invasores em fragmentos florestais da APA Mananciais do Rio Paraíba do Sul. Relatório de Acompanhamento (2017–2018) do Programa Institucional de Bolsas de Iniciação Científica do Instituto Chico Mendes de Conservação da Biodiversidade- PIBIC/ICMBio. 17pp.

São José dos Campos. 2014. *Plano de Manejo Parque Natural Municipal Augusto Ruschi*. 358pp.

São José dos Campos. 2021. Prefeitura de São José dos Campos. Website: https://www.sjc.sp.gov.br/noticias/2021/janeiro/21/video-revela-presenca-do-saguida-serra-escuro-em-sfx/. Acessado em 19/04/2021.

São Paulo. 2015. *Plano de Ação para Conservação dos Primatas do Estado de São Paulo* 2015. Secretaria de Meio Ambiente, São Paulo, SP. 89pp.

Schunck. F, Candia-Gallardo, C., Benectido, G. A., Yabe, R. S., e Antas, P. T. Z. 2022. A importância das áreas particulares na conservação da avifauna do estado de São Paulo, sudeste do Brasil. *Biodiversidade* 21(1): 19–57.

Souza, C. M. Z., Shimbo, J., Rosa, M. R., Parente, L. L. A., Alencar, A., et al. 2020. Reconstructing three decades of land use and land cover changes in Brazilian biomes with Landsat archive and Earth Engine. *Remote Sensing* 12, 2735. https://doi.org/10.3390/rs12172735

Stallings, J. R. e Robinson, J. G. 1991. Disturbance, forest heterogeneity and primate communities in a Brazilian Atlantic Forest park. Em: *Primatologia no Brasil – 3*, A. B. Rylands e A. T. Bernardes (eds.), pp.357–368. Fundação Biodiversitas e Sociedade Brasileira de Primatologia.

Paulo de Tarso Zuquim Antas, **José Roberto Matos** e **Saulo R. Lima**, Fundação Pró-Natureza de Conservação – FUNATURA, SCLN 107 Bloco B sala 201, Asa Norte, Brasília, Distrito Federal. **Igor Pfeifer Coelho**, Núcleo de Ecologia de Rodovias e Ferrovias, Departamento de Ecologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul. E-mail: <djakare@gmail.com>.

OBSERVATIONS OF GOLDEN-MANTLED TAMARINS (*LEONTOCEBUS TRIPARTITUS*) IN AMAZONIAN ECUADOR

Rachel Voyt
Sofia Di Fiore
Anthony Di Fiore

DOI: https://doi.org/10.62015/np.2022.v28.229

Abstract

Golden-mantled tamarins (*Leontocebus tripartitus*) are an understudied callitrichid primate the geographic range of which extends from the Río Napo and Río Curaray in Perú into eastern Ecuador. Only one behavioral study of this species has been published to date, which focused on the population overlapping the Tiputini Biodiversity Station in Amazonian Ecuador over two decades ago. We reevaluated this same population via a two-month preliminary assessment of demography, ranging patterns, and behavior. We located five groups within a roughly 1 km radius of the station, with group sizes ranging from approximately 5 to 11 individuals. Most groups were unhabituated to human presence, but for one group that was well habituated we collected ranging and behavioral data over approximately 101 follow-hours. The group had a mean daily path length of 1,483 m and home range estimates of 25.9 to 39.9 ha, depending on the method used. Intergroup encounters occurred at a rate of 0.08 per follow hour. Group members exhibited substantial variation in cohesion, with individuals routinely traveling, foraging, and sleeping up to 40 m apart. We observed repeated use of several sleep sites as well as the use of a tree hole as a sleep site (the first recorded use for this species) and documented rapid-avoidance and mobbing anti-predator behaviors. These data suggest substantial changes to the Tiputini golden-mantled tamarin population and provide much needed information on callitrichids from the western Amazon, furthering our understanding of variation in socioecology across the callitrichid radiation overall.

Keywords: Golden-mantled tamarins, home range, intergroup encounters, sleep sites, anti-predator behavior

Resumen

El tití de manto dorado (*Leontocebus tripartitus*) es una especie de primates calitrícidos poco estudiada cuya distribución geográfica se extiende desde los Ríos Napo y Curaray en Perú hasta el este de Ecuador. Hasta la fecha, solo un estudio de comportamiento ha sido publicado. Este estudio se realizo hace dos décadas en la población de titíes de La Estación de Biodiversidad de Tiputini. En el presente estudio, reevaluamos la misma población de titíes de manto dorado a través de un estudio preliminar de dos meses enfocado en la demografía, patrones de movimiento y comportamiento. Ubicamos cinco grupos dentro de un radio aproximado de 1 km de la estación, con tamaños de grupo que abarcaron de 5 a 11 individuos. La mayoría de los grupos estaban deshabituados a la presencia humana, pero para un grupo habituado colectamos datos de movimiento y comportamiento durante 101 horas. Este grupo tuvo un promedio de recorrido diario de 1.483 m y su rango de hogar estimado fue de 25,9 a 39,9 ha, dependiendo del método utilizado. Los encuentros entre grupos ocurrieron a una tasa de 0,08 por cada hora de seguimiento. Los miembros del grupo exhibieron niveles de cohesión variable, con individuos rutinariamente moviéndose, forrajeando, y durmiendo a 40 metros de distancia aproximadamente. Observamos el uso repetido de varios dormideros además del uso de un hueco en un árbol como dormidero (el primer registro para esta especie) y documentamos evitación rápida y "mobbing" como comportamientos anti-predatorios. Estos datos sugieren cambios considerables en la población de titíes de manto dorado de Tiputini y proveen información necesaria de los calitrícidos del oeste de la Amazonía, lo que promueve nuestro entendimiento de la variación socioecológica de la radiación de los calitrícidos en general.

Palabras clave: Tití de manto dorado, rango de hogar, encuentros entre grupos, dormideros, comportamiento anti-predatorio

Introduction

Over 500 primate species are recognized, but very little has been published on the behavior and ecology of the majority of taxa. Updated assessments of lesser-studied species are necessary to contribute to our general understanding of behavioral, ecological, and social diversity patterns, as well as to provide a baseline knowledge that may prove essential to conservation efforts as anthropogenic activities continue to threaten primates across the world. One taxonomic group that deserves more attention is the callitrichids, small-bodied platyrrhine primates living in Central and South America. Studies of wild callitrichids are few relative to other American primates and fewer still relative to primates overall (Bezanson and McNamara 2019), and those that exist have thus far focused heavily on Atlantic Forest callitrichids (e.g., common marmosets, *Callithrix jacchus*), with information on Amazonian callitrichids still largely lacking.

Golden-mantled tamarins (*Leontocebus tripartitus*) are one such species of little-studied Amazonian callitrichid. Their geographic range extends from between the Río Napo and Río Curaray in Perú into eastern Ecuador (Rylands et al. 2011), and only a small number of reports have documented even the most basic data about the species' population density and group size (Albuja 1994; Heymann 2000; Aquino et al. 2005). These studies, which were usually limited to a few days of observation, suggest a mean group size of approximately 5 to 6 individuals (Thorington Jr. 1988; Albuja 1994; Heymann 2000; Aquino et al. 2005) and a population density ranging from approximately 13 to 27 individuals per km^2, depending on the location (Aquino et al. 2005, 2014). Our understanding of golden-mantled tamarin behavior is even more limited. Only a single behavioral study exists, which was conducted between 1997 and 1999 at the Tiputini Biodiversity Station in Amazonian Ecuador (76°08'W, 0°38'S, Figure 1) (Kostrub 2003). This study provides an initial characterization of the social and ecological factors mediating group composition dynamics, reproduction, and infant care of golden-mantled tamarins at the site. However, no behavioral study of golden-mantled tamarins has occurred at this site – nor, to the best of our knowledge, at any others – in over two decades.

In a two-month field season at the Tiputini Biodiversity Station in summer 2019, we reevaluated the state of this same population of golden-mantled tamarins through a preliminary assessment of demography, ranging patterns, and behavior. We also documented the occurrence of several behaviors that have not been previously recorded or described for wild golden-mantled tamarins, including variation in group cohesion, aerial and arboreal antipredator behavior, and sleep site usage.

Methods

We conducted this study from June 16 to August 10, 2019. This time of year was expected to overlap with the mating season for golden-mantled tamarins at the site (Kostrub 2003). We conducted daily surveys to ascertain the approximate number, size, and distribution of golden-mantled tamarin groups in portions of the Tiputini Biodiversity Station trail system as well as habitat usage and ranging patterns of the groups we contacted whenever possible. We conducted surveys between 0545 and 1800 hours by walking established trails multiple times per day and waiting for tamarins at known feeding trees within a ~1 km radius of the station. We also used playbacks of golden-mantled tamarin long-calls, which were originally recorded at the Tiputini Biodiversity Station in 2009 and are archived in the Cornell Lab of Ornithology's Macaulay Library (ML148787).

When we encountered a group of tamarins, we recorded their habituation level, approximate group size, and location. We judged habituation level based on the group's tolerance of human presence and, when possible, their tolerance of being followed. We considered groups that immediately fled on contact as "poorly habituated" and those exhibiting little to no noticeable changes in behavior as "well-habituated".

To record group size, we found that path counts (i.e., counts made as a group traveled along a single path) provided the most accurate estimates. However, path counts proved difficult for unhabituated groups, which tended to scatter on contact. We were unable to accurately estimate group sex ratios due to sexual monomorphism in body size and appearance. Age composition estimates were also impossible as the last births likely occurred over five months prior to observations, and offspring had already obtained their adult fur coloring (Kostrub 2003).

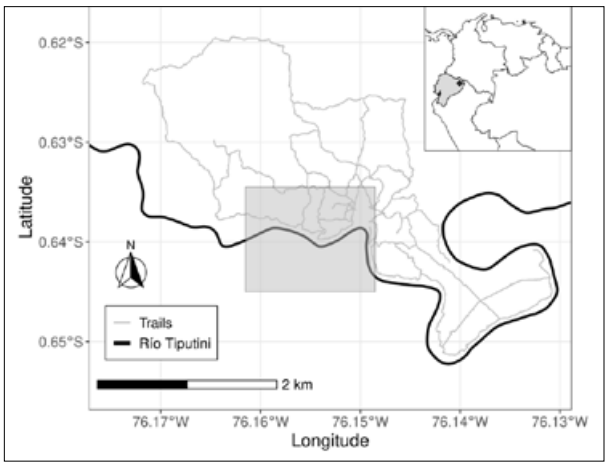

Figure 1. Map of Tiputini Biodiversity Station. Grey rectangle represents the area shown in detail in Figure 2. Upper right inset panel shows the station's location (black diamond) within Ecuador (grey).

Upon encountering groups, we recorded their location as well as their travel paths for as long as we were able to follow them using a datalogging GPS unit worn by the observer (Garmin GPSMAP 64, location records stored at 20 second intervals). On occasions when we were able to follow groups until they entered a sleep tree at the end of the day, we stayed at least 45 minutes to confirm that the group did not change sleeping sites. We returned to the tree before dawn the next day and marked the trees with a GPS waypoint and physical tag once the group exited the tree.

For the single habituated group for which we obtained tracking data covering multiple days ("Lago" group), we calculated daily path length and home range size estimates. We used location records collected during all encounters with the group to estimate home range size, but for calculating daily path lengths we used data only from full-day follows, in which we remained with the group from when they exited a sleep tree in the morning until they entered a sleep tree in the evening. Before using GPS data in home range and path length calculations, we extracted location records at regular 15-minute intervals (on the hour and at 15, 30, and 45 minutes past the hour) by averaging all GPS coordinates recorded in the two minutes on either side of those time points. To determine daily path lengths, we used packages *sfheaders* (Cooley 2020) and *sf* (Pebesma 2018) for the statistical programming software R (version 4.1.0, R Core Team 2021) to sum the distance between these location records collected within each full-day follow. We used the packages *adehabitatHR* (Calenge 2006) and *tlocoh* (Lyons et al. 2013) to estimate home ranges as 95% minimum convex polygons (Mohr 1947), 95% utilization density kernels (Worton 1989), and 100% local convex hulls (Getz et al. 2007) based on the entire set of 15-minute location records.

We recorded all intergroup encounters during follows, noting the time and location at which they occurred. We considered intergroup encounters to have occurred when neighboring groups were in visual range of each other (i.e., less than 50 m) and exchanged long-calls (Peres 1989; Garber et al. 1993; Kostrub 2003) and/or overt agonistic interactions, such as chases or physical aggression (Kostrub 2003).

Results & Discussion

We encountered an estimated total of five groups within a roughly 1-km radius of the station, but only one was well-habituated to human observers ("Lago" group). The home range of Lago group overlaps some of the most commonly used trails at the station as well as the living quarters and offices of the station itself, likely leading to this group's high tolerance of human presence and follows. While we did occasionally find other groups near the station, these were usually in areas less commonly used by humans. All other groups usually fled on contact, with follows of these non-habituated groups lasting a maximum of 1 hour and 41 minutes (N = 15 follows, mean follow time: 32 minutes). By contrast, we were able to follow Lago group for multiple days in a row on several occasions, with a total follow time of 101 hours and 5 minutes (N = 21 follows, mean follow time: 4 hours, 49 minutes) across 18 days of the field season.

We confidently ascertained the group size for Lago group (N = 11) and for one of the unhabituated groups (N = 8). We estimated that all other unhabituated groups contained a minimum of 5 individuals. A group size of 11 individuals is the largest documented thus far for *Leontocebus tripartitus*, with previous surveys reporting a maximum of 10 individuals per group for this species (Albuja 1994). Notably, these counts are substantially larger than those documented in this same population almost two decades prior by Kostrub (2003) (mean group size: 4 individuals, range: 2 to 7 individuals), potentially suggesting an increase in population density over the past 20 years.

We observed substantial variation in group cohesion, with subsets of individuals from Lago group routinely splitting off to travel, forage, or rest up to 30-40 m apart. We also observed one unhabituated group that did not appear to scatter, but to split into two cohesive subgroups of four individuals traveling approximately 50 m apart from one another. Similar observations in *Leontocebus tripartitus* have previously been coded as a temporary association of two groups (Kostrub 1997), which may have been the case for the unhabituated group. However, such a large group spread also fits with that observed in the habituated group in this study as well as in other tamarin species (e.g., *Saguinus labiatus, S. imperator, Leontocebus fuscicollis*: Buchanan-Smith 1999), leaving both as potential options.

We also observed behaviors that appeared to be clearly linked to predator presence, including responses to both aerial and arboreal predators. The tamarins exhibited "rapid avoidance" (*sensu* Ferrari and Ferrari 1990) anti-predator behavior when raptors flew overhead (N=3 observations) as well as in response to a toucan call (N =1 observation), with two observations of rapid avoidance behavior in response to unknown stimuli. In all situations, the entire group rapidly descended toward the ground and occasionally sought cover by moving onto the ground itself. Raptors and toucans have been previously shown to elicit alarm behavior in other callitrichids, with similar avoidance behaviors reported for these and other aerial predators (e.g., *Callithrix flaviceps*: Ferrari and Ferrari 1990; *Saguinus mystax, Leontocebus nigrifrons*: Heymann 1990; *L. avilapiresi*: Peres 1993). We also observed one occasion in which individuals exhibited mobbing behavior toward a tayra (*Eira barbara*), a member of the weasel family native to the Americas,

where the entire group faced the tayra while emitting loud alarm call and chatter vocalizations until the tayra left the group. "Mobbing" anti-predator behavior in callitrichids appears to be typical for tayra and other non-aerial predators (Bartecki and Heymann 1987; Ferrari and Ferrari 1990; Peres 1993), although studies have reported rapid avoidance responses to non-aerial predators as well (Ferrari and Ferrari 1990).

We obtained 21 total GPS tracks consisting of 410 averaged location records acquired over 18 days from the Lago group (Figure 2), four of which were full-day follows averaging 10 hours 38 minutes ± SD 21 minutes from sleep tree to sleep tree. From these, we calculated a mean daily path length of 1,483 ± SD 470 m (range: 937 to 2,120 m). This value is consistent with those recorded by Kostrub (2003), who calculated daily path lengths ranging from 466 to 2,308 m (mean=1,470 m; N=63 follows). We also calculated a 95% minimum convex polygon home range estimate of 39.9 ha, which is approximately twice that of the largest home range calculated for this population 20 years ago (21 ha) using the same method, though much closer to those recorded for other small-bodied tamarin species (Digby et al. 2007). Home range size estimates based on the 95% kernel utilization distribution and on 100% local convex hulls (Figure 2) were 30.8 ha and 25.9 ha, respectively.

During our follows of Lago group, we observed 8 intergroup encounters (Figure 2). Intergroup encounters appeared to take place at the edges of the group's territory no later than 1400 hours, with no more than one encounter observed per day. We observed encounters during three of the four full-day follows, yielding an estimated rate of 0.75 encounters per day. Across the total number of hours spent with Lago group (101 hours, 5 minutes), this rate translates to 0.08 encounters per follow hour. This rate is substantially higher than that found by Kostrub (2003), who observed only six intergroup encounters in 235 observation hours (0.03 encounters per follow hour) during the dry season—the same period as the current study. These rates are instead more similar to those found during the rainy season, where Kostrub (2003) observed 25 intergroup encounters in 323 hours of observation (0.07 encounters per follow hour). The reasons for the higher intergroup encounter rate cannot be determined without additional study, but may be related to changes in population density, food availability, and/or breeding patterns from those observed 20 years ago. The playbacks used in the course of the present study may have also influenced the intergroup encounter rate.

We located sleep trees for the Lago group on 10 occasions. The group used six unique trees, with two trees used twice and one used three times on non-consecutive nights during the two-month study (Figure 2). Repeated use of sleep sites in tamarins has been documented previously (e.g., Heymann 1995; Pontes and Soares 2005), including in golden-mantled tamarins (Kostrub 2003). In general, sleep trees supported large masses of vines into which the group would disappear. On one occasion, however, we observed them using a tree hole. Patterns of tree hole use for sleep sites vary across callitrichids, with some species using tree holes occasionally (e.g., *Callithrix jacchus*: Pontes and Soares 2005; *Leontocebus nigrifrons*: Heymann 1995) and others habitually (e.g., *Leontopithecus rosalia*: Hankerson et al. 2007). We set up a camera trap for one additional month at this location to see if the group might use it again, but the group's use of the tree hole as a sleep site seemed to be limited to this one instance.

These new observations of wild golden-mantled tamarin grouping and ranging behavior provide suggestive evidence of substantial changes in the golden-mantled tamarin population at the Tiputini Biodiversity Station since the population was last studied over 20 years ago. These observations also provide additional data on behaviors that were seldom previously recorded for the species, including anti-predator behavior and sleep-site usage. In doing so, we provide further support encouraging the establishment of long-term studies as well as additional studies of Amazonian callitrichids to better understand the variation and similarities within and between these species.

Acknowledgments

We are very grateful to the Ecuadorian government (Ministerio del Medio Ambiente) for granting research permission for our research group's long-term work at the Tiputini Biodiversity Station (MAE-DNB-CM-2019-0117). Special thanks are also due to Dr. David Romo, Dr. Kelly Swing, and the entire Tiputini

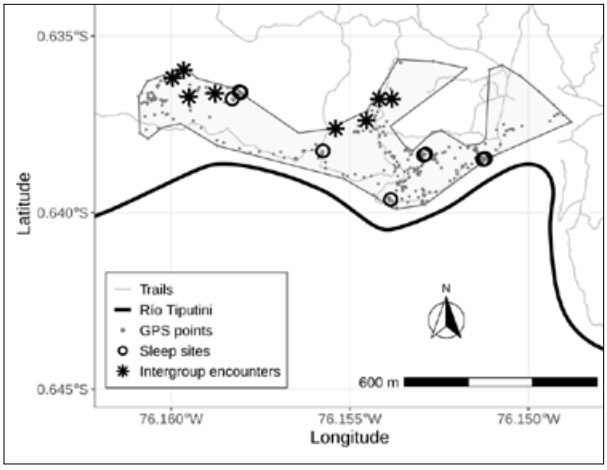

Figure 2. 100% local convex hull home range estimate with GPS points from daily follows (grey points), sleep sites (black open circles), and intergroup encounters (black asterisks) recorded between June 10 and August 16, 2019 from golden-mantled tamarins (*Leontocebus tripartitus*) in the Lago group at the Tiputini Biodiversity Station in Amazonian Ecuador.

Biodiversity Station staff for logistical support. Fieldwork for this project was supported through grants awarded to the lead author by the Primate Society of Great Britain, the American Society of Mammalogists, and The University of Texas at Austin. Additional field support for AD was provided by The University of Texas at Austin. All research described herein was done in full agreement with all Ecuadorian legislation and approved by The University of Texas at Austin IACUC.

Rachel Voyt and **Anthony Di Fiore**, Department of Anthropology, The University of Texas at Austin, Austin, TX, USA. Sofia Di Fiore, Department of Anthropology, University of Oregon, Eugene, OR, USA. Email: <sofia.difiore@gmail.com>. **Anthony Di Fiore**, Tiputini Biodiversity Station, College of Biological and Environmental Sciences, Universidad San Francisco de Quito, Cumbayá, Ecuador. Email: <anthony.difiore@austin.utexas.edu>.

Rachel Voyt is the corresponding author <ravo@utexas.edu>.

References

Albuja, L. 1994. Nuevos registros de *Saguinus tripartitus* en la Amazonía Ecuatoriana. *Neotrop. Primates* 2: 1988–1990.

Aquino, R., Ique, C. and Gálvez, H. 2005. Reconocimiento preliminar de la densidad y estructura poblacional de *Saguinus tripartitus* Milne-Eduards en la Amazonía peruana. *Rev. Peru. Biol.* 12: 435–440.

Aquino, R., López, L., García, G. and Heymann, E. W. 2014. Diversity, abundance and habitats of the Primates in the Río Curaray Basin, Peruvian Amazonia. *Primate Conserv*. 28: 1–8.

Bartecki, U. and Heymann, E. W. 1987. Field observation of snake-mobbing in a group of saddle-back tamarins, *Saguinus fuscicollis nigrifrons*. *Folia Primatol* 48(3-4): 199–202.

Bezanson, M. and McNamara, A. 2019. The what and where of primate field research may be failing primate conservation. *Evol. Anthropol.* 28(4): 166–178.

Buchanan-Smith, H. 1999. Tamarin polyspecific associations: forest utilization and stability of mixed-species groups. *Primates* 401: 233–247.

Calenge, C. 2006. The package adehabitat for the R software: a tool for the analysis of space and habitat use by animals. *Ecol. Modell*. 197: 516–519.

Cooley, D. 2020. Sfheaders: Converts between R objects and simple feature objects. R package version 0.4.0. https://CRAN.R-project.org/package=sfheaders

Digby, L. J., Ferrari, S. F. and Saltzman, W. 2007. Callitrichines: the role of competition in cooperatively breeding species. In: *Primates in Perspective, 2nd ed.*, Campbell, C., Fuentes, A., MacKinnon, K. C., Panger, M., Berader, S. (eds.), pp.85–106. Oxford University Press, New York.

Ferrari, S. F. and Ferrari M. A. L. 1990. Predator avoidance behaviour in the buffy-headed marmoset, *Callithrix flaviceps*. *Primates* 31:323–338.

Garber, P. A., Pruetz, J. D. and Isaacson, J. 1993. Patterns of range use, range defense, and intergroup spacing in moustached tamarin monkeys (*Saguinus mystax*). *Primates* 34: 11–25.

Getz, W. M., Fortmann-Roe, S., Cross, P. C., Lyons, A. J., Ryan, S. J. and Wilmers, C. C. 2007. LoCoH: nonparametric kernel methods for constructing home ranges and utilization distributions. *PLoS ONE* 2(2), e207.

Hankerson, S. J., Franklin, S. P. and Dietz, J. M. 2007. Tree and forest characteristics influence sleeping site choice by golden lion tamarins. *Am. J. Primatol.* 69: 976–988.

Heymann, E. W. 1990. Reactions of wild tamarins, *Saguinus mystax* and *Saguinus fuscicollis* to avian predators. *Int. J. Primatol.* 11: 327–337.

Heymann, E. W. 1995. Sleeping habits of tamarins, *Saguinus mystax* and *Saguinus fuscicollis* (Mammalia; Primates; Callitrichidae), in north-eastern Peru. *J. Zool.* 237: 211–226.

Heymann, E. W. 2000. Field observations of the golden-mantled tamarin, *Saguinus tripartitus*, on the Rio Curaray, Peruvian Amazonia. *Folia. Primatol.* 71: 392–398.

Kostrub, C. 1997. Preliminary field observations of golden-mantled tamarins, *Saguinus tripartitus*, in eastern Ecuador. *Neotrop. Primates*, 5(4): 102–103.

Kostrub, C. 2003. The social organization and behavior of golden-mantled tamarins. Doctoral thesis, University of California Davis, California, USA.

Lyons, A. J., Turner, W. C., and Getz, W. M. 2013. Home range plus: a space-time characterization of movement over real landscapes. *Mov. Ecol.* 1:2.

Macaulay Library, Cornell Lab of Ornithology. https://macaulaylibrary.org/asset/148787.

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. *Am. Midl. Nat.* 37: 223–249.

Mustoe, A. C., Jensen, H. A. and French, J. A. 2012. Describing ovarian cycles, pregnancy characteristics, and the use of contraception in female white-faced marmosets, *Callithrix geoffroyi*. *Am. J. Primatol.* 74: 1044–1053.

Pebesma, E. 2018. Simple features for R: standardized support for spatial vector data. *The R Journal* 10(1): 439–446.

Peres, C. A. 1989. Costs and benefits of territorial defense in wild golden lion tamarins, *Leontopithecus rosalia*. *Behav. Ecol. Sociobiol.* 25: 227–233.

Peres, C. A. 1993. Anti-predation benefits in a mixed-species group of Amazonian tamarins. *Folia. Primatol.* 61: 61–76.

Pontes, A. R. M. and Soares, M. L. 2005. Sleeping sites of common marmosets (*Callithrix jacchus*) in defaunated urban forest fragments: a strategy to maximize food intake. *J. Zool.* 266: 55–63.

Rylands, A. B, Matauschek, C., Aquino, R., Encarnación, F., Heymann, E. W., de la Torre, S. and Mittermeier,

R. A. 2011. The range of the golden-mantle tamarin, *Saguinus tripartitus* (Milne Edwards, 1878): distributions and sympatry of four tamarin species in Colombia, Ecuador, and northern Peru. *Primates* 52: 25–39.

Thorington Jr., R. W. 1988. Taxonomic status of *Saguinus tripartitus* (Milne-Edwards, 1878). *Am. J. Primatol.* 15: 367–371.

Worton, B. J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. *Ecology* 70(1): 164–168.

REPORT OF A PYGMY MARMOSET (*CEBUELLA NIVEIVENTRIS*) SWIMMING IN IGAPÓ FOREST FLOODWATERS

Colin Phillip Jackson
Ulrich Reichard

DOI: https://doi.org/10.62015/np.1995.v3.265

Introduction

Swimming occurs when an individual is partially or fully submerged in water without contacting a substrate and uses its limbs for propulsive, spatially directed movement (Kempf 2009; Bender and Bender 2013). Researchers have observed swimming behavior in 17 catarrhines and seven platyrrhines (Table 1). We found no published observations for tarsiids or lorisiforms, and only two descriptions for lemuriforms, neither of which we include because Petter and Peyrieras (1975) provided only a secondhand account and Gaide et al. (2015) were unclear about the source of the observation. Five of the seven platyrrhines are medium or large-bodied (>1 kg), while the other two are small-bodied. In most cases, individuals traversed bodies of water, while in fewer cases, individuals rescued themselves after unintentionally falling into bodies of water (Table 1). The distribution of swimming anecdotes suggests that swimming is rare in platyrrhines and even more so in its small-bodied members.

Pygmy marmosets (*Cebuella* spp.), weighing between 85 and 160 g, are the tiniest monkeys within the primate order (Soini, 1988; Ford and Davis 1992). Recent molecular and morphological studies have recognized two species of pygmy marmosets endemic to western Amazonia, *C. pygmaea* north of and *C. niveiventris* south of the Solimões River (Rylands 2009; Boubli et al. 2018; Garbino et al. 2019; Porter et al. 2021). These tiny monkeys thrive in seasonally flooded and river-edge habitats, subsisting by claw-climbing and claw-clinging in the forest understory, where they spend most of their time gouging tree trunks and consuming exudates (Soini 1988; Youlatos 1999, 2009; Jackson 2011). Even though pygmy marmosets preferentially live in wet habitats and forage precariously close to floodwaters and rivers, there have been no swimming reports for either species. Here, we describe a juvenile southern pygmy marmoset (*C. niveiventris*) swimming in igapó floodwaters.

Study Site

The swimming event occurred during a field study of pygmy marmoset ecology at the Tahuayo Lodge in north-eastern Peruvian Amazonia (04°18'S, 73°13'W). Located near the confluence of the Tahuayo and Blanco rivers, this facility rests in a landscape of palm swamps, flood plains that inundate from December to June, and *terra firme* habitats (Santillán and Tegnér 2015). El Chino village is 1.5 km northeast of the Tahuayo Lodge on the right bank of the Tahuayo River. Local community members subsist via fishing and small-scale farming, which has produced some deforested plots along the riverbank. Despite these anthropogenic disturbances, at least eight pygmy marmoset groups lived along the river between the Tahuayo Lodge and El Chino (Sheehan and Papworth 2019). Additionally, nine other primate species lived near the Tahuayo Lodge and surrounding areas: brown capuchins (*Sapajus apella macrocephalus*), moustached tamarins (*Tamarinus mystax*), owl monkeys (*Aotus nancymaae*), saddle-back tamarins (*Leontocebus nigrifrons*), sakis (*Pithecia monachus*), coppery titi monkeys (*Plecturocebus cupreus*), squirrel monkeys (*Saimiri macrodon*), uakaris (*Cacajao ucayalii*), and white-fronted capuchins (*Cebus yuracus*) (updated from Santillán and Tegnér 2015).

Observation

The swimming event occurred 0.35 km northeast of El Chino on the edge of a deforested plot in the middle of the flooding season on March 19th, 2019. CPJ was conducting preliminary observations of a potential study group with four adults and one juvenile of unknown sexes and ages. Just before the swimming event, the group was foraging for the pulp of *Inga alba* pods. To acquire this food, an individual would hold onto a terminal branch with its non-hallux toes, reach above or suspend its entire body below, and then grasp a single pod with both hands. Aligning its head parallel to the pod's transverse axis, the individual would anchor its incisors into the lateral edges and pull off a single segment of the exocarp, revealing a single seed surrounded by pulp. After removing the seed and pulp, the individual would move onto a more stable branch near the trunk and then roll the seed and pulp in its mouth before spitting it into the water below. Individuals in the group foraged for 40 minutes and then left the feeding tree. The juvenile left last.

Exiting the feeding tree, the juvenile attempted a terminal-branch leap but could not generate sufficient propulsion during the take-off phase to reach the next support because the branch it took off from was too compliant. The juvenile fell 2 m, splashed into the floodwater, and

Table 1. Published observations of swimming events by non-human primates, ordered by parvorder and then by body size.

Species	Body Size (kg)	Description	Source(s)
Platyrrhini			
Cebuella niveiventris	0.09-0.16[1]	recovering after falling into floodwater	this study
Callithrix jacchus	0.21-0.31[1]	fleeing zookeeper	Hershkovitz (1977)
Saguinus geoffroyi	0.43-0.66[1]	recovering after falling into pond	Hershkovitz (1977)
Cacajao melanocephalus	2.71-3.16[2]	recovering after falling into floodwater	Bezerra et al. (2011)
Alouatta palliata	3.10-9.80[1]	crossing river, strait	Gonzalez-Socoloske & Snarr (2010); Herrera et al. (2015)
Alouatta seniculus	4.50-7.60[1]	crossing river	Soini (1986)
Ateles geoffroyi	6.00-9.00[1]	crossing river	Chaves and Stoner (2010)
Ateles chamek	9.33-9.41[2]	crossing river	Nunes (2014)
Catarrhini			
Miopithecus talapoin	1.12-2.50[2]	fleeing predator	Gautier-Hion (1973)
Chlorocebus pygerythrus	2.98-5.30[2]	playing in the wild; regulating body temperature	McFarland et al. (2019)
Macaca sinica	3.20-5.68[2]	foraging for underwater roots	Linfield (1997)
Cercopithecus neglectus	3.55-7.35[2]	fleeing conspecific; playing in captivity	Gautier-Hion (1971)
Macaca fascicularis	3.59-5.36[2]	crossing pond, river; regulating body temperature	Fittinghoff & Lindberg (1980); van Schaik et al. (1996); Mohammad & Wong (2019); Han (2021)
Macaca radiata	3.85-6.67[2]	crossing pond, river; playing in the wild	Simonds (1965); Krishnan (1971); Agoramoorthy et al. (2000)
Cercopithecus nictitans	4.26-6.67[2]	fleeing zookeeper	Gautier-Hion (1971)
Macaca mulatta	5.37-11.00[2]	retrieving food in experiment; traveling between islands	Berman (1977); Anderson et al. (1992); Arre and Horschler (2021)
Semnopithecus entellus	6.91-19.20[2]	recovering after falling into pond	Agoramoorthy (1986)
Macaca fuscata	8.03-11.00[2]	playing in the wild; traveling between islands	Kawai (1965)
Nasalis larvatus	9.82-20.40[2]	crossing river; fleeing observers	Kawabe & Mano (1972); Galdikas (1985); Salter et al. (1985); Bennett & Sebastian (1988); Yeager (1991); Boonratana (2000); Onuma (2002); Matsuda et al. (2008)
Papio hamadryas	9.90-21.00[2]	playing in captivity	Schultz (1969)
Papio anubis	11.70-25.10[2]	playing in the wild	Pfeyffers (2000)
Theropithecus gelada	11.70-19.00[2]	playing in captivity	Schultz (1969)
Papio ursinus	14.80-29.80[2]	crossing river	Cheney et al. (2004)
Pan troglodytes	33.70-59.70[2]	playing in captivity	Bender and Bender (2013)
Pongo pygmaeus	35.60-78.50[2]	crossing gaps between branches; playing in captivity	Russon et al. (2010); Bender and Bender (2013)

[1] Ford and Davis (1992)
[2] Smith and Jungers (1997)

sank for two or three seconds before swimming towards the tree using dog-paddle strokes. It had difficulties keeping its head above water, stopped to tread water several times, struggled against the current, and took 30 seconds to swim the 1 m to the tree trunk. Upon reaching the tree, it climbed to the nearest branch and emitted several infant-distress vocalizations. A few seconds later, an adult returned and allowed the juvenile to cling to its back; they rested for five minutes before the juvenile

dismounted. They both left the tree and regrouped with the others.

Discussion

Primates swim for various reasons, but sometimes individuals accidentally fall into bodies of water, and the sole purpose of swimming is to avoid drowning - our anecdote is another example of a primate swimming to survive an accidental fall. CPJ has observed pygmy marmosets falling out of trees on two other occasions. In one instance, a dominant-breeding female tumbled 0.5 m to the forest floor while running down an obliquely angled trunk; in another, an independently locomoting infant dropped 1.5 m to the forest floor while attempting an upward bound. Even though pygmy marmosets are agile creatures, they may occasionally fall out of trees and face a situation where they must swim to avoid drowning. Our observation shows at least juvenile pygmy marmosets can swim well enough to rescue themselves.

Acknowledgments

We thank Dr. Paul Beaver of Amazonia Expeditions for granting permission to conduct research at the Tahuayo Lodge. Additionally, we thank Hersog Smith Chávez of Nauta and Walter Mermao of El Chino for their excellent work as field guides. Finally, we thank the anonymous reviewer for their comments on the original manuscript.

Colin Phillip Jackson and **Ulrich Reichard**, School of Anthropology, Political Science and Sociology, Southern Illinois University, Carbondale, IL. E-mail: <cpjackson@siu.edu>

References

Agoramoorthy, G. 1986. A note on Hanuman langur, *Presbytis entellus* swimming: a preliminary description of a new phenomenon in India. *J. Bombay Nat. Hist. Soc.* 83: 419.

Agoramoorthy, G., Smallegange, I., Spruit, I. and Hsu, M. J. 2000. Swimming behaviour among bonnet macaques in Tamil Nadu. *Folia Primatol.* 71: 152–153.

Anderson, J. R., Peignot, P., and Adelbrecht, C. 1992. Task-directed and recreational underwater swimming in captive rhesus monkeys (*Macaca mulatta*). *Lab. Primate Newsl.* 31: 1–4.

Arre, A. M. and Horschler, D. J. 2021. Swimming and diving as social play in juvenile rhesus macaques (*Macaca mulatta*). *Behaviour* 158: 529–546.

Bender, R. and Bender, N. 2013. Brief communication: Swimming and diving behavior in apes (*Pan troglodytes* and *Pongo pygmaeus*): first documented report. *Am. J. Phys. Anthropol.* 152: 156–162.

Bennett, E. L. and Sebastian, A. C. 1988. Social organization and ecology of proboscis monkeys (*Nasalis larvatus*) in mixed coastal forest in Sarawak. *Int. J. Primatol.* 9: 233–255.

Berman, C. 1977. Seaside play is a serious business. *New Sci.* 73: 761–763.

Bezerra, B. M., Barnett, A. A., Souto, A., and Jones, G. 2011. Ethogram and natural history of golden-backed uakaris (*Cacajao melanocephalus*). *Int. J. Primatol.* 32: 46–68.

Boonratana, R. 2000. Ranging behavior of proboscis monkeys (*Nasalis larvatus*) in the Lower Kinabatangan, northern Borneo. *Int. J. Primatol.* 21: 497–518.

Boubli, J. P., da Silva, M. N. F., Rylands, A. B., Nash, S. D., Bertoul, F., Nunes, M., Mittermeier, R. A., Byrne, H., Silva, F. E., Röhe, F., Sampaio, I., Schneider, H., Farias, I. P. and Hrbek, T. 2018. How many pygmy marmoset (*Cebuella* Gray, 1870) species are there? A taxonomic re-appraisal based on new molecular evidence. *Mol. Phylogenet. Evol.* 120: 170–182.

Chaves, O. M. and Stoner, K. E. 2010. River crossings by *Ateles geoffroyi* and *Alouatta pigra* in southern Mexico: a preliminary report. *Rev. Chil. Hist. Nat.* 83: 435–442.

Cheney, D. L., Seyfarth, R. M., Fischer, J., Beehner, J., Bergman, T., Johnson, S. E., Kitchen, D. M., Palombit, R. A., Rendall, D. and Silk, J. B. 2004. Factors affecting reproduction and mortality among baboons in the Okavango Delta, Botswana. *Int. J. Primatol.* 25: 401–428.

Fittinghoff, N. A. and Lindburg, D. G. 1980. Riverine refuging in east Bornean *Macaca fascicularis*. In: *The Macaques: studies in ecology, behavior, and evolution*, D. G. Lindburg (ed.), pp.182–214. Van Nostrand Reinhold Company, New York.

Ford, S. M. and Davis, L. C. 1992. Systematics and body size: Implications for feeding adaptations in New World monkeys. *Am. J. Phys. Anthropol.* 88: 415–468.

Gaide, N., Pelandakis, M., Robveille, C., Albaric, O., Jouvion, G., Souchon, M., Risler, A. and Abadie, J. 2015. Necrotizing meningoencephalitis in a captive black and white ruffed lemur (*Varecia variegata variegata*) caused by *Acanthamoeba* T4 genotype. *J. Comp. Pathol.* 153: 231–235.

Galdikas, B. M. F. 1985. Crocodile predation on a proboscis monkey in Borneo. *Primates* 26: 495–496.

Garbino, G. S. T., Casali, D. M., Nascimento, F. O. and Serrano-Villavicencio, J. E. 2019. Taxonomy of the pygmy marmoset (*Cebuella* Gray, 1866): geographic variation, species delimitation, and nomenclatural notes. *Mamm. Biol.* 95: 135–142.

Gautier-Hion, A. and Gautier, J. P. 1971. La nage chez les cercopitheques arboricoles du Gabon. *Rev. Ecol.* 1: 67–75.

Gautier-Hion, A. 1973. Social and ecological features of talapoin monkeys: comparisons with sympatric cercopithecines. In: *Comparative Ecology and Behavior of Primates*, R. P. Michael and J. H. Crook (eds.), pp.147–170. Academic Press, New York.

Gonzalez-Socoloske, D. and Snarr, K. A. 2010. An incident of swimming in a large river by a mantled howling

monkey (*Alouatta palliata*) on the north coast of Honduras. *Neotrop. Primates* 17: 28–31.

Han, C. Z. 2021. Biodiversity record: Long-tailed macaque swimming with infant in Upper Seletar Reservoir. *Nat. Singap.* 14: e2021009.

Herrera, H., Escobar-Lasso, S., González-Ancín, H. and Béal, M. C. 2015. Observaciones del nado de un grupo de monos aulladores (*Alouatta palliata*) en el Océano Pacífico de Costa Rica. *Mastozool. Neotrop.* 22: 385–389.

Hershkovitz, P. 1977. *Living New World Monkeys (*Platyrrhini*): With an Introduction to Primates.* University of Chicago Press, Chicago.

Jackson, C. P. 2011. The positional behavior of pygmy marmosets (*Cebuella pygmaea*) in northwestern Bolivia. *Primates* 52: 171–178.

Kabwe, M. and Mano, T. 1972. Ecology and behavior of the wild proboscis monkey, *Nasalis larvatus* (Wurmb.) in Sabah, Malaysia. *Primates* 13: 213–227.

Kawai, M. 1965. Newly-acquired pre-cultural behavior of the natural troop of Japanese monkeys on Koshima Islet. *Primates* 6: 1–30.

Kempf E. 2009. Patterns of water use in primates. *Folia Primatol*. 80: 275-94. https://doi.org/10.1159/000252586.

Krishnan, M. 1971. An ecological survey of the larger mammals of peninsular India. *J. Bombay Nat. Hist. Soc.* 68: 503–549.

Linfield, M. 1997. The temple troop. In: *The Natural World*, N. Nightingale (director), run time 50 min. BBC and Discovery Channel, Great Britain.

McFarland, R., Barrett, L., Costello, M. A., Fuller, A., Hetem, R. S., Maloney, S. K., Mitchell, D. and Henzi, P. S. 2020. Keeping cool in the heat: behavioral thermoregulation and body temperature patterns in wild vervet monkeys. *Am. J. Phys. Anthropol.* 171: 407–418.

Matsuda, I., Tuuga, A., Akiyama, Y. and Higashi, S. 2008. Selection of river crossing location and sleeping site by proboscis monkeys (*Nasalis larvatus*) in Sabah, Malaysia. *Am. J. Primatol.* 70: 1097–1101.

Mohammad, M. and Wong, A. 2019. The daily activity budgets of long-tailed macaque (*Macaca fascicularis*) at Padang Teratak Wildlife Sanctuary, Beaufort, Sabah, Malaysia. *Journal of Tropical Biology and Conservation.* 16: 165–183.

Nunes, A. V. 2014. Report of a black spider monkey (*Ateles chamek*) swimming in a large river in central-western Brazil. *Neotrop. Primates* 21: 204–206.

Onuma, M. 2002. Daily ranging patterns of the proboscis monkey, *Nasalis larvatus*, in coastal areas of Sarawak, Malaysia. *Mammal Study* 27: 141–144.

Petter, J. J. and Peyrieras, A. 1975. Preliminary notes on the behavior and ecology of *Hapalemur griseus*. In: *Lemur Biology, I*. Tattersall & R. W. Sussman (eds.), pp.281–286. Plenum Press, New York.

Pfeyffers, R. 2000. Underwater swimming by baboons *Papio anubis* in Nigeria. *Afr. Primates* 4: 72–74.

Porter, L. M., de la Torre, S., Pérez-Peña, P. and Cortés Ortiz, L. 2021. Taxonomic diversity of *Cebuella* in the western Amazon: molecular, morphological and pelage diversity of museum and free-ranging specimens. *Am. J. Phys. Anthropol.* 175: 251–267.

Russon, A. E., Kuncoro, P., Ferisa, A. and Handayani, D. P. 2010. How orangutans (*Pongo pygmaeus*) innovate for water. *J. Comp. Psychol.* 124: 14–28.

Rylands, A. B., Coimbra-Filho, A. F. and Mittermeier, R. A. 2009. The systematics and distributions of the marmosets (*Callithrix*, *Callibella*, *Cebuella*, and *Mico*) and callimico (*Callimico*) (Callitrichidae, Primates). In: *The Smallest Anthropoids: The Marmoset/Callimico Radiation*, S. M. Ford, L. M. Porter, and L. C. Davis (eds.), pp.25–62. Springer, New York.

Salter, R. E., MacKenzie, N. A., Aken, K. M. and Chai, P. P. K. 1985. Habitat use, ranging behaviour, and food habits of the proboscis monkey, *Nasalis larvatus* (van Wurmb), in Sarawak. *Primates* 26: 436–451.

Santillán, A. D. and Tegnér, F. 2015. Amazonian plethora: biodiversity monitoring of jaguars, pumas, primates and other flagship species of the Peruvian Amazon. Unpublished report, Biosphere Expeditions.

Schultz, A. H. *The Life of Primates*. Universe Books, New York.

Sheehan, R. L. and Papworth, S. 2019. Human speech reduces pygmy marmoset (*Cebuella pygmaea*) feeding and resting at a Peruvian tourist site, with louder volumes decreasing visibility. *Am. J. Primatol.* 81: e22967.

Simonds, P. E. 1965. The bonnet macaque in South India. In: *Primate Behavior, I*. Devore (ed.), pp.175–196. Holt, Rinehart, and Winston, New York.

Smith, R. J. and Jungers, W. L. 1997. Body mass in comparative primatology. *J. Hum. Evol.* 32: 523–559.

Soini, P. 1986. A synecological study of a primate community in the Pacaya-Samiria National Reserve, Peru. *Primate Conserv.* 7: 63–71.

Soini, P. 1988. The pygmy marmoset, genus *Cebuella*. In: *Ecology and Behavior of Neotropical Primates, vol. 2*, R. A. Mittermeier, A. B. Rylands, A. F. Coimbra-Filho, and G. A. B. da Fonseca (eds.), pp.79–129. World Wildlife Fund, Washington, DC.

van Schaik, C. P., van Amerongen, A. and van Noordwijk, M. A. 1996. Rivering refuging by wild Sumatran long-tailed macaques (*Macaca fascicularis*). In: *Evolution and Ecology of Macaque Societies*, J. F. Fa and D. G. Lindburg (eds.), pp.160–177. Cambridge University Press, Cambridge.

Yeager, C. P. 1991. Possible antipredator behaviour associated with river crossings by proboscis monkeys (*Nasalis larvatus*). *Am. J. Primatol.* 24: 61–66.

Youlatos, D. 1999. Positional behavior of *Cebuella pygmaea* in Yasuní National Park, Ecuador. *Primates* 40: 543–550.

Youlatos, D. 2009. Locomotion, postures, and habitat use by pygmy marmosets (*Cebuella pygmaea*). In: *The Smallest Anthropoids: The Marmoset/Callimico Radiation*, S. M. Ford, L. M. Porter, and L. C. Davis (eds.), pp.279–297. Springer, New York.

TERRESTRIAL FEEDING ON FRUITS OF *MAURITIA FLEXUOSA* (ARECACEAE) BY *SAIMIRI MACRODON*

Eckhard W. Heymann
Sofya Dolotovskaya

DOI: https://doi.org/10.62015/np.2022.v28.230

The diet of squirrel monkeys mainly consists of arthropods and fruit pulp (Mittermeier and Van Roosmalen 1981; Terborgh 1983; Soini 1986; Lima and Ferrari 2003; Stone 2007; Montoya Cepeda and Pérez Torres 2020). With regard to fruit consumption, squirrel monkeys are adapted to feeding on soft fruits (Janson and Boinski 1992; Rosenberger 1992). Consumption by squirrel monkeys of hard fruits like those of most palms is possibly facilitated by other animals that remove or partially remove the husks, like *Sapajus apella* opening fruits of the palm *Scheelea* (Terborgh 1983). Here we report terrestrial feeding on fruits of the aguaje palm, *Mauritia flexuosa*, by Ecuadorian squirrel monkeys, *Saimiri macrodon* (name in Peru: mono fraile).

Our report is based on camera trapping at the Estación Biológica Quebrada Blanco (EBQB) in northeastern Peruvian Amazonia (4°21'S, 73°09'W; for details of EBQB see Heymann et al. [2021] and Heymann and Tirado Herrera [2021]). We placed a camera trap in a swampy area circa 5 m from the base of the trunk of a *Mauritia flexuosa*, focusing on the ripe fruits lying on the ground, to record the terrestrial consumers of this palm. Recordings were made between 8 July and 23 August 2022, for a total of 810 hours; the study was terminated when there were no ripe fruits left on the ground or in the palm.

Mauritia flexuosa is a widespread Neotropical palm used by many animals and humans (Aquino and Bodmer 2004; Prada Villalobos and Araujo Bagno 2012; Acevedo-Quintero and Zamora-Abrego 2016; Virapongse et al. 2017) and has even been considered a keystone species (van der Hoek et al. 2019). The pulp is rich in carbohydrates and fat, including diverse unsaturated fatty acids (Lopes et al. 1980; Pereira Freire et al. 2016).

The camera trap recorded the following non-primate mammals foraging on fallen palm fruits: *Agouti paca* (paca, name in Peru: majáz); *Dasyprocta fuliginosa* (agouti, name in Peru: añuje); *Dasypus kappleri* (greater long-nosed armadillo, name in Peru: carachupa); and *Tapirus terrestris* (tapir, name in Peru: sacha vaca). During diurnal checks of the place, intact palm fruits and fruits with the scaly husk partially removed were found on the ground. Whether removal of the husks was by arboreal, flying or terrestrial visitors could not be determined.

On 18 August 2022, a group of *Saimiri macrodon* appeared continuously over 21 consecutive video recordings (camera setting: 20 sec recording duration, 10 sec lapse before new recording) between 1631 h and 1653 h (Figure 1). Variable numbers of squirrel monkeys were moving and foraging in the low vegetation near the palm; the maximum number of individuals recorded simultaneously was six. The videos captured 16 occasions where a squirrel monkey picked up a fruit on the ground. On 15 of these, the squirrel monkey moved to a thin trunk or branch near the ground and started to feed, or disappeared from view; in one case, the squirrel monkey dropped the fruit again. On two occasions, a squirrel monkey hastily picked up a fruit near the camera trap, shortly glancing at the camera trap and then jumping out of sight, suggesting that it perceived the camera trap as an unusual, perhaps threatening object. The resolution of the camera trap did not allow us to distinguish whether fruits picked up by the squirrel monkeys had their husk already partially removed or whether they were intact. Foraging in the low vegetation around the palm may have been targeted at arthropods attracted to the fruits (see van der Hoek et al. 2019), but this could not be unambiguously recognized from the videos.

A brown capuchin monkey, *Sapajus apella* (name in Peru: machín negro), appeared in one video along with squirrel monkeys, picking up a fruit on the ground, briefly handling it, and then moving up into the vegetation with the fruit held in one hand (Figure 1d). At EBQB, we encounter squirrel monkeys most often in the riparian forest along Quebrada Blanco. When encountered in terra firme forest away from the river, they are usually traveling in association with *S. apella* or with red uacaris, *Cacajao ucayalii* (name in Peru: huapo rojo), very rarely with Spix's white-fronted capuchin, *Cebus unicolor* (name in Peru: machín blanco). Association with *S. apella* was apparently the case during the observations reported here.

Consumption of *Mauritia flexuosa* by squirrel monkeys, *Saimiri cassiquiarensis*, has previously been reported only by Acevedo-Quintero and Zamora-Abrego (2016), but no details were provided by these authors on whether it took place in the palm or on the ground. *Mauritia flexuosa* fruit pulp is unlikely to be important in the diet of squirrel monkeys, but given its nutritional value, even opportunistic foraging may render physiological benefits.

References

Acevedo-Quintero, J. F. and Zamora-Abrego, J. G. 2016. Papel de los mamíferos en los procesos de dispersión y

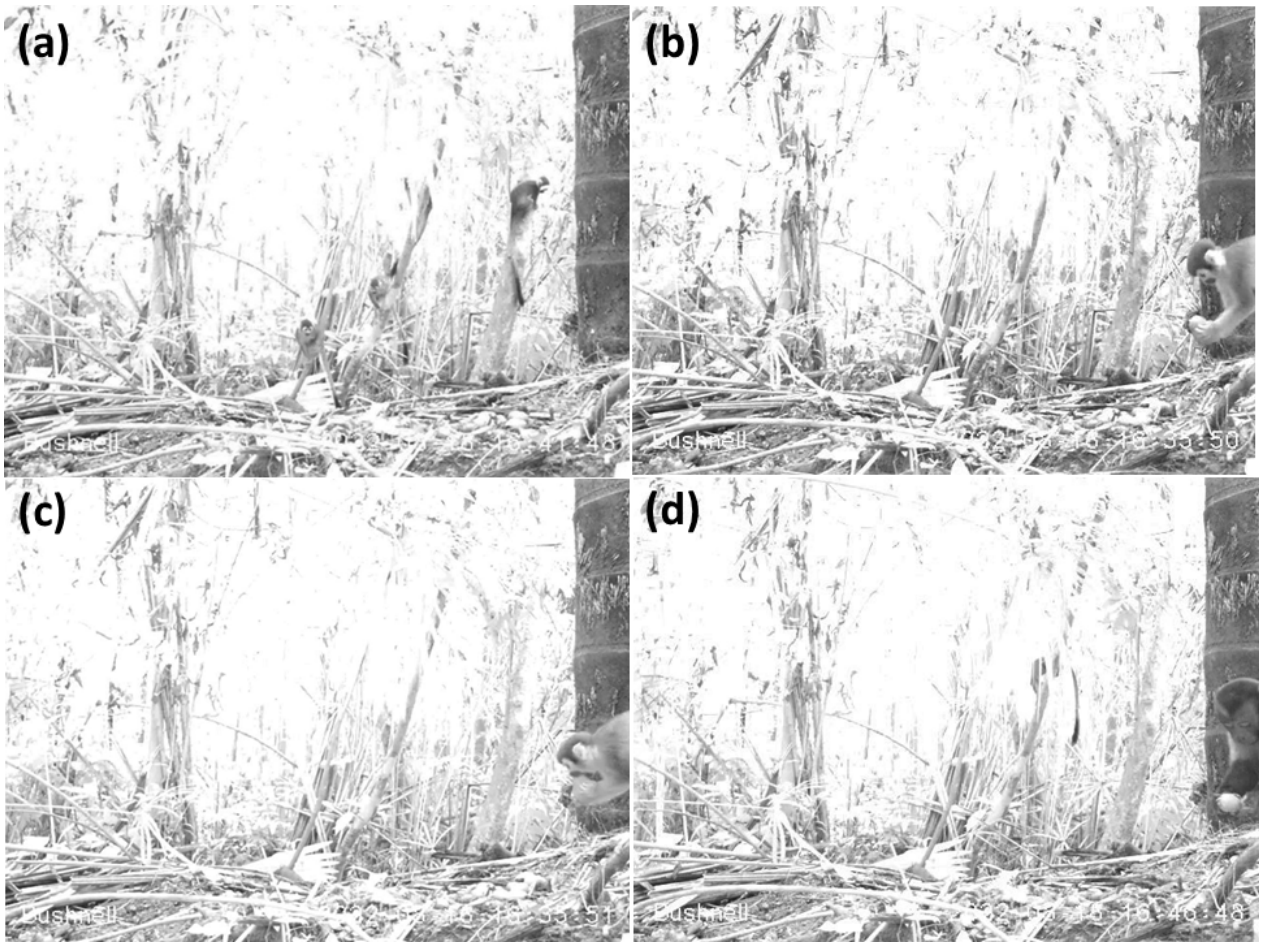

Figure 1. (a) Three squirrel monkeys glancing at aguaje (*Mauritia flexuosa*) fruits on ground. (b) A squirrel monkey inspecting an aguaje fruit. (c) The same individual biting into an aguaje fruit. (d) A robust capuchin monkey inspecting an aguaje fruit.

depredación de semillas de *Mauritia flexuosa* (Arecaceae) en la Amazonía colombiana. *Rev. Biol. Trop.* 64: 5–15.

Aquino, R. and Bodmer, R. E. 2004. Plantas útiles en la alimentación de primates en la cuenca del Río Samiria, Amazonia Peruana. *Neotrop. Primates* 12: 1–6.

Heymann, E. W. and Tirado Herrera, E. R. 2021. Estación Biológica Quebrada Blanco—un sitio poco conocido para investigación en biodiversidad y ecología en la Amazonía peruana. *Rev. Peru. Biol.* 28: e20266.

Heymann, E. W., Tirado Herrera, E. R. and Dolotovskaya, S. 2021. Estación Biológica Quebrada Blanco. *Ecotropica* 23: 202101.

Lima, E. M. and Ferrari, S. F. 2003. Diet of a free-ranging group of squirrel monkeys (*Saimiri sciureus*) in eastern Brazilian Amazonia. *Folia Primatol.* 74: 150–158.

Lopes, J. P., Albuquerque, H., Silva, Y. and Shrimpton, R. 1980. Aspectos nutritivos de alguns frutos da Amazônia. *Acta Amaz.* 10: 755–758.

Mittermeier, R. A. and Van Roosmalen, M. G. M. 1981. Preliminary observations on habitat utilization and diet in eight Suriname monkeys. *Folia Primatol.* 36: 1–39.

Montoya Cepeda, J. and Pérez Torres, J. 2020. Repartición en el uso de los recursos y del espacio de tres especies de primates simpátricos (*Alouatta seniculus*, *Saimiri cassiquiarensis* y *Sapajus apella*) en San Martín, Meta. Tesis de grado. Pontificia Universidad Javeriana, Bogotá, Colômbia.

Pereira Freire, J. A., Barros, K. B. N. T., Lima, L. K. F., Martins, J. M., Araújo, y. de D., da Silva Oliveira, G. L., de Souza Aquino, J. and Pinheiro Ferreira, P. M. 2016. Phytochemistry profile, nutritional properties and pharmacological activities of *Mauritia flexuosa*. *J. Food Sci.* 81: r2611–r2622.

Prada Villalobos, M. and Araujo Bagno, M. 2012. Avian frugivores feeding on *Mauritia flexuosa* (Arecaceae) fruits in central Brazil. *Rev. Brasil. Ornitol.* 20: 26–29.

Rosenberger, A. L. 1992. Evolution of feeding niches in New World Monkeys. *Am. J. Phys. Anthropol.* 88: 525–562.

Soini, P. 1986. A synecological study of a primate community in the Pacaya-Samiria National Reserve, Peru. *Primate Conserv.* 7: 63–71.

Stone, A. I. 2007. Ecological risk aversion and foraging behaviors of juvenile squirrel monkeys (*Saimiri sciureus*). *Ethology* 113: 782–792.

Terborgh, J. 1983. *Five New World Primates: A Study in Comparative Ecology*. Princeton University Press, Princeton, NJ.

van der Hoek, Y., Solas, S. Á. and Peñuela, M. C. 2019. The palm *Mauritia flexuosa*, a keystone plant resource on multiple fronts. *Biodiv. Conserv.* 28: 539–551.
Virapongse, A., Endress, B. A., Gilmore, M. P., Horn, C. and Romulo, C. 2017. Ecology, livelihoods, and management of the *Mauritia flexuosa* palm in South America. *Glob. Ecol. Conserv.* 10: 70–92.

Eckhard W. Heymann and **Sofya Dolotovskaya**, Verhaltensökologie & Soziobiologie, Deutsches Primatenzentrum – Leibniz-Institut für Primatenforschung, Kellnerweg 4, 37077 Göttingen, Germany, E-mail: <eheyman@gwdg.de>.

PREDAÇÃO DE *ICTERUS CROCONOTUS* POR *SAPAJUS CAY*

Odair Diogo da Silva
Thatiane Martins da Costa
Manoel dos Santos Filho
Maria Antonia Carniello
Claumir Cesar Muniz
Almério Câmara Gusmão
Dionei José da Silva

DOI: https://doi.org/10.62015/np.2022.v28.346

Os primatas do gênero *Sapajus* são predadores potenciais em ambientes naturais (Canale et al. 2013). Possuem hábitos alimentares generalista, com grande flexibilidade comportamental (La Salles et al. 2018), exímio consumidor de frutos, flores, vertebrados, incluindo aves, pequenos mamíferos, lagartos e anfíbios (Galetti 1990; Rose, 1997; Ferreira et al. 2002; Rose et al. 2003; Milano e Monteiro-Filho 2009; Palmeira e Pianca 2012). Até mesmo outros primatas compõem sua dieta, conforme relatos disponíveis na literatura, onde foi visto macaco-prego consumindo *Aotus brumbacki*, *Plecturocebus moloch*, *Callithrix jacchus* e *Mico melanurus* (Sampaio e Ferrari 2005; Carretero-Pinzón et al. 2008; Albuquerque et al. 2014; Costa et al. 2020).

Esses primatas são considerados importantes predadores de ninhos de aves (Watts 2020; Lee e Huang 2021). De fato, registros de predação de aves adultas são mais raros que em aves filhotes (Ferreira et al. 2002). Desse modo, nós relatamos no presente estudo um evento de predação de *Icterus croconotus* (João Pinto) por *Sapajus cay* em área de vegetação contígua à Área de Proteção Permanente do rio Paraguai, Pantanal Norte.

O evento ocorreu em mata ripária às margens do rio Paraguai, no município de Porto Estrela, Mato Grosso (15º20'01.95"S, 57º16'04.18"W) (Figura 1). A vegetação da região é predominantemente de Cerrado com enclaves de Floresta Amazônica, caracterizada como a zona de transição em que a província fitogeográfica do Pantanal está comprimida entre os biomas Cerrado e Amazônico (Silva Junior et al. 2019). Segundo Alvares et al. (2014) o clima da região é do tipo Aw (clima tropical úmido e seco, ou de savana). A precipitação média anual é de 1.330 mm, com temperatura variando de 10 ºC em junho a 38º C em dezembro (Resende et al. 1994).

As observações ocorreram de forma oportunística durante atividade de deslocamento a barco no rio Paraguai. Utilizamos um binoculo e uma câmera fotográfica Nikon P610 para o registro.

A identificação cientifica das espécies relacionadas seguiram as ilustrações e diagnoses descritas na literatura, com inferência a distribuição geográfica, onde para *Sapajus cay* utilizamos como base Silva-Junior (2001) e Gusmão et al. (2017). Para identificar o *Icterus croconotus* utilizamos Sigrist (2013) e a plataforma online Wikiaves.

No dia 19 de julho de 2018, às 10h45min foi observado um indivíduo jovem de *Sapajus cay* alimentando-se de um indivíduo adulto de *Icterus croconotus* em uma árvore de aproximadamente 20 m de altura, margem esquerda do rio Paraguai (Figura 2). Durante a observação o jovem de *S. cay* segurou a ave pela região do pescoço enquanto a ave ainda estava se debatendo. O primata iniciou a ingestão da presa pela cabeça, enquanto segurava firmemente a ave pelo pescoço. Em seguida a parte da lateral direita do corpo da ave, sempre intercalado a ingestão de parte da carne da presa com frutos de figueira (*Ficus gomelleira* Kunth). Observamos este comportamento por 23 minutos, até que o primata adentrou à mata levando o resto de sua presa. Durante a observação detectamos outros cinco indivíduos de macacos-pregos na árvore, por sua vez, não houve compartilhamento da presa entre si. Não compartilhamento de presa parece ser comum no grupo, pois em um estudo com *Cebus capucinus* no Parque Nacional de Santa Rosa, Costa Rica, Rose (1997) foi relatado que na predação de vários animais, entre eles aves, o compartilhamento de alimentos é pouco frequente. Os poucos relatos na literatura que tivemos acesso retratou que *S. apella* costumava compartilhar as presas em sua maioria entre adultos, principalmente entre fêmeas, sendo, portanto, mais raro entre jovens (Ferreira et al. 2002).

A forma em que a presa foi consumida foi semelhante ao relatado por Lee e Huang (2021), com a espécie *Sapajus apella* se alimentando de ratos do arroz (*Oecomys* sp.). Os autores descreveram que as presas foram mortas com mordida craniocervical, e a cabeça é a primeira parte ingerida. Essa pode ser uma estratégia para facilitar o abete da preza, dificultando que ela fuja.

Segundo Costa et al. (2020) *Sapajus cay* ocorre em alta abundância nas matas ripárias do rio Paraguai, desse modo, a espécie atua como mesopredador com aspectos generalista na sua dieta (Crooks e Soulé 1999). De fato, durante o período de estudo foi observado a espécie

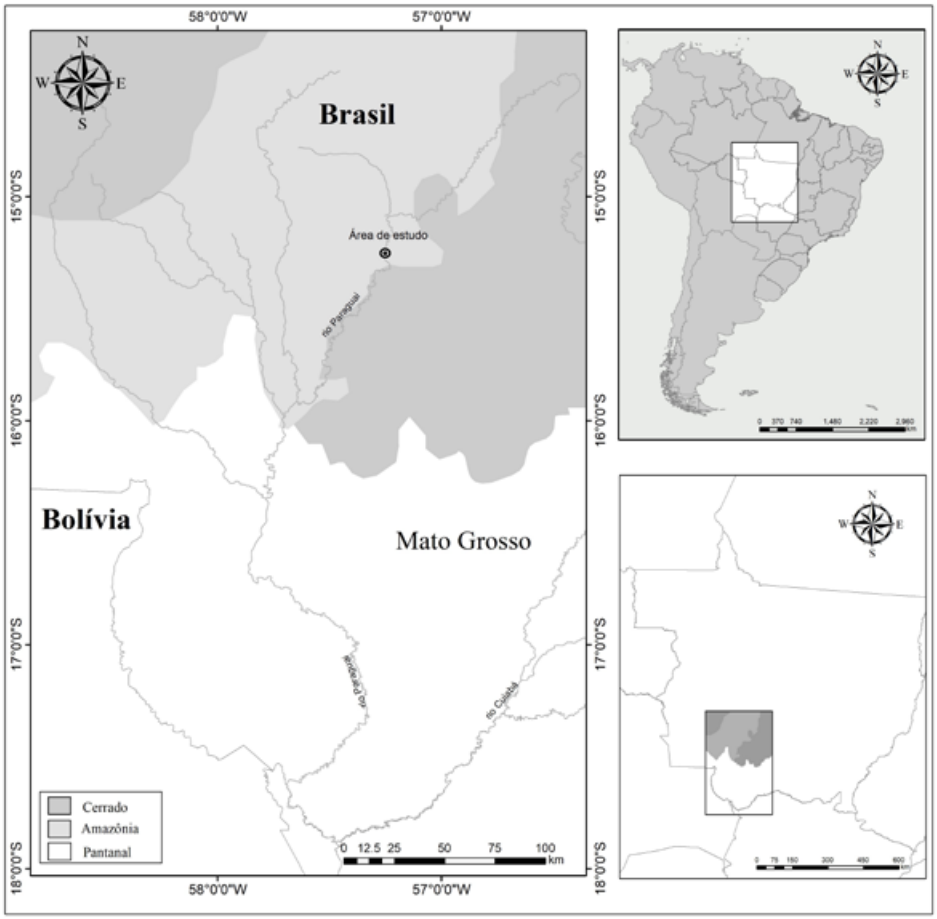

Figura 1. Mapa da área de estudo; círculo negro representa o local da predação no municipio de Porto Estrela, MT.

Figura 2. Jovem de *Sapajus cay* predando *Icterus croconotus* no município de Porto Estrela, MT; A) Vista Frontal; B) Vista lateral. Fotografia de T. M. Costa.

explorando outros recursos disponíveis no ambiente, sobretudo, com o consumo de parte de aguapé (*Eichhornia azurea*) e captura de moluscos em águas rasas do rio Paraguai. É possível que durante o inverno, época de estiagem na região com escassez de alimentos de origem vegetal (flores, frutos, brotos), a espécie passa a compensar sua dieta com fonte de proteína animal (Costa et al. 2020).

Segundo Ferreira et al. (2002) eventos de predação de aves ocorrem de forma muito rápido e silencioso, o que faz que a frequência destes eventos seja subjugadas. Diante disso, o presente estudo contribui para o conhecimento do uso dos recursos disponíveis no ambiente por *Sapajus cay* e a importância da captura das aves para compor sua dieta.

Agradecimentos

À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) pela bolsa de mestrado de ODS, TMC, e de doutorado de ACG; a FAPEMAT (Fundação de Amparo à Pesquisa no Estado de Mato Grosso) pelo financiamento ao projeto Erosão da biodiversidade na bacia do Alto Paraguai – Edital no. 037/2016 – Rede de pesquisa. A toda a equipe de campo do projeto Erosão da Biodiversidade, que nos forneceu suporte e apoio para realização da pesquisa. E aos pescadores, entre eles Jânio que foi de suma importância para a realização do projeto.

Odair Diogo da Silva, Thatiane Martins da Costa, Manoel dos Santos Filho, Maria Antonia Carniello e **Claumir Cesar Muniz**, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Estado de Mato Grosso, Centro de Pesquisa de Limnologia, Biodiversidade, Etnobiologia do Pantanal, Av. Santos Dumont, s/nº – Cidade Universitária (Bloco II), CEP 78200-000, Cáceres, Mato Grosso. Email: <odair_diogo@hotmail.com>, **Almério Câmara Gusmão**, Programa de Pós-Graduação em Rede Bionorte, Universidade do Estado de Mato Grosso (UNEMAT). **Dionei José da Silva**, Universidade do Estado de Mato Grosso, Cáceres, Mato Grosso. Programa de Pós-Graduação em Ciências Ambientais, Universidade do Estado de Mato Grosso, Centro de Pesquisa de Limnologia, Biodiversidade, Etnobiologia do Pantanal, Av. Santos Dumont, s/nº – Cidade Universitária (Bloco II), CEP 78200-000, Cáceres, Mato Grosso.

Referências

Albuquerque, N. M., Silvestre, S., Cardoso, T. S. e Ferrari, S. F. 2014. Capture of a common marmoset (*Callithrix jacchus*) by a capuchin monkey (*Sapajus* sp.) in the Ibura National Forest, Sergipe (Brazil). *Neotrop. Primates* 21(2): 219–221. https://doi.org/10.1896/044.021.0216.

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Moraes, G., Leonardo, J. e Sparovek, G. 2014. Köppen's climate classification map for Brazil. *Meteorol. Z.* 22: 711–728.

Canale, G. R., Freitas, M.A. e Andrade, L. L. 2013. Predation of lizards by a critically endangered primate (*Sapajus xanthosternos*) in a tropical biodiversity hotspot in Brazil. *Herpetology Notes* 6: 323–326.

Carretero-Pinzón, X., Defler, T. R. e Ferrari, S. F. 2008. Observation of black-capped capuchins (*Cebus apella*) feeding on an owl monkey (*Aotus brumbacki*) in the Colombian llanos. *Neotrop. Primates* 15(2): 62–63. http://dx.doi.org/10.1896/044.015.0210

Costa, T. M., Silva, D. J., Carniello, M. A., Muniz, C. C., Gusmão, A. C., Silva-Diogo, O., Silva-Alves, V. D. e Santos-Filho, M. 2020. Predação oportunística de *Mico melanurus* (Primates, Callitrichidae) por *Sapajus cay* (Primates, Cebidae) em ecótono entre o Pantanal e a Amazônia. *Oecol. Aust.* 24(1):179–184. https://doi.org/10.4257/oeco.2020.2401.15

Crooks, K. e Soulé, M. E. R. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. *Nature* 400: 563–566.

Galetti, M. 1990. Predation on the squirrel *Sciurus aestuans* by capuchin monkeys, *Cebus apella*. *Mammalia* 54: 152–154.

Ferreira, R., Resende, B. D., Mannu, M., Ottoni, E. B. e Izar, P. 2002. Bird predation and prey-transfer in brown capuchin monkeys (*Cebus apella*). *Neotrop. Primates* 10(2): 84–89.

Gusmão, A. C., Oliveira, R., Silva-Diogo, O., Melo, F. R. e Santos-Filho, M. 2017. An extension of the known geographic distribution of *Sapajus cay* (Illiger, 1815), (Primates, Cebidae) in southwestern Brazilian Amazonia. *Check List* 14(1): 11–14. https://doi.org/10.15560/14.1.11.

La Salles, A. Y. F. Carreiro, A. N., Medeiros, G. X., Muniz, J. A. P. C. e Menezes, D. J. A. 2018. Aspectos biológicos e comportamentais de *Sapajus libidinosus*: revisão. *Pubvet* 12(1): 1–13. http://ojs.pubvet.com.br/index.php/revista/article/view/1198.

Lee, A. e Huang, M. 2021. Oropendola nest predation and rodent consumption by the black-capped capuchin (*Sapajus apella*) in the Manu Biosphere Reserve, Peru. *Neotrop. Primates* 27(1): 30–33.

Milano, M. Z. e Monteiro-Filho, E. L. 2009. Predation on small mammals by capuchin monkeys, *Cebus cay*. *Neotrop. Primates* 16(2): 78–80.

Palmeira, F. B. L. e Pianca, C. C. 2012. Predation attempt on a roadkilled brown-eared woolly opossum (*Caluromys lanatus*) by a black-horned capuchin (*Sapajus nigritus*). *Neotrop. Primates* 19(1): 36–38. https://doi.org/10.1896/044.019.0107.

Resende, M. S., Sandanielo A. e Couto E. G. 1994. Zoneamento agroecológico do sudoeste do estado de Mato Grosso. Documentos 4. EMPAER/EMBRAPA.

Rose, L. 1997. Vertebrate predation and food-sharing in *Cebus* and *Pan*. *Int. J. Primatol.* 18: 727–765.

Rose, L. M., Perry, S., Panger, M. A., Jack, K., Manson, J. H., Gros-Louis, J., Mackinnon, K. C. e Vogel, E. 2003. Interspecific interactions between *Cebus capucinus* and

other species: data from three Costa Rican sites. *Int. J. Primatol*. 24(4): 759–796.

Ruaro, R., Alves, G. H. Z., Tonella, L., Ferrante, L. e Fearnside, P. M. 2022. Loosening of environmental licensing threatens Brazilian biodiversity and sustainability. *Erde* 153: 60–64.

Sampaio, T. D. e Ferrari, S. F. 2005. Predation of an infant titi monkey (*Callicebus moloch*) by a tufted capuchin (*Cebus apella*). *Folia Primatol*. 76: 113–115.

Sigrist, T. 2013. *Guia de Campo Avis Brasilis Avifauna Brasileira: Descrição das Espécies*. pp. 506. Avis Brasilis Editora, Vinhedo, São Paulo, Brasil.

Silva-Junior, J. S. 2001. Especiação nos macacos-prego e caiararas, gênero *Cebus* Erxleben, 1777 (Primates, Cebidae). Tese do Doutoramento, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil.

Silva-Junior, C. A., Costa, G. M., Rossi, F. S., Vale, J. C. E., Lima, R. B., Lima, M., Oliveira-Junior, J. F., Teodora, P. E. e Santos, R. C. 2019. Remote sensing for updating the boundaries between the Brazilian Cerrado-Amazonia biomes. *Environ. Sci. Policy* 101: 383–392. https://doi.org/10.1016/j.envsci.2019.04.006

Watts, D. P. 2020. Meat eating by nonhuman primates: a review and synthesis. *J. Hum. Evol.* 149: 102882.x

News

VI FIELD COURSE ON METHODS TO STUDY PRIMATES IN PANAMA

A field course called "Training course of primatological methods in Panama" has been held at the Chucantí Private Natural Reserve (CPNR), Darien province, Panamá to study and conserve the Darien black spider monkey (*Ateles fusciceps rufiventris*), a Critically Endangered species that have been monitored by the Fundación Pro-Conservación de los Primates Panameños (FCPP) since 2009 to the present. Every year since 2016 to the present we put out a call for Panamanian students interested to learn about primatology and basic techniques to keep track of *A. f. rufiventris*, *Alouatta palliata aequatorialis*, *Cebus imitator*, and *Saguinus geoffroyi*, all inside the CPNR, the highest point of the Majé Mountain Chain, one of the most suitable habitats for primates in Panama, according to new MaxEnt data on Panamanian primates' distribution evaluation (Méndez-Carvajal, 2019). The course was held from January 23 to 27, 2023, organized by FCPP together with the Primatological Research Group of the University of Panama (GIP-UP) and the Thematic Group of Primatology from the Mesoamerican Society for the Biology and Conservation (GIT Primates Meso-SMBC). This course is now offered to Mesoamerican students as well, so far with participation from Guatemala and Honduras. The course was supported by a grant from Margot Marsh Biodiversity Foundation, the Primate Action Fund and Re:wild. The field course was directed by Pedro Méndez-Carvajal and Karol M. Gutiérrez-Pineda. 10 students including two rangers from CPNR participated. Activities carried out during the field course included:

- Use of compass, GPS, and map, and how to calculate distances;
- Basic statistics applying to research in the field (including use of R);
- Use of QGis program;
- Methods to detect primates and calculate densities (Transects, Listening posts);
- Development of a small project in the field;
- Use of Orion Camera System (OCS) and how to install and review camera traps;
- Behaviour methods (*Ad-libitum*, Focal and Scan Sampling);
- Project presentations (Scientific method); and
- Filming primates in the field.

The course provided an opportunity to become familiar with the problems associated with primatological field studies and also gathered information related to primate conservation problems.
https://www.youtube.com/watch?v=g8ao6ygV_VQ

VI CURSO DE CAMPO SOBRE MÉTODOS DE ESTUDIO DE PRIMATES EN PANAMÁ

Se llevó a cabo un curso de campo en la Reserva Natural Privada Cerro Chucantí (RNPC), provincia de Darién, Panamá, el "VI Curso de Capacitación en Métodos Primatológicos en Panamá" para estudiar y conservar al mono araña negro de Darién (*Ateles fusciceps rufiventris*), una especie en Peligro Crítico que ha sido monitoreada por la Fundación Pro-Conservación de los Primates Panameños (FCPP) desde 2009 hasta la actualidad. Todos los años desde 2016 a la fecha convocamos a estudiantes panameños interesados en aprender sobre primatología y técnicas básicas para realizar un seguimiento de *A. f. rufiventris*, *Alouatta palliata aequatorialis*, *Cebus imitator* y *Saguinus geoffroyi*, en la RNPC, punto más alto de la Cordillera del Majé, uno de los hábitats más adecuados para primates en Panamá, según nuevos datos de MaxEnt sobre evaluación de distribución de primates panameños (Méndez-Carvajal, 2019). El curso se realizó del 23 al 27 de enero de 2023 organizado por la FCPP, el Grupo de Investigación de Primatología de la Universidad de Panamá (GIP-UP), y el Grupo de Interés Temático de Primates Mesoamericanos de la Sociedad Mesoamericana para la Biología y la Conservación (GIT Primates Meso-SMBC). Esta vez, abierto también para estudiantes mesoamericanos, con la participación de Guatemala y Honduras. El curso fue apoyado por una subvención de la Margot Marsh Biodiversity Foundation, Primate Action Fund y Re:wild. El curso de campo estuvo a cargo de Pedro Méndez-Carvajal y Karol M. Gutiérrez-Pineda. Participaron 10 estudiantes, incluidos dos guardaparques del RNPC. Las actividades realizadas durante el curso de campo incluyeron:

- Uso de brújula, GPS y mapa, cómo calcular distancias;
- Estadísticas básicas que se aplican a la investigación en el campo (incluido el uso de R);
- Uso del programa QGis;
- Métodos para detectar primates y calcular densidades (Transectos, Puestos de escucha);
- Desarrollo de un pequeño proyecto en campo;
- Uso del Sistema de Cámara Orión (OCS) y cómo instalar y revisar cámaras trampa;
- Métodos de comportamiento (Ad-libitum, Focal y Scan Sampling);
- Presentaciones de proyectos (método científico); and
- Filmación de primates en el campo.

El curso brindó la oportunidad de familiarizarse con los problemas asociados con los estudios de campo primatológicos y también agregó información relacionada con los problemas de conservación de primates.
https://www.youtube.com/watch?v=g8ao6ygV_VQ

Pedro G. Méndez-Carvajal, Fundación Pro-Conservación de los Primates Panameños (FCPP) (FCPP), 0816-05855, Panama. mendezp@fcprimatespanama.org
Professor, Department of Physiology and Animal Behavior, Biology School, University of Panama, and Coordinator of Grupo de Investigación de Primatología de la Universidad de Panamá (GIP-UP).

Karol M. Gutiérrez-Pineda, Fundación Pro-Conservación de los Primates Panameños (FCPP) (FCPP), 0816-05855, Panama. gutierrezpinedakm@gmail.org
Professor, Department of Organic Chemistry, University of Panama, and Coordinator of Grupo de Interés Temático de Primates Mesoamericanos, Sociedad Mesoamericana para la Biología y la Conservación (GIT-Primates Meso-SMBC).

Recent Publications

BOOKS

Primates in Anthropogenic Landscapes: Exploring Primate Behavioural Flexibility Across Human Contexts, edited by McKinney T, Waters S, & Rodrigues MA. Springer Nature 359pp. 2022. ISBN: 978-3031117350. This text aims to review the recent literature with regard to studies of primates in human-altered landscapes, including Human Influences on Primate Habitat, Primates in Human-Dominated Landscapes, and Primates in Captivity. *Contents:* 1) Introduction – Rodrigues M et al; 2) Consequences of habitat loss and fragmentation for primates behavioral ecology – Ramsay et al; 3) The emerging importance of regenerating forest for primates in anthropogenic landscapes – Millington et al; 4) Hunting of primates in the tropics: Drivers, unsustainability and ecological and socio-economic consequences – Koné et al; 5) Dogs, primates and people: a review – Waters et al; 6) Climate change impacts on non-human primates: What have we modelled and what do we do now? – Winder et al; 7) Community based strategies to promote primate conservation in agricultural landscapes: lessons learned from case studies in South America – Abondano et al; 8) Primates in the urban mosaic: terminology, flexibility and management – Thatcher et al; 9) Infectious diseases in primates in human-impacted landscapes – Ramon et al; 10) Primate conservation in shared landscapes – Besacola et al; 11) Primate tourism – Friis M, et al; 12) Shared ecologies, shared futures: using ethnoprimatological approach to study human-primate interfaces and advance the sustainable coexistence of people and primates - Riley et al; 13) Perspectives on the continuum of wild to captive behaviour – Rodrigues et al; 14) The past, present and future of the primate pet trade – Alexander et al; 15) Rescue, rehabilitation and reintroduction – Speiran et al; 16) Through the looking glass: effects of visitors of primates in zoos – Edes & Hall; 17) Primate portrayals: Narratives and perceptions of primates in entertainment – Aldrich et al; 18) Conclusion: twenty-first-century primatology – Rodrigues et al.

The Natural History of Primates: A Systematic Survey of Ecology and Behavior, edited by Sussman RW, Hart D & Colquhoun IC. Rowman & Littlefield Publishers, 698pp, 2022. ISBN: 978-1442248991. This book offers the most current information on wild primates in their natural environments providing information on how groups of social primates interact with each other and with their ecosystems, their diet, predators, reproductive behaviour, parental care, visual and vocal communication, their ability to craft and use tools, and the varieties of locomotion they employ. This book is not only the first new primatology text available in a decade, but also it is the first reference book covering all primate taxa. Twenty-four chapters combine the latest in-depth findings on ecology, behaviour, and conservation from primatologists who have studied primates in the wild.

Nonhuman Primate Welfare, edited by Robinson LM & Weiss A, Springer, 684 pp. 2023. ISBN: 978-3030827076. This volume encompasses the broad topic of welfare in nonhuman primates under human care, describing the history of primates in captivity, ethical and legal issues surrounding the use of nonhuman primates as entertainment or in research, the different approaches to how welfare is measured, and how housing, enrichment, and other conditions can foster or degrade welfare. *Contents:* The history of primates in Zoos – Hosey G; The history of chimpanzees in biomedical research - Turnes PV; Using primates in captivity: research, conservations and education – Prescott MJ; The welfare of primates in zoos – Baker KR et al; Welfare of primates in laboratories: opportunities for refinement – Buchanan-Smith A et al; The welfare of primates kept as pets and entertainers – Hevesi R; Primates under human care in developing countries: examples from Latin America – Ferreira RG, et al; Using behaviour to assess primate welfare – Lutz CK & Baker KC; Cognitive bias tasks: a new set of approaches to assess welfare in nonhuman primates – Betchell EJ & Pfefferle D; Physiological measures of welfare - Capitano JP et al; Questionnaires and their use in primate welfare – Gartner MC; Meeting cognitive, behavioural and social needs of primates in captivity – Talbot CF et al; Primate breeding colonies: colony management and welfare –Ha JC & Sussman AF; Common husbandry, housing and animal care practices – Coleman K et al; Housing and husbandry for primates in zoos – Farmer HL et al; Humane endpoints and end of life in primates used in laboratories – Wolfensohn S; Primate personality and welfare – Robinson LM & Weiss A; Sociality, health and welfare in nonhuman primates – Beisner BA et al; Research benefits of improving welfare in captive primates – Schapiro SJ & Hau J; Enrichment – Kemp C; Challenging cognitive enrichment: examples from caring for the chimpanzees in the Kumamoto Sanctuary, Japan and Bossou, Guinea

– Morimura N; Training research primates – Bloomsmith M et al; Arguments against using nonhuman primates in research – Bailey J; The indispensable contribution of nonhuman primates to biomedical research – Treue S & Lemon R; An unexpected symbiosis of animal welfare and clinical relevance in a refined nonhuman primate model of human autoimmune disease – Hart BA et al; Animal welfare, animal rights, and a sanctuary ethos – Gruen L & Fleury E; The welfare impact of regulations, policies, guidelines, and directives and nonhuman primate welfare – Bayne K et al.

ARTICLES

Amendoeira M. R. R, Arruda I. F., Moreira S. B, Ubiali D. G., Barbosa A. S., Pena H. F. J., Pereira A. H. B., Raso N. S., Bonifácio T. F., Clemes Y. S., Pissinatti T. A., Santos A. F. A. and Pissinatti A. 2022. Isolation and genetic characterization of *Toxoplasma gondii* from a captive black-and-gold howler monkey (*Alouatta caraya* Humboldt, 1812) in Brazil. *Int. J. Parasitol – Paras & Wildlife* 19: 187–190.

Araújo A. C. L., Bezerra B. M., Lima I. M. S., Oliveira-Silva L. B., da C. Campêlo A. and Souza-Alves J. P. 2022. Plant community and native primate as drivers of habitat use by an exotic primate (*Saimiri* spp. Linnaeus, 1758) in an Atlantic Forest fragment. *J. Trop. Ecol.* 38(5): 322–330.

Azofeifa Rojas I., Gregory T. 2022. Canopy bridges: preventing and mitigating anthropogenic impacts on mantled howler monkeys (*Alouatta palliata palliata*) in Costa Rica. *Folia Prim.* 93: 383–395.

Bahadian Moreira S., Barbosa Pereira A. H., de Abreu Pissinatti A., Falco Arruda I., Miguel de Azevedo F. R., Bittencourt Schiffler F., Reis Amendoeira M. G., Andrade dos Santos A. F., Pissinatti A. and Guimarães Ubiali D. 2022. Subacute multisystemic toxoplasmosis in a captive black-and-gold howler monkey (*Alouatta caraya*) indicates therapy challenging. *J. Med. Prim.* 51(6): 392–395.

Bolt L. M, Hadley C. M., Schreier A. L. 2022. Crowded in a fragment: high population density of Mantled Howler Monkeys (*Alouatta palliata*) in an anthropogenically disturbed Costa Rican rainforest. *Prim. Cons.* 36: 37–44.

Bolt L. M., Russell D. G. and Schreier A. L. 2022. River edge feeding: howler monkey feeding ecology in a fragmented riparian forest. *Folia Prim.* 94(1): 1–11.

Brasington L. F., Kulick N. K., Hogan J.D., Fedigan L. M. and Jack K. M. 2022. The impact of alpha male replacements on reproductive seasonality and synchrony in white-faced capuchins (*Cebus imitator*). *Am. J. Biol. Anthropol.* 179(1): 60–72.

Buss G., Ludwig G., Beltrão-Mendes R., Valença-Montenegro M. M., Branquinho Martins A. and Chein Alonso, A. 2022. Installation and monitoring of a canopy bridge connecting Atlantic Forest fragments containing endangered species in Northeastern Brazil. *Folia Prim.* 93: 493–505.

Cáceres N., Cerezer F. O. and Bubadué J. 2022. Size reduction and skull shape parallelism following the evolutionary forest-to-savanna transition in Platyrrhini monkeys. *Am. J. Prim.* 84(12): e23447.

Camboim Franceschi I., Terra Dasoler B., Menger T., Kindel A., Almeida da Silva F., Gonçalves Leonardo J. C., Miranda Braga R. and Zimmermann Teixeira F. 2022. Monitoring the use of a canopy bridge and underpasses by arboreal mammals on a Brazilian coastal road. *Folia Prim.* 93: 507–518.

Cárdenas-Navarrete A. and Van Belle S. 2023. Birth of a wild black howler monkey (*Alouatta pigra*) at an anthropogenic site. *Primates* 64(1): 17–23.

Chalk-Wilayto J., Dutra Fogaça M., Wright B. W., van Casteren A., Fragaszy D. M., Izar P., Visalberghi E., Strait D. S., Ross C. F,. Wright K. A. and Laird M. F. 2023. Effects of food material properties and embedded status on food processing efficiency in bearded capuchins. *Am. J. Biol. Anthropol.* 178(4): 617–635.

Costa-Araújo R., Gonçalves da Silva L., Rodrigues de Melo F., Vieira Rossi R., Bottan J. P., Silva D. A., Oliveira do Nascimento F., Pessoa da Silva F., Buss G., Lima-Silva L. G., Ferreira da Silva L., Fialho M., de Lázari M. R., Suertegaray Rossato R., Lumi Vendramel R., Braga de Mendonça R. F., Sampaio R., Hrbek T., Macedo de Alencar R., de Sousa, Silva Junior J. and Rodrigues Canale G . 2022. Primate conservation in the Arc of Deforestation: a case study of Vieira's titi monkey *Plecturocebus vieirai*. *Oryx* 56(6): 837–845.

da Silva W. B., de Souza Teixeira A. L., Guimarães Oliveira K., Nunes Gonzaga C., Moreira de Souza A. and Pereira Almosny, N. R. 2022. Lipid profile, apolipoproteins A-1 and B in owl monkeys (*Aotus infulatus*) in captivity. *J. Med. Prim.* 51(6): 367–373.

de La Salles A. Y. F., de Andrade J. K., de Souza J. G., de B. Freitas K., da N. Carreiro A., Veloso E. V. L., Rocha E. F., Klem M. A. P., Câmara F. V. and de Menezes, D. J. A. 2022. Osteology applied to image diagnosis of the forelimb of the black-striped capuchin (*Sapajus libidinosus* Spix, 1823). *Am. J. Prim.* 84(11): e23433.

Dias P. A. D. and Coyohua-Fuentes A. and Rangel-Negrín A. 2023. Demography and life-history parameters of mantled howler monkeys at La Flor de Catemaco: 20 years post-translocation. *Primates* 64(1): 143–152.

Dias, P. A. D. and Rangel Negrín A. 2022. One step forward, two steps backward: the frailty of howler monkey conservation in Los Tuxtlas, Mexico. *Am. J. Prim.* 84(11): e23437.

Falótico T. 2002. Vertebrate predation and tool-aided capture of prey by savannah wild Capuchin Monkeys (*Sapajus libidinosus*). *Int. J. Prim.* 44: 9–20.

Felippi D. A., Franco P. N., Bonatelli S. P., Pereira da Silva J., Yunes Guimarães V., Santos Breda M. R., Pagani R., dos Santos B., Takahira R. K. , Canevese Rahal S. and Mamprim, M. J. 2023. Prevalence of cholelithiasis

in lion tamarins (*Leontopithecus* spp.) kept under human care by using abdominal ultrasound. *J. Med. Prim.* 52(1): 17–23.

González-Ruiz M., Cervantes F. A., Mondragón-Ceballos R. 2022. Social networks and tolerance differences associated to grouping patterns in *Ateles geoffroyi*. *Folia Prim.* 94(1): 51–72.

Gregory T., Carrasco-Rueda F., Balbuena D. and Kolowski J. 2022. Rush hour: arboreal mammal activity patterns in natural canopy bridges in the Peruvian Amazon. *Folia Prim.* 93: 465–477.

Guimarães V. Y., Sousa Zanoni D., Fonseca Alves C. E., Laufer Amorim R. and Takahira R. K. 2022. Immunohematological features of free-living *Alouatta belzebul* (Linnaeus, 1766) red-handed howler monkeys in the Eastern Amazon. *Primates* 63(5): 671–682 .

Hack R. O. E., de Oliveira M. B, Villegas Vallejos M. A, de Melo B. N. L, Eltz J. S and Rodrigues C. B. 2022. Discovery of new populations of Southern Muriquis (*Brachyteles arachnoides*) in Paraná, Brazil, and implications for the species' conservation. *Prim. Cons.* 36: 55–61.

Hawkins E. and Papworth S. 2002. Little evidence to support the risk–disturbance hypothesis as an explanation for responses to anthropogenic noise by Pygmy Marmosets (*Cebuella niveiventris*) at a tourism site in the Peruvian Amazon. *Int. J. Prim.* 43: 1110–1132.

Hernández-Cruz G., Ferreira R.G., Rooney N.J., dos Santos Guidi R., Pereira do Rego R.D., Freire Costa T.S., Klefasz A., Feijó Oliveira W., Conceição, Gaio F., Holanda Duarte N. F., De Forte Viana, V. and Mendl, M. 2022. Haematology, physiological parameters, morphometry and parasitological status of rescued bearded capuchin monkeys (*Sapajus libidinosus*). *J. Med. Prim.* 51(4): 213–222.

Hutschenreiter A., Kalan A. K., Bonilla Moheno M., Morales Mávil J., Mandujano S., Briseño Jaramillo M., Spaan D. and Aureli F. 2022. Spider monkeys (*Ateles geoffroyi*) habituate to anthropogenic pressure in a low-impact Tourism area: insights from a multi-method approach. *Int. J. Prim.* 43: 946–964.

Kruse T. N. and Coke, R. L. 2023. Use of oral chemotherapeutic agent, chlorambucil, as palliative treatment of thryoid adenocarcinoma in a golden-headed lion tamarin (*Leontopithecus chrysomelas*). *J. Med. Prim.* 52(1): 79–82.

Kwak J., Kim J. M., Woo C. G., Kim J. I., Ryu S. K. and Kang, B. C. 2022. Acute aspiration pneumonia in common marmoset (*Callithrix jacchus*) with marmoset duodenal dilation syndrome: a case report. *J. Med. Prim.* 51(4): 253–25.

López L., Aquino R., Guerra-Torres L. N., Francisco, T. M. and Ruiz-Miranda, C. R. 2022. Primates in montane forests of the región Amazonas, Peru: new records and the current situation of *Lagothrix flavicauda* and other primates. *Prim. Cons.* 36: 75–90.

Malaga S. K., de Souza Balbueno M. C., Amâncio Martins J., Swarg T., Mariotti Guerra J., Fernandes N. and Coelho C. P. 2022. First report on herpesvirus in black-fronted titi (*Callicebus nigrifrons*) kept under human care. *J. Med. Prim.* 51(6): 384–387.

Malta A., Caselli C., Souto A., De la Fuente M. F. and Schiel N. 2022. Number of adult females in a group affects infant motor development of a cooperative breeding primate (*Callithrix jacchus*). *Primates* 63(5): 683–689.

Marques dos Santos A., Borba da Silva M., Sousa Prado I., Santos de Antonio E., Teixeira Silva Dourado A. T., Silva Alves B., Belini Nishiyama P., Tomazi L. and Evangelista Fraga R. 2022. Evaluation of Sound Enrichment in the Behavior of *Sapajus xanthosternos* (Wied-Neuwied, 1826) (Primates: Cebidae) in Captivity. *Prim. Cons.* 36: 45–53.

Monroy-Cendales M. J., Vélez-García J. F., Castañeda-Serrano R. D. and Miglino M. A. 2023. Gross anatomical description of the extrinsic and intrinsic scapular and brachial muscles of *Sapajus apella* (Linnaeus, 1758). *J. Med. Prim.* 52(1): 3–16.

Monticelli C., Comassetto Maciel P. and de Oliveira Garcia F. 2022. Rope bridges provide safe connectivity for the southern brown howler monkey (*Alouatta guariba clamitans* Cabrera, 1940) in an urban Atlantic Forest remnant. *Folia Prim.* 93: 519–532.

Moreira L. A. A., Watsa M, Erkenswick G, Higham J. P., Melin A. D. 2023. Evaluating genital skin color as a putative sexual signal in wild saddleback (*Leontocebus weddelli*) and emperor (*Saguinus imperator*) tamarins. *Am. J. Prim.* 85(2): e23456.

Narváez-Rivera G. M. and Lindshield S. M. 2022. Assessing the importance of artificial canopy bridge design for Costa Rican monkeys in an experimental setting. *Folia Prim.* 93: 397–417.

Parente de Carvalho T., Oliveira dos Santos D., Rodrigues Oliveira A., Arthuso Vasconcelos I. M., Penha Tinoco H., Mendes Coelho C., Muniz Carvalho G., Clark Xavier R. G., Silveira Silva R. O., Alves Paixão T. and de Lima Santos R. 2022. Lethal acute diarrhea associated with *Clostridioides difficile* toxin A and B in a buffy-tufted-ear marmoset (*Callithrix aurita*). *J. Med. Prim.* 51(6): 400–403.

Pereira da Silva G., de Souza Pereira T. H., Imbeloni I. A., de Andrade R. S., Dias Neto R. N., Coutinho L. N., Gering A. P., Camara Benarrós M. S., Pereira Junior J. J., Barros Monteiro F. O. and Takeshita R. S. C. 2022. Effect of age and sex in renal function by ultrasound and serum chemistry in two primate species (*Alouatta caraya* and *Sapajus apella*). *J. Med. Prim.* 51(4): 223–233.

Phillips K. A., Lopez M., Salmon A. B., Ross C. N., Abbott D. H. and Capitanio J. P. 2022. Determination of dexamethasone dose for cortisol suppression in adult common marmosets (*Callithrix jacchus*). *J. Med. Prim.* 51(6): 407–41.

Pozzi L., Voskamp M. and Kappeler P. M. 2022. The effects of body size, activity, and phylogeny on primate sleeping ecology. *Am. J. Biol. Anthropol.* 179(4): 598–608.

Raño M., Palazzo M. C., Soliz A., Holzer J. C., Perez D. A., Sánchez E. M., Romero V. L., Sánchez Gavier F. and Kowalewski M. M. 2022. Community participatory action to build a canopy bridge for wild black and gold howler monkeys (*Alouatta caraya*) in northern Argentina. *Folia Prim.* 93: 453–463.

Ribeiro Andrade M. C., Pickler Lemos B. R., de Araújo Lopes C. A., Barbosa Ribeiro M. J., Melo da Silva L., Batalha Knackfuss F. and Fernandes Viana C. 2023. Morphometry of cryopreserved organs from the gastrointestinal system of squirrel monkeys (*Saimiri sciureus*, Linnaeus, 1758) for improvement of management. *J. Med. Prim.* 52(1): 34–44.

Ribeiro de Oliveira P. L., Ramirez Uscategui R. A., Albuquerque Vieira R. L., Souza Queiroz Gondim L., Maronezi M. C. and Rossi Feliciano M. A. 2022. Radiographic study of the axial and appendicular skeleton of *Callithrix jacchus* and *Callithrix penicillata*. *J. Med. Prim.* 51(4): 201–212.

Rodrigues Oliveira A., Ferreira de Castro M., Pinheiro Pimentel S., Parente de Carvalho T., Santana C. H., de Oliveira Santos D., Penha Tinoco H., Mendes Coelho C., Tinoco Pessanha A., Alves da Paixão T. and Lima Santos R. 2022. *Streptococcus pasteurianus*-induced valvular endocarditis and sepsis in a puerperal emperor tamarin (*Saguinus imperator*). *J. Med. Prim.* 51(6): 388–391.

Schreier A. L., Voss K. A. and Bolt L. M.: 2022. Behavioral responses to riparian and anthropogenic edge effects in mantled howler monkeys (*Alouatta palliata*) in a disturbed riverine forest. *Primates* 63(5): 659–670.

Silva Catenacci L., Raboy B. E., Oliveira L., Guidorizzi de Carvalho C. E., Gomes Neves L., Suscke P., Deem S. L., Costa T. and De Vleeschouwer K. M. 2022. Golden-headed lion tamarins, *Leontopithecus chrysomelas* (Kühl, 1820): 27 years of experience in methods for their capture and the collection of biological material. *Prim. Cons.* 36: 23–35.

Silva F. E., Gosi Pacca L., Pereira Lemos L., Câmara Gusmão A., da Silva O. D., Dalponte J. C., Franco C. L. B, Santana M. I., Buss G. and El Bizri H. R. 2022. Using population surveys and models to reassess the conservation status of an endemic Amazonian titi monkey in a deforestation hotspot. *Oryx* 56(6): 846–853.

Spaan D., Ramos-Fernández G. and Aureli F. 2022. Resurveying primate populations: a comparison of methods to monitor change over time. *Prim. Cons.* 36: 15–21.

Spadacenta S., Dicke P. W. and Their P. 2022. A prosocial function of head-gaze aversion and head-cocking in common marmosets. *Primates* 63(5): 535–546.

Spiezio C., Pugassi M., Agrillo C. and Regaiolli B. 2022. Color preference and manual laterality in the emperor tamarin (*Saguinus imperator*). *Am. J. Prim.* 84(10): e23375.

Steinberg D. L., Lynch J. W. and Cartmill E. A. 2022. A robust tool kit: first report of tool use in captive crested capuchin monkeys (*Sapajus robustus*). *Am. J. Prim.* 84(11): e23428.

Vale G. L., Williams L., Webb S. N., Schapiro S. J. and Brosnan SF. 2022. Female squirrel monkeys' (*Saimiri boliviensis*) responses to inequity in a group context; testing a link between cooperation and inequity responses. *Anim. Behav.* 193: 51–62.

Winkler S. L. and Perry S. E. 2022. The development of sex differences in play in wild white-faced capuchins (*Cebus capucinus*). *Am. J. Prim.* 84(11): e23434.

Witczak L. R. and Blozis S. A. and Bales K. L. 2022. Assessing variability in affiliative maintenance behaviours in captive coppery titi monkeys, *Plecturocebus cupreus*. *Anim. Behav.* 191: 117–124.

Zambolli A. H., Manzano M. C. R., Honda L. K, Rezende G. C. and Culot L. 2023. Performance of autonomous recorders to detect a cryptic and endangered primate species, the black lion-tamarin (*Leontopithecus chrysopygus*). *Am. J. Prim.* 85(1): e23454.

Zarate M. A., Shanee S., Charpentier E., Sarmiento Y. and Schmitt C. A. 2023. Expanded distribution and predicted suitable habitat for the critically endangered yellow-tailed woolly monkey (*Lagothrix flavicauda*) in Peru. *Am. J. Prim.* 85(2): e23464.

Zimmermann Teixeira F., Gonçalves da Silva L., Abra F., Rosa C., Buss G., Guerreiro M., Rodrigues Costa E., Souza de Menezes Medeiros A., Gordo M. and Secco H. 2022. A review of the application of canopy bridges in the conservation of primates and other arboreal animals across Brazil, *Folia Prim.* 93: 479–492

ABSTRACTS

Abstracts related to Neotropical primates from the 44th Annual Meeting of the American Society of Primatologists, Denver Colorado, 25 – 28 August 2022.

Arcusa I., Risko G. and Wolovich C. K. Behavioral Responses to Conspecific Urinary Cues in Pair-Living Owl Monkeys (*Aotus nancymaae*).

Arroyo J. P., Hickmott A. J., Greig J., Colman R., Power M. L., Tardif S. D. and Ross C. N. Body Composition, Morphometrics, Physical Activity and Resting Energy Expenditure as Predictors of Mortality in the Common Marmoset (*Callithrix jacchus*).

Boulinguez-Ambroise G. P., Dunham N., Bradley--Cronkwright M., Boyer D. M., Yapuncich G. S., Zeininger A., Schmitt D. and Young J. W. How to Surpass Yourself at Jumping: A Lesson from Zoo-Living Bicolor Tamarins and Goeldi's Monkeys.

de Faria Oliveira G., Ash H., Colman R., Kulkarni P., Gandhi A., Ferris C. F. Processing Olfactory Social Odors by Brain Imaging in Juvenile Common Marmosets: Gender Matters.

de Faria Oliveira G., Ziegler T. E. Social Style as a Predictor of the Neuroendocrine Stress Response in Juvenile Common Marmosets, *Callithrix jacchus.*

Dobson K. M., Carlos-Shanley C., Schapiro S. J., Lambeth S., Keeling M. E. and Burges C. A First Glimpse of the Captive *Saimiri* Gut Microbiome – Preliminary Data.

Jasso-del Toro C., Smith Aguilar S. E., Aureli F., Schaffner C. M. and Ramos-Fernandez G. Maternal Kinship Influences the Association Network Structure in Spider Monkeys (*Ateles geoffroyi*).

Karaskiewicz C. L, Ramirez M., Kacevas K. and Bales K. New Pairs of Captive Titi Monkeys (*Plecturocebus cupreus)* Demonstrate Lower Nighttime Activity Across Their First Week of Pairing.

Lau A. and Bales K. Titi Monkey Responses to Playbacks of Paired and Unpaired Individuals.

Majoral Antich G., Hernandez Monzon O. and Morales-Hernandez R. Social Network Analysis as a Tool for Making Better Management Decisions in Heterogeneous Rescued Spider Monkey (*Ateles geoffroyi*) Groups.

Risko G., Breitenbach R., Ambros S., Durland Donahou A. and Wolovich C. K. The Importance of Auditory, Olfactory, and Visual Cues for Insect Foraging in *Aotus nancymaae.*

Ross C. N., Hickmott A. J., Arroyo J. P. and Colman R. Maternal Characteristics Associated with Infant Survival in Captive Marmosets (*Callithrix jacchus*).

Saldana J., Watzek J. and Brosnan S. F. Capuchin Monkeys and Humans Differ on Sequence Preference Development

Simmons S., Watzek J. and Brosnan S. F. Humans', Capuchin Monkeys' (*Cebus* [*Sapajus*] *apella*), and Rhesus Macaques' (*Macaca mulatta*) Size Judgements Shift When Stimuli Change in Frequency.

Task S., Martínez M., Babb M., Range F. and Brosnan S. F. Capuchin monkeys (*Sapajus* [*Cebus*] *apella*) Show Co-Representation in a Computer-Based Joint .

van der Heide G. and Fernandez-Duque E. How Well Do Potential Owl Monkey (*Aotus azarae*) Food Resources Fit the Resource Distribution "Monogamy Bill"?

Meetings

PSGB SPRING MEETING 2023

The Primate Society of Great Britain spring meeting will be held on 11th and 12th May in Anglia Ruskin University, Cambridge. The conference will consist of speed talks, 15-minute presentations, and poster showings, alongside "meet a mentor" and professional panel discussions. Dr Anthony Rylands and Dr Nicola Koyama as plenary speakers. For more information visit meetings@psgb.org.

45TH MEETING AMERICAN SOCIETY OF PRIMATOLOGISTS

The annual meeting of the ASP will be held in Reno, Nevada June 20-23, 2023. For more information go to https://www.asp.org/asp-meetings/asp-reno-meeting-2023/

IPS - MALAYSIAN PRIMATOLOGICAL SOCIETY JOINT MEETING

The Joint meeting International Primatological Society and the Malaysian Primatological Society in Kuching, Sarawak, Malaysia will take place between August 19 and 25, 2023 and the topic of this meeting is: *Primates and People: A New Horizon*. This will be a hybrid meeting, so you will be able to participate live, in-person in Kuching, or live over the internet, or via recorded presentation. The Early bird registration will be available from December 1, 2022 to March 31, 2023. On time registration runs from April 1, 2023 to August 1, 2023. Check out the https://ipskuching.com/

Notes to Contributors

Scope

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

Contributions

Manuscripts may be in English, Spanish or Portuguese, should be prepared with MS Word, and must use page and line numbering. 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 the language of the manuscript submission should have their manuscripts carefully reviewed by a native speaker. To submit a manuscript on-line, please register at https://primate.socgen.ucla.edu/index.php/multivitaminic/user/register or you can send your contribution to: Jessica Ward Lynch, University of California, Los Angeles, email: jwlynx@g.ucla.edu. Manuscripts that do not conform to the formal requirements (formatting, style of references, etc.) will be returned to authors without review. They can be resubmitted, provided all formal requirements are met.

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). An abstract in the local Indigenous language relevant to the study may also be included. 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 by the editors only. 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 color 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. When reporting geographic coordinates please utilize one of the following formats consistently throughout the manuscript: DMS (degrees, minutes, seconds) standard 4°36'19.1"N, 74°3'20.7"W or DD (Decimal Degrees) 4.605306, -74.055750.

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 information on projects, field sites, courses, theses or dissertations recently defended, recent publications, awards, events, activities of Primate Societies, etc. to Brenda Solórzano brenda_solorzano@yahoo.com.mx.

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
A Journal and Newsletter of the IUCN SSC Primate Specialist Group
Vol. 28(1-2), December 2022

Contents

Articles

Short Articles