

CEBUS UNICOLOR (SPIX, 1823) (CEBIDAE, PRIMATES), A VULNERABLE SPECIES IN AN ANTHROPIZED IGAPÓ FOREST, AÇUTUBA, CENTRAL AMAZONIA, BRAZIL

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Abstract

Cebus unicolor (Spix's white-fronted capuchin, popularly called Cairara in Brazil) has a Central Amazonian distribution, and is classified as Vulnerable by the IUCN. Here we present a study of *C. unicolor* in flooded forest (*igapó*) in Açutuba, municipality of Iranduba, Amazonas, Brazil. The species persists in anthropized *igapó* (coexisting with hunting and timber extraction), present during both flooded and low-water periods. Over 16 months, we conducted a primate census by river transect (136 km) by canoe during flooding and by land transect (68 km) during the low-water period. We recorded eight groups of *C. unicolor* (5.8 ± 2.3 ind), with an average sighting rate of 9.6 ind/km². The main global threat to the species is hunting. In this study, interviews confirmed that primates are hunted by the local community, but that *C. unicolor* was not among those species hunted. Habitat loss, fragmentation, and fire are the greatest regional threats, driven by logging and unplanned/uncontrolled human occupation. To mitigate these effects, educational measures are needed on the importance of primates and the conservation of flooded forests, as well as generation of employment and income through observation and contemplation tourism.

Keywords: Cebidae, conservation, ecology, ecotourism, flooded forest

Resumo

Cebus unicolor (Cairara) é um primata com distribuição na Amazônia Central, e classificado como Vulnerável pela IUCN e desconhecido. Apresentamos um estudo pontual de *C. unicolor* em floresta inundada (*igapó*), em Açutuba, município de Iranduba, Amazonas, Brasil. A espécie ainda persiste em uma área de *igapó* antropizado (com caça e extração de madeira), ocupando-o nos períodos de cheia e vazante dos rios. Durante 16 meses, realizamos o censo de primatas, por transecto fluvial (136 km) de canoa no período de cheia e por transecto terrestre (68 km) durante a vazante. Registramos oito grupos de *C. unicolor* ($5,8 \pm 2,3$ ind), com taxa média de avistamento de 9,6 ind/km². A principal ameaça global à espécie é a caça. Neste estudo, as entrevistas confirmaram que primatas são caçados pela comunidade local, entretanto, *C. unicolor* não estava entre as espécies caçadas. A perda de habitat, a fragmentação e o fogo são as maiores ameaças regionais, impulsionadas pela exploração madeireira e ocupação humana desordenada. Para mitigar tais efeitos, são necessárias medidas educativas sobre a importância dos primatas e da conservação das florestas alagadas, além de geração de renda através do turismo de observação e contemplação.

Palavras-chave: Cebidae, conservação, ecologia, ecoturismo, florestas alagadas

Introduction

The genus *Cebus* (Erxleben, 1777), of the family Cebidae, includes species that occur in Central America, the Andes and the Amazon. Across Amazônia, seven species are found: *Cebus albifrons* (Humboldt, 1812), *C. castaneus* (I Geoffroy, 1851), *C. cuscinus* (Thomas, 1901), *C. kaapori* (Queiroz, 1992), *C. olivaceus* (I Geoffroy, 1851), *C. unicolor* (Spix, 1823), and *C. yuracus* (Hershkovitz, 1949) with distributions described in Spironello and colleagues (2023). Some publications (e.g., Barnett et al., 2002, 2011, 2023; Ginani et al., 2021) consider the white-fronted

capuchin monkey that inhabits the Negro-Solimões interfluvium to be *Cebus albifrons* (Humboldt, 1812; Defler and Hernandez-Camacho, 2002). However, based on genetic analyses Boubli et al. (2012) propose that *Cebus unicolor* (Spix, 1823) should be used for the *Cebus* populations present in this region. We follow Boubli et al. (2012, 2021) in the current study.

Cebus unicolor weighs up to about 3.1 kg and has a head-body length of 37 cm and a tail length of 45 cm (dos Reis et al., 2015). It is native to the Amazon Basin and is found in Brazil, Colombia, and Venezuela (Spironello

et al., 2023). The species is classified as Vulnerable by the IUCN, with population decline principally due to hunting (Boubli et al., 2021); habitat loss and forest fragmentation are also threats. Like other species of the genus *Cebus*, it occupies a wide variety of habitat types throughout its extensive range, including dry forest, flooded forest (*igapó* and *várzea*), and savanna (Defler, 1985). There are no population data for the species, but considering other species of the same genus, they are quite variable, with reported group sizes ranging from 5 to 35 individuals, home ranges from 120 to 534 ha, and densities from 2.8 to 35.0 ind/km² (Defler, 1979, 1982; Terborgh, 1983; Iwanaga, 2004; Matthews, 2009; Jack and Campos, 2012). The genus *Cebus* is omnivorous, with a wide variety of diet items reported: fruits, arthropods (including larvae) and vertebrates (frogs, lizards and small mammals), leaves, seeds and eggs (insects, birds and turtles) (Defler, 1979; Terborgh, 1983; Defler and Hernández-Camacho, 2002; Gentil et al., 2021; Barnett et al., 2023); it is also considered an important seed disperser (Whencke and Dominguez, 2007).

As there are few studies of *Cebus unicolor*, the present study aims to provide information, albeit limited, on the natural history and ecology of this species, including its use of *igapó*, group size, population density, fruits used for consumption, use of the ground for foraging, and persistence in an anthropized area of an *igapó* forest in the central region of the Brazilian Amazon.

Materials and Methods

Study Area

The study was conducted at Açutuba (3°05'S, 60°18'W), an 1840 ha area of *igapó* forest within Iranduba municipality, Amazonas state, in central Amazonian Brazil. Açutuba is an area of human-impacted *igapó*, lying 25 km west of the state capital Manaus, on the right (southern) bank of the Rio Negro (Fig. 1).

Since the 1980s, the landscape surrounding Açutuba *igapó* has experienced drastic forest cover reduction. Natural vegetation decreased from 77.3% to 21.4% between 1980 and 2021, with only 13,209 ha of forest remaining south of Iranduba (FVA, 2014). The remaining forest is found as isolated fragments, of which only three are larger than 1000 ha, including the 2286 ha study area of which 1840 ha (80.5%) is *igapó* (FVA, 2014).

Field Study

A census of *Cebus unicolor* was conducted as part of a larger study on primates of the Açutuba area (Rocha et al., 2024). Primate censuses were carried out using six trails, line transects (Peres and Cunha, 2011) in *igapó*, for the 16 months from January 2015 to April 2016 (Rocha et al., 2024). Survey trails ranged from 1.1 to 3.5 km in length and totaled 14 km (Fig. 1). Distances from the

mainland varied from 0 to 1000 m. As the habitat floods seasonally, methodology varied with the flood-pulse, with censuses conducted on foot during the low-water season, and by canoe during flooded periods, following Barnett (2010). Each transect was sampled twice per trail month in the flooded season, and once per month in the unflooded season, for 1-2 trails per day, for a total of 240 km traversed in a single year. At Açutuba, the *igapó* includes: 1) *Low Igapó*, characterized by herbaceous-shrubby species, normally present at forest edges, in natural clearings and in impacted areas; 2) *Medium Igapó*, with tree species up to 20m in height, and 3) *High Igapó*, with trees > 20 m in height and DAP ≥ 5 m (Rocha, 2017). Whenever there was visual or auditory contact, we recorded behavioral activity *ad libitum* (Altmann, 1974), including any food resources being consumed and the height of the *igapó* and the strata occupied within the forest for each primate sighting record (Kasecker, 2006).

To acquire information on human-primate interactions in the local area, we interviewed knowledgeable community members, following methods used by other ethnoprimate studies (Fuentes, 2010), including the “snowball” method when selecting informants (Davis and Wagner, 2003; dos Santos et al., 2020; Rocha et al., 2024). In the current study, informants were *igapó* residents, people who fish, hunt and gather and use, and have contact with the flooded forest daily. As described in Rocha et al. (2024), we carried out semi-structured interviews with these informants, using a combination of questions and images of primates to enable species recognition and confirmation and, at the same time, test the informants' knowledge of Amazonian primates. Of the 63 interviews obtained, 60 were used, with three interviewees excluded because they provided unrealistic information (citing the occurrence of primates from other biomes), so showing lack of local primate knowledge.

We also used six camera traps during the dry season, which lasts four months in the region, with the aim of recording primates searching for fallen fruit foraging on the ground.

Results and Discussion

In the Açutuba *igapó*, over the 16-month period we recorded eight groups of *Cebus unicolor* (Fig. 1). Six additional primate species were also observed: *Alouatta juara* (Elliot, 1910), *Aotus vociferans* (Spix, 1823), *Cacajao ouakary* (Spix, 1823), *Pithecia chryscephala* (I. Geoffroy, 1850), *Saimiri cassiquiarensis* (Lesson, 1840) and *Sapajus macrocephalus* (Spix, 1823) (see Rocha et al., 2024 for more details). Compared to studies of *Cebus* in lightly impacted *igapó* the average size of *C. unicolor* groups in anthropized *igapó* (5.8 ± 2.3 ind.) was similar to the data found by Iwanaga (2004) in the *igapó* of nearby Jáu National Park (5.3 ind.), but differed from that reported

by Kasecker (2006) from the Piagaçu-Purus Sustainable Development Reserve, in central Amazonas, Brazil (14.3 ind.) (Table 1).

The *Cebus unicolor* groups we recorded were composed mainly of adults, with only one infant (in May) and one juvenile (in July). The average *C. unicolor* sighting rate in the Açutuba *igapó* was 9.6 individuals/km². This was significantly lower than the 30 individuals/km² recorded for *Cebus albifrons* in the humid forests of Colombia and Peru (Fig. 1; Defler, 1979, 1982; Terborgh, 1983, respectively).

At Açutuba, *C. unicolor* used low to medium strata at heights of 10 to 15 m, similar to those found for *C. unicolor*

by Kasecker (2006) in the *igapó* of the Piagaçu-Purus Sustainable Development Reserve.

Throughout the *igapó* from the *igapó/terra firme* interface to islands up to 4 km away (Fig. 2), the species occupied low to medium *igapó* (Rocha, 2017), moving at heights of between 10 and 15 m, in logged mature and secondary forest. The species was more abundant in *igapó* than the robust capuchin, *Sapajus macrocephalus*, which was sighted only twice, each time at the *igapó-terra firme* interface, with a sighting rate of 1.5 ind/km².

Ethnoprimateological interviews showed that primates are hunted (n= 24 of 60 interviews, 40%), especially

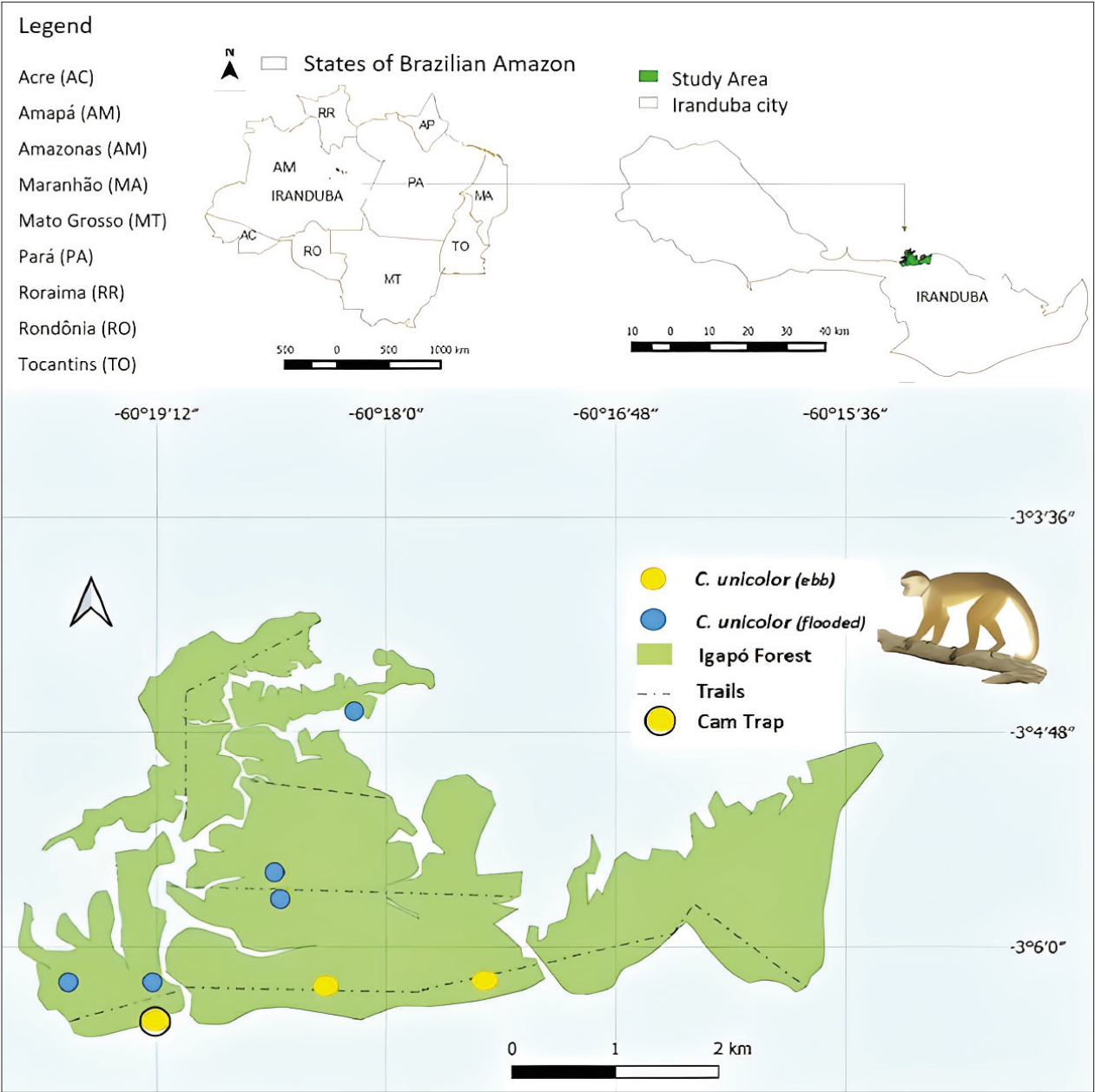


Figure 1. Study area in the *igapó* forest at Açutuba, Iranduba municipality, Amazonas State, Brazil, showing the distribution of survey trails and the location of observations of *Cebus unicolor*.

Table 1. Comparison of group size, distribution area, and sighting rates from studies of *Cebus* monkeys.

Species	Mean group size (ind)	Home Range (ha)	Sighting rate (ind/km ²)	Country	Locality	Habitat	Source
<i>C. aequatorialis</i>	13.9	534	2.8	Ecuador	West of Andes	Rainforest	Jack and Campos, 2012
<i>C. albifrons</i>	30-35	120	30.0	Colombia	El Tuparro National Park, Vichada	Semideciduous forest, Llanos	Defler, 1979, 1982
<i>C. albifrons</i>	9.4	-	2.6	Colombia (south): Ayo, Pintadillo, Caparú	Baixo Rio Caquetá and Apaporis	<i>Terra firme</i> forest	Palacios and Peres, 2005
<i>C. unicolor</i>	5.3	-	-	Brazil	Jaú National Park	<i>Igapó</i> forest	Iwanaga, 2004
<i>C. unicolor</i>	14.3	-	10.2	Brazil	RDS Piagaçu Purus	<i>Terra firme</i> forest	Kasecker, 2006
<i>C. unicolor</i>	10.3	-	5.5	Brazil	RDS Piagaçu Purus	<i>Igapó</i> forest	Kasecker, 2006
<i>C. unicolor</i>	5.8	-	9.6	Brazil	Iranduba, AM	<i>Igapó</i> forest	This study
<i>C. versicolor</i>	3.2	-	62.2	Colombia	Magdalena Valley	Rainforest	Marsh et al., 2016
<i>C. yuracus</i>	8.5	150	35.0	Peru	Manu National Park	Rainforest	Terborgh, 1983
<i>C. yuracus</i>	6.5	240	-	Ecuador	Tiputini Biodiversity Station	Rainforest	Matthews, 2009
<i>C. yuracus</i>	5.0	-	5.2	Peru	Pacaya-Samiria National Reserve	Rainforest	Soini, 1986

Alouatta juara (100% of positive replies), but none of the interviewees mentioned *Cebus unicolor* as a species targeted for hunting.

We only obtained one camera trap record for *Cebus unicolor* (Fig. 2). We recorded consumption of fruit from three plant species by *C. unicolor*: *Garcinia madruno* (Kunth) Hammel (Clusiaceae), *Mollia speciosa* Mart. (Malvaceae) and *Spondias mombin* L. (Anacardiaceae). Individuals collected *Spondias* from the *igapó* forest-floor during the low-water period (Fig. 2), and *Garcinia* and *Mollia* from canopies in the middle of the *igapó* during the rainy season.

In the Açutuba *igapó*, *Cebus unicolor* appears resilient to environmental impacts (habitat loss, fragmentation and fire), paralleling *C. albifrons* and *C. olivaceus* species known to tolerate high habitat disturbance (Hernandez-Camacho and Cooper, 1976; Norconk et al., 2025). *Cebus* seems more able to adapt to the anthropogenic changes compared to species such as *Cacajao ouakary*, sighted twice in *igapó* in this 16-month study (a solitary individual and a group of four individuals), yet abundant in Jaú National Park some 220 km to the west in the same interfluve (Barnett, 2010; Rocha, 2017; Rocha et al., 2024).

Cebus unicolor is a permanent inhabitant of the anthropized Açutuba *igapó*, distributed throughout the flooded forest during the flood and ebb periods, and is

a potential seed disperser (Whencke and Dominguez, 2007). The average group size of *C. unicolor* in Açutuba is comparable to that of the protected areas of the Jaú National Park, but the sighting rate is lower than in other areas where species of the genus *Cebus* have been studied, which may mean there are a smaller number of groups in the Açutuba population, possibly a reflection of the anthropogenic impact.

The current study provides preliminary data on the ecology of a species which is threatened but little studied, with almost no prior information from *igapó* forest areas, with most studies focusing on *terra firme* and considering distribution (Gusmão et al., 2017), biogeography (Lima et al., 2017) or phylogenetics (Ruiz-García et al., 2010). More studies are needed on *Cebus unicolor* population dynamics, interspecific interactions, key resources and relationship with *igapó*. Long-term studies would increase understanding for effective conservation of the species and associated ecosystem.

In the Açutuba region, conservation actions are needed to promote the preservation of the species, combined with environmental education and the development of ecotourism to enhance local perception of the benefits of biodiversity conservation (Vidal et al., 2024). The involvement of local riverine community members in *igapó*-based primate watching (Lebrão et al., 2021) and



Figure 2. Camera trap image of *Cebus unicolor* foraging terrestrially in igapó forest. Right inset: fruits consumed by *Cebus unicolor* in Açutuba during this study: A) *Spondias mombin*, B) *Mollia speciosa* and C) *Garcinia madruno*.

birdwatching (De Sá Freitas et al., 2022) could furnish an economic and sustainable alternative to logging and hunting.

Acknowledgments

We thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for AR's Master's Degree scholarship; Conservation International and Margot Marsh Foundation for research funding; and the Instituto Nacional de Pesquisas da Amazônia (INPA) for scientific support. AR thanks field work helpers Antonio Jerimum, José Ribeiro, Joninhas and Aroldo for their dedication. We also thank the owners of Sítio Santa Maria, G. Vieira, L. H. R. Py Daniel and R. de C. G. Mesquita, for their accommodation and logistical support. This is publication n°64 from the GPMA/INPA.

References

- Barnett, A. A. 2010. Diet, habitat use and conservation ecology of the golden-backed uacari, *Cacajao melanocephalus ouakary*, in Jaú National Park, Amazonian Brazil. Doctoral thesis, Roehampton University, London, UK.
- Barnett A. A., Borges S., de Castilho C. V., Neri F. and Shapley R. L. 2002. Primates of Jaú National Park, Amazonas, Brazil. *Neotrop. Primates*. 10: 65–70. <https://doi.org/10.62015/np.2002.v10.505>
- Barnett, A. A., Schiel, V., Deveny, A., Valsko, J., Spirone-llo, W. and Ross, C. 2011. Predation on *Cacajao ouakary* and *Cebus albifrons* (Primates: Platyrrhini) by harpy eagles. *Mammalia* 75: 169–172. <https://doi.org/10.1515/mamm.2011.004>
- Barnett, A. A., Stone, A. I., Shaw, P., Ronchi-Teles, B., dos Santos-Barnett, T. C., Penhorwood, G., Urmeed, R., Bezerra, B. M., Bitencourt, A., Spirone-llo, W. R., Ross, C., Boyle, S. and Wenzel, J. W. 2023. When food fights back: Cebid primate strategies of larval paper wasp predation and the high-energy yield of high-risk foraging. *Austral Ecol.* 48: 719–742. <https://doi.org/10.1111/aec.13287>
- Boubli, J. P., Lynch Alfaro, J. W., Heymann, E. W., Valença-Montenegro, M. M., Mollinedo, J. M. and Calouro, A. M. 2021. *Cebus unicolor* (amended version of 2020 assessment). The IUCN Red List of Threatened Species 2021: e.T70333194A191708016. Accessed 19 March 2025.
- Boubli, J. P., Rylands, A. B., Farias, I. P., Alfaro, M. E. and Alfaro, J. L. 2012. *Cebus* phylogenetic relationships: a preliminary reassessment of the diversity of the untufted capuchin monkeys. *Am. J. Primatol.* 74: 381–393.
- Davis, A. and Wagner, J. R. 2003. Who knows? On the importance of identifying “experts” when researching local ecological knowledge. *Human Ecol.* 31: 463–489. <https://doi.org/10.1023/A:1025075923297>
- De Sá Freitas, F. N., Aleixo, D. and dos Santos Moraes-Ornellas, V. 2022. Birdwatching tourism: potential of sustainable economy in the Paraense Amazon. *Rev. Bras. Ecoturismo* 15(3): 593–608. <https://doi.org/10.34024/rbecotur.2022.v15.13606>
- Defler, T. R. 1979. On the ecology and behavior of *Cebus albifrons* in eastern Colombia. I. *Ecol. Primates* 20: 475–490. <https://doi.org/10.1007/BF02373430>

- Defler, T. R. 1982. A comparison of intergroup behavior in *Cebus albifrons* and *C. apella*. *Primates* 23: 385–392. <https://doi.org/10.1007/BF02381321>
- Defler, T. R. 1985. Contiguous distribution of two species of *Cebus* monkeys in El Tuparro National Park, Colombia. *Am. J. Primatol.* 8: 10–112. <https://doi.org/10.1002/ajp.1350080203>
- Defler, T. and Hernández-Camacho, J. 2002. True identity and characteristics of *Simia albifrons* Humboldt, 1812: description of neotype. *Neotrop. Primates* 10: 1–16. <https://doi.org/10.62015/np.2002.v10.504>
- Dos Reis, N. R., Peracchi, A. L., Batista, C. B. and Rosa, G. L. M. 2015. *Primates do Brasil: Guia de Campo*. Technical Books Editora, Rio de Janeiro.
- Dos Santos, J. S., dos Santos Teixeira, J. V., Guanaes, D. H. A., da Rocha, W. D. and Schiavetti, A. 2020. Conflicts between humans and wild animals in and surrounding protected area (Bahia, Brazil): an ethnozoological approach. *Ethnobiol. and Conserv.* 9. <https://doi.org/10.15451/10.15451/ec2020-02-9.05-1-22>
- Fuentes, A. 2010. Natural/cultural encounters in Bali: monkeys, temples, tourists, and ethnoprimateology. *Cultural Anthropol.* 25: 600–624. <https://doi.org/10.1111/j.1548-1360.2010.01071.x>
- FVA, 2014. *Irاندوبا: características socioambientais de um município em transformação*, M. S. Rodrigues, C. T. Pedrollo, S. H. Borges, Y. R. Camargo, M. P. Moreira, G. S. Amaral, D. O. Brandão and S. Iwanaga (eds.). Manaus Série Documentos Técnicos Fund. Vitória Amazônica, Manaus.
- Gentil, E., Bezerra, B., Medeiros, L. A. D. and Barnett, A. A. 2021. Predation by white-fronted capuchin monkeys, *Cebus albifrons* on eggs of three species of freshwater turtles in Brazilian Amazonia: solitary nests are also depredated. *J. Nat. History* 55: 1983–1997. <https://doi.org/10.1080/00222933.2021.1977863>
- Gusmão, A. C., Tuyama, C. A., Tuyama, M. C., Gusmão, M. C. C. and Ferrari, S. F. 2017. Extension of the geographic distribution of *Cebus unicolor* Spix, 1823, in Mato Grosso, Brazil. *Neotrop. Primates* 23: 46–47.
- Hernández-Camacho, J. and R. W. Cooper, 1976. The non-human primates of Colombia. In: *Neotropical Primates: Field Studies and Conservation*, R. W. Thorington and P. G. Heltne (eds.), pp.35–98. National Academy of Sciences, Washington D. C.
- Humboldt, A. von and Bonpland, A. 1812. *Recueil d'observations de zoologie et d'anatomie comparée, faites dans l'océan atlantique dans l'intérieur du nouveau continent et dans la mer du sud pendant le années 1799, 1800, 1801, 1802 et 1803. viii, pt. 2, vol. 1*, Paris.
- Iwanaga, S. 2004. Levantamento de mamíferos diurnos de médio e grande porte no ParNa do Jaú. In: *Janelas para a Biodiversidade no Parque Nacional do Jaú: uma estratégia para o estudo da biodiversidade na Amazônia*, S. H. Borges, S. Iwanaga, C. C. Durigan and M. R. Pinheiro (eds.), pp.195–207. Fund. Vitória Amazônica, Manaus.
- Jack, K. M. and Campos, F. A. 2012. Distribution, abundance, and spatial ecology of the critically endangered Ecuadorian capuchin (*Cebus albifrons aequatorialis*). *Trop. Conserv. Science* 5: 173–191. <https://doi.org/10.1177/194008291200500207>
- Kasecker, T. 2006. Efeito da estrutura do hábitat sobre a riqueza e composição de comunidades de primatas da RDS Piagaçu-Purus, Amazônia Central, Brasil. MSc thesis in Ecology, Inst. Nacional Pesquisas da Amazônia, Manaus, Brazil.
- Lebrão, C., Rosa, L. M. V., Paim, F. P., Nassar, P. M., El Bizri, H. R. and Silva, F. E. 2021. Community-based ecotourism and primate watching as a conservation tool in the Amazon rainforest. *Int. J. Primatol.* 42(4): 523–527. <https://doi.org/10.1007/s10764-021-00226-2>
- Lima, M. G., Buckner, J. C., Silva-Júnior, J. D. S. E., Aleixo, A., Martins, A. B., Boubli, J. P., Link, A. and Lynch Alfaro, J. W. 2017. Capuchin monkey biogeography: understanding *Sapajus* Pleistocene range expansion and the current sympatry between *Cebus* and *Sapajus*. *J. Biogeogr.* 44: 810–820.
- Marsh, C., Link, A., King-Bailey, G. and Donati, G. 2016. Effects of fragment and vegetation structure on the population abundance of *Ateles hybridus*, *Alouatta seniculus* and *Cebus albifrons*, Magdalena Valley, Colombia. *Folia Primatol.* 87: 17–30. <https://doi.org/10.1159/000443929>
- Matthews, L. 2009. Activity patterns, home range size, and intergroup encounters in *Cebus albifrons* support existing models of capuchin socioecology. *Int. J. Primatol.* 30: 709–728. <https://doi.org/10.1007/s10764-009-9370-1>
- Norconk, M., Thompson, C. L., Vreedzaam, A., Atsalis, S., Ledogar, J. A., Landburg, C. and Wright, B. W. 2025. Ecological resilience in a primate community affected by gold mining in Suriname. *Biotropica* 57(2). <https://doi.org/10.1111/btp.70007>
- Palacios, E. and Peres, C. 2005. Primate population densities in three nutrient-poor Amazonian *terra firme* forests, south-eastern Colombia. *Folia Primatol.* 76: 135–145. <https://doi.org/10.1159/000084376>
- Peres, C. A. and Cunha, A.A. 2011. *Manual para censo e monitoramento de vertebrados de médio e grande porte por transecção linear em florestas tropicais*. Wildlife Conservation Society, New York, NY.
- Rocha, A., Barnett, A. A. and Spironello, W. R. 2024. The Last Surviving Population of *Cacajao ouakary* (Spix, 1823) (Pitheciidae, Primates) in an *Igapó* Forest in the Manaus Metropolitan Region, Central Amazonia, Brazil. *Neotrop. Primates* 30(1) [this issue].
- Rocha, A. 2017. Disponibilidade de recursos e antropização estruturando a assembleia de primatas na floresta de igapó. MSc Thesis in Ecology, Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil.
- Ruiz-García, M., Castillo, M. I., Vásquez, C., Rodríguez, K., Pinedo-Castro, M., Shostell, J. and Leguizamón, N. 2010. Molecular phylogenetics and phylogeography of the white-fronted capuchin (*Cebus albifrons*; Cebidae, Primates) by means of mtCOII gene sequences. *Molecular Phylogenetics and Evolution* 57(3): 1049–1061.

- Soini, P. 1986. A synecological study of a primate community in the Pacaya-Samiria National Reserve, Peru. *Primate Conserv.* 7: 63–71.
- Spironello, W. R., Barnett, A. A., Jucá, T., Sobroza, T. V., Rylands, A. B., Mittermeier, R. A., Azevedo, R. B. Buss, G. Jerusalinsky, L., Silva-Jr., J. S. and Lynch, J. W. 2023. Primates of Brazilian Amazonia: Knowledge, Research Gaps, and Conservation Priorities. In: *Amazonian Mammals: Current Knowledge and Conservation Priorities*, W. R. Spironello, A. A. Barnett, J. W. Lynch, P. E. Bobrowiec and S. A. Boyle (eds.), pp.73–109. Springer, Cham. https://doi.org/10.1007/978-3-031-43071-8_4
- Spix, J. B. von, 1823. *Simiarum et vespertilionum Brasiliensium species novae, ou Histoire naturelle des espèces nouvelles de singes et de chauves-souris, observées et recueillies pendant le voyage dans l'intérieur du Brésil*. Typis Francisci Seraphici Hübschmanni, Monaco.
- Terborgh, J. 1983. *Five New World Primates: A Study in Comparative Ecology*. Princeton University Press, Princeton.
- Vidal, M. D., Santos, P. M. D. C., Simonetti, S. R. and Siciliano, S. 2024. Wildlife ecotourism in Protected Areas of the lower Negro River, Brazilian Amazon: characterization, challenges, and potentials. *Turismo: Visão e Ação* 26. <https://doi.org/10.14210/tva.v26.19646>
- Wehncke, E. and Dominguez, C. 2007. Seed dispersal ecology of non-restricted frugivores, capuchin monkeys in three neotropical forests. *J. Trop. Ecol.* 23: 519–528. <https://doi.org/10.1017/S0266467407004257>