BIODIVERSITY AND CONSERVATION | SHORT COMMUNICATION

Avifauna of a white-sand forest in the Colombian Amazon

Gabriel J. COLORADO Z.[1]* , Giovany VALENCIA-C[1]

[1] Universidad Nacional de Colombia, Departamento de Ciencias Forestales, Grupo en Ecología y Conservación de Fauna y Flora Silvestre. Carrera 65 # 59a – 110, Medellín, Antioquia, Colombia.

* Corresponding author: gjcoloradoz@unal.edu.co

ABSTRACT

White-sand forests are unique ecosystems with high levels of biological specificity. Despite their uniqueness, these ecosystems have significant knowledge gaps in Colombia regarding the associated vertebrate communities, particularly birds. Between February and March 2015, richness and composition of birds in a white-sand forest in the southern-most region of the Colombian Amazon were evaluated using mist nets and censuses. 38 bird species were detected, less than half of the number recorded in the surrounding *terra-firme* forest (81 species). In addition, the white-sand forest exhibited a high degree of specificity, as indicated by a Jaccard index of 0.25 when compared to the *terra-firme* forest. Although this ecosystem currently faces low conservation threats in this region of Colombia, its biological fragility and specificity, and the absence of a legal protection status, make it a vulnerable ecosystem.

KEYWORDS: Amazon biome, endemism, habitat specialization, specialized avifauna, varillal.

Avifauna de un bosque de arenas blancas en la Amazonia Colombiana

RESUMEN

Los bosques de arenas blancas son ecosistemas únicos que presentan altos niveles de especificidad biológica. A pesar de su particularidad, existen importantes vacíos en Colombia en el conocimiento de vertebrados como las aves. Entre febrero y marzo de 2015, se evaluó la riqueza y composición de aves de un bosque de arenas blancas en el sur de la Amazonia Colombiana empleando redes de niebla y censos. Se detectaron 38 especies de aves, menos de la mitad de las aves registradas en el bosque de tierra firme circundante (81 especies). Adicionalmente, el bosque de arenas blancas exhibió un alto grado de especificidad, como lo indicó el índice de Jaccard de 0,25 al compararlo con el bosque de tierra firme. A pesar de que este ecosistema actualmente presenta un bajo grado de amenaza para su conservación en esta región en Colombia, su fragilidad biológica y especificidad, y la ausencia de un estatus legal de protección, hacen que sea un ecosistema vulnerable.

PALABRAS CLAVE: Avifauna especializada, bioma Amazónico, endemismo, especialización de hábitat, varillal.

Despite the apparent homogeneity of the Amazon forest, this region presents a wide variety of ecosystems, some with a high level of biological specificity. This is the case of white-sand forests or *varillales*, as they are known regionally in Colombia, which are fragile ecosystems, unique and relatively small in extent, with vegetation established on very old substrates, sandy and poor in nutrients (Anderson 1981; Capurucho *et al.* 2020). These characteristics, coupled with the sparse distribution of white-sand forests in patches across the Amazon, make it a habitat with high endemicity that significantly contribute to spatial heterogeneity and the Amazonian biodiversity (Adeney *et al.*, 2016). White-sand forests, with their unique and isolated ecosystems, are critical habitats for many bird species, some of which are newly discovered (e.g., Whitney and Alonso 2005, Stiles and Avendaño 2019). Studies from Peru (e.g., Álvarez *et al.*, 2013), Brazil (e.g., Guilherme 2012; Laranjeiras *et al.*,

2014; Borges *et al.* 2016a,b), Venezuela (e.g., Kvarnbäck and Bosque 2017), and Colombia (e.g., Stiles *et al.*, 1995; Stiles and Avendaño 2019) highlight the ecological significance of these forests, stressing the need for further research particularly across the western Amazon, where important knowledge gaps still remain on white-sand and other poor-soil specialist birds (Socolar *et al.* 2022). The study of white-sand forests can significantly increase the diversity in the Amazon (Borges *et al.*, 2016b), and contribute to understanding biogeographical patterns this bioregion. This research evaluated the richness and composition of birds in a white-sand forest in the southernmost part of the Colombian Amazon.

The white-sand forest under study is located approximately 24 km northeast of Leticia municipality, Amazonas Department (4° 0'34.62"S, 69°53'35.95"W; Figure 1). The forest has approximately 70 ha, ~110 m asl, average annual precipitation of 3,400 mm (data from Vázquez Cobo Airport

Figure 1. White-sand forest, Colombian Amazon. The dark line marks the boundary of the white-sand forest, which is embedded within the surrounding *terra-firme* forest. Based on Google Earth.

weather station), immersed in a matrix of *terra-firme* forest. It has an open canopy, with thin trees (5 - 8 m), a slightly dense understory, with dominance of bromeliads, mosses and ferns (Figure 2). Between February and March 2015, two seven-day visits (i.e. 14-day sampling) were conducted in which the white-sand forest bird community was characterized using complementary techniques of mist netting, transect censuses, recordings, and *ad libitum* observations. Ten 12 m x 2.5 m mist nets were used to catch birds. Two 150 m transects separated at least 150 m from the forest edges and between them were established. Bird sounds were recorded with a digital recorder. Same methods were applied to characterize the bird fauna in the surrounding *terra-firme* forest. Sampling locations in this ecosystem were distributed sparsely around the white-sand forest, with sites established at least 200 m from the forest edge. We categorized the species recorded exclusively in the white-sand forest by the degree of association with this ecosystem, according to the classification offered by Borges *et al.* (2016a). Birds were identified using the illustrated guides of Hilty and Brown (1986) and Schulenberg *et al.* (1997), and the taxonomic sequence suggested by Remsen *et al.* (2024) was followed. The number of recorded species was used as a richness index. The degree of similarity between birds of the white-sand forest and the *terra-firme* forest was assessed

using the Jaccard index. An individual-based rarefaction curve using capture data was constructed to assess the effectiveness of sampling, and the Chao 1 and Jacknife estimators were calculated to estimate the expected species richness. These analyses were conducted using EstimateS (Colwell 2006). A total of 38 bird species were recorded in the white-sand forest and 81 in the *terra-firme* forest. Best represented families were Psittacidae (parrots), Thamnophilidae (arboreal antbirds), Trochilidae (hummingbirds), Tyrannidae (flycatchers), and Thraupidae (tanagers). Of the 19 species captured in nets (98 individuals), the most commonly recorded were the Great-billed hermit *Phaethornis malaris* (23 individuals), and the Saffron-crested tyrant-manakin *Neopelma chrysocephalum* (10). Most of the species caught (63%) were represented by a maximum of three individuals. The individual-based rarefaction curve showed that species richness in the white-sand forest had not yet reached stabilization (Figure 3). The non-parametric estimator Chao 1 revealed that the estimated species richness was 48 species (95% Confidence Interval = 41.1 – 55.8), while the Jacknife estimator suggested a richness of 61 species (95% Confidence Interval = 59.2 – 62.7).

Species composition differed between the two ecosystems. Of the 95 species in total registered in the two ecosystems (16 orders and 34 families), 14 species were exclusively registered

Figure 2. White-sand forest appearance and bird species exclusive of this environment in the Colombian Amazon. a) typical appearance with a high density of narrow trees and presence of bromeliads in the understory, b) close-up of the soil and understory dominated by ferns, c) *Attila citriniventris*, d) *Neopelma chrysocephalum*.
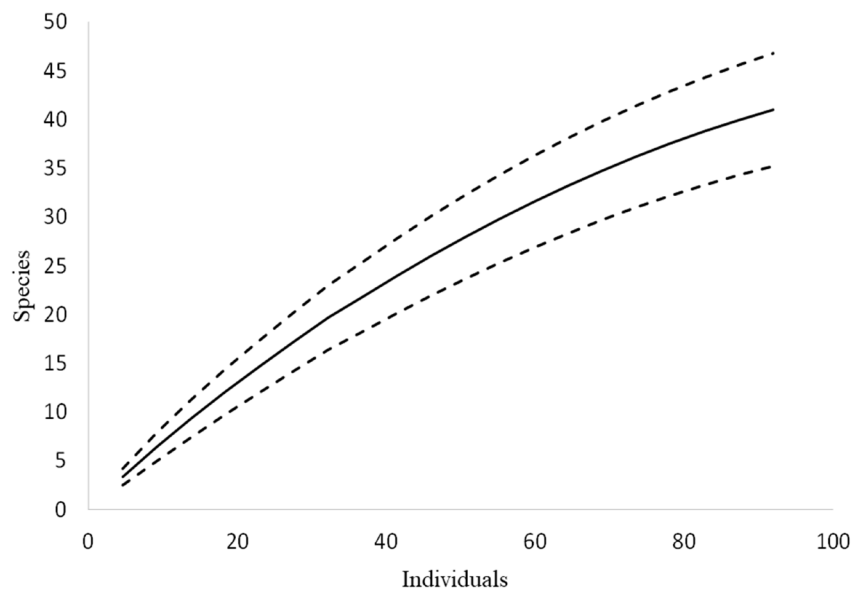

Figure 3. Individual-based rarefaction curve using capture data for birds of a white-sand forest, Colombian Amazon. Dotted line: 95% confidence intervals.

in the white-sand forest (Figure 2c,d), 24 were registered both in the white-sand forest and *terra-firme* forest, and 57 were recorded only in the *terra-firme* forest (Jaccard index = 0.25; Table 1). The most represented guild in the white-sand forest was insectivorous, with 7 species, while in the *terra-firme* forest, frugivores dominated with 23 species. Based on Borges *et al.* (2016a), of the 14 species recorded exclusively in the white-sand forest, *Attila citriniventris* and *Neopelma chrysocephalum* were classified as near-restricted species, and the rest as regular users of this ecosystem.

The white-sand forest showed a low number of species, contrasting with the surrounding *terra-firme* forest that harbored more than twice bird species. White-sand forests in other localities of Amazonia have shown a larger species

Table 1. Bird species recorded in a white-sand forest (varillal) and *terra-firme* forest (forest), Colombian Amazon. February-March 2015

Table 1. Continued

ORDER	FAMILY	SPECIES	ECOSYSTEM
TINAMIFORMES	Tinamidae	*Tinamus major*	Forest
		Tinamus guttatus	Forest
		Crypturellus undulatus	Forest/Varillal
GALLIFORMES	Cracidae	*Penelope jacquacu*	Forest
		Nothocrax urumutum	Forest/Varillal
		Crax globulosa	Forest
	Odontophoridae	*Odontophorus gujanensis*	Forest
COLUMBIFORMES	Columbidae	*Claravis pretiosa*	Varillal
		Patagioenas plumbea	Forest/Varillal
		Patagioenas subvinacea	Forest
		Leptotila rufaxilla	Forest
		Geotrygon montana	Forest
NYCTIBIIFORMES	Nyctibiidae	*Nyctibius grandis*	Forest
CAPRIMULGIFORMES	Caprimulgidae	*Nyctiprocne leucopyga*	Varillal
APODIFORMES	Apodidae	*Chaetura sp.*	Forest/Varillal
		Tachornis squamata	Forest/Varillal
		Panyptila cayennensis	Forest/Varillal
	Trochilidae	*Glaucis hirsutus*	Forest
		Threnetes leucurus	Forest
		Phaethornis malaris	Forest/Varillal
		Florisuga mellivora	Forest
		Heliothryx auritus	Varillal
		Heliomaster longirostris	Forest
		Thalurania furcata	Forest/Varillal
GRUIFORMES	Psophiidae	*Psophia crepitans*	Forest

ORDER	FAMILY	SPECIES	ECOSYSTEM
CATHARTIFORMES	Cathartidae	*Cathartes burrovianus*	Forest/Varillal
		Coragyps atratus	Forest/Varillal
ACCIPITRIFORMES	Accipitridae	*Harpagus bidentatus*	Forest
		Rupornis magnirostris	Forest
STRIGIIFORMES	Strigiidae	*Pulsatrix perspicillata*	Forest
TROGONIFORMES	Trogonidae	*Trogon viridis*	Forest/Varillal
		Trogon Rufus	Forest/Varillal
CORACIIFORMES	Momotidae	*Electron platyrhynchum*	Forest
		Momotus momota	Forest
	Alcedinidae	*Chloroceryle aenea*	Forest/Varillal
GALBULIFORMES	Galbulidae	*Galbula dea*	Forest/Varillal
	Bucconidae	*Monasa morphoeus*	Forest
PICIFORMES	Capitonidae	*Capito aurovirens*	Forest
	Ramphastidae	*Rhamphastus tucanus*	Forest
		Rhamphastus vitellinus	Forest
		Pteroglossus castanotis	Varillal
		Pteroglossus azara	Forest
	Picidae	*Melanerpes cruentatus*	Forest
		Dryobates affinis	Forest/Varillal
		Celeus torquatus	Forest
		Celeus elegans	Varillal
		Dryocopus lineatus	Forest
FALCONIFORMES	Falconidae	*Micrastur gilvicollis*	Varillal
		Ibycter americanus	Forest
		Daptrius ater	Forest

Table 1. Continued

ORDER	FAMILY	SPECIES	ECOSYSTEM
PSITTACIFORMES	Psittacidae	*Ara ararauna*	Forest
		Ara macao	Forest
		Aratinga weddellii	Forest
		Forpus xanthopterygius	Forest/Varillal
		Brotogeris versicolorus	Forest/Varillal
		Amazona amazonica	Forest
		Pionites melanocephalus	Forest
PASSERIFORMES	Thamnophilidae	*Thamnophilus murinus*	Varillal
		Thamnophilus schistaceus	Forest
		Hafferia fortis	Forest
		Thamnomanes ardesiacus	Forest
		Megastictus margaritatus	Forest/Varillal
		Hypocnemis hypoxantha	Forest/Varillal
		Percnostola rufifrons	Forest
	Pipridae	*Tyranneutes stolzmanni*	Varillal
		Neopelma chrysocephalum	Varillal
		Ceratopipra erythrocephala	Forest
	Pipridae	*Tyranneutes stolzmanni*	Varillal
		Neopelma chrysocephalum	Varillal
		Ceratopipra erythrocephala	Forest
	Cotingidae	*Cotinga maynana*	Forest
		Lipaugus vociferans	Forest
	Tityridae	*Schiffornis turdina*	Forest/Varillal
	Onychorhynchidae	*Onychorhynchus coronatus*	Forest

Table 1. Continued

ORDER	FAMILY	SPECIES	ECOSYSTEM
PASSERIFORMES	Tyrannidae	*Myiopagis gaimardii*	Forest
		Mionectes oleagineus	Forest/Varillal
		Platyrinchus sp.	Varillal
		Myiozetetes granadensis	Varillal
		Rhamphotrigon ruficauda	Varillal
		Attila citriniventris	Varillal
	Troglodytidae	*Microcerculus marginatus*	Forest
		Cyphorhinus arada	Forest
	Turdidae	*Catharus ustulatus*	Forest
		Turdus albicollis	Forest/Varillal
		Euphonia chrysopasta	Forest
		Euphonia xanthogaster	Forest/Varillal
	Icteridae	*Psarocolius angustifrons*	Forest
		Psarocolius decumanus	Forest/Varillal
		Cacicus cela	Forest
	Cardinalidae	*Habia rubica*	Forest
	Thraupidae	*Thlypopsis sordida*	Varillal
		Tachyphonus surinamus	Forest
		Cyanerpes nitidus	Forest
		Saltator grossus	Forest
		Tangara chilensis	Forest
		Tangara velia	Forest
		Tangara callophrys	Forest
		Tangara gyrola	Forest

richness than that recorded in this study (Stiles *et al.*, 1995: 111 species; Borges 2004: 128 species, Guilherme *et al.* 2018: 171), with some exceptions (Vásquez-Arévalo *et al.* 2021: 45-57 species), likely reflecting the more intensive sampling efforts in those studies. However, despite the low bird richness, we found that 37% (14 out of 38 species) of these were exclusively recorded in this ecosystem. Nevertheless, the birds of the white-sand forest showed different levels of specificity. *N. chrysocephalum*, for example, is a species

restricted to white-sand forests (i.e., obligated specialist) in countries such as Colombia (Hilty and Brown 1986) and Brazil (Ridgely and Tudor 1994). In turn, *Attila citriniventris* was registered in this research only in the white-sand forest, but it is a species of *terra-firme* forests in Ecuador and Brazil (Ridgely and Greenfield 2001; but see Guilherme and Borges 2011 who associated it with white-sand vegetation in southwestern Brazilian Amazon), and common in both *terra-firme* forest and white-sand forest in the Eastern region

of the Colombian Amazon (Hilty and Brown 1986). Other species such as *Claravis pretiosa* and *Ramphotrigon ruficauda* were also found exclusively in the white-sand forest, but are considered as facultative species of this ecosystem. Finally, our study did not detect other diagnostic species of white-sand forests (e.g. *Xenopipo atronitens*). This may be due to a limited sampling effort, especially for rare and elusive species, as well as the location being at the southernmost edge of the distribution for several white-sand specialists in Colombia, distant from the Guiana Shield. The bird species found in white-sand forests are generally linked to the ecosystem's structure and diversity, habitat amount in the landscape and biogeographical context (Borges *et al.* 2016; Capurucho *et al.* 2020), evolutionary history (Matos *et al.* 2016), and edaphic and climatic conditions (Fine *et al.* 2012). Therefore, it is important to examine the relationship of white-sand forest birds with the different environmental attributes, as well as to study ecomorphological and evolutionary aspects of these birds (Lima et al 2023).

This white-sand forest is in a relatively good state of conservation, possibly related to its distance to populated areas. Additionally, poor soils and low biomass of the tree component limit its use for agriculture, livestock or selective logging. However, the small size and isolation of this ecosystem and its biological specificity make it susceptible to disturbances. Consequently, a legal protection status as a strategic ecosystem is needed, as well as the recognition of other white-sand forests in the area that can be studied allowing for a better understanding of the relevance of this ecosystem for Amazon biodiversity.

ACKNOWLEDMENTS

REFERENCES

Adeney, J.M.; Christensen N.L.; Vicentini A.; Cohn-Haft, M. 2016. White-sand Ecosystems in Amazonia. *Biotropica* 48: 7-23.

Álvarez, A.J.; Metz, M.R.; Fine, P.V.A. 2013. Habitat Specialization by Birds in Western Amazonian White-sand Forests. *Biotropica* 45: 365-372.

Anderson, A. 1981. White-sand vegetation of Brazilian Amazonia. *Biotropica* 13: 199-210.

Borges, S.H. 2004. Species poor but distinct: Bird assemblages in white sand vegetation in Jaú National Park, Brazilian Amazon. *Ibis* 146: 114–124.

Borges, S.H.; Cornelius, C.; Ribas, C.C.; Almeida, R.; Guilherme, E.; Aleixo, A.; *et al.* 2016a. What is the avifauna of Amazonian white-sand vegetation? *Bird Conservation International* 26: 192–204.

Borges, S.H.; Cornelius, C.; Moreira, M.; Ribas, C.C.; Cohn-Haft, M.; Capurucho, J.M.; *et al.* 2016b. Bird communities in Amazonian white-sand vegetation patches: Effects of landscape configuration and biogeographic context. *Biotropica* 48: 121–131.

Capurucho, J.M.G.; Ashley, M.V.; Tsuru, B.R.; Cooper, J.C.; Bates, J.M. 2020. Dispersal ability correlates with range size in Amazonian habitat-restricted birds. *Proceedings of the Royal Society B* 287: 20201450.

Colwell, R.K. 2006. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.

Fine P.V.A.; Zapata, F.; Daly, D.C.; Mesones, I.; Misiewicz, T.M.; Cooper, H.F.; *et al.* 2012. The importance of environmental heterogeneity and spatial distance in generating phylogeographic structure in edaphic specialist and generalist tree species of *Protium* (Burseraceae) across the Amazon Basin. *Journal of Biogeography* 40: 646–661.

Guilherme, E; Borges, S.H. 2011. Ornithological records from a campina/campinarana enclave on the upper Juruá River, Acre, Brazil. *Wilson Journal of Ornithology* 123: 24–32.

Guilherme, E. 2012. Birds of the Brazilian state of Acre: Diversity, zoogeography, and conservation. *Revista Brasileira de Ornitologia* 20: 393–442.

Guilherme, E.; Lemes Marques, E.; Santos, G.S. 2018. Avifauna of a white-sand vegetation enclave in northwest Rondônia, Brazil: relevant records, body mass and morphometrics. *Bulletin of the British Ornithologists' Club* 138: 286-306.

Hilty, S.L.; Brown, W.L. 1986. *A guide to the birds of Colombia*. Princeton University Press.

Kvarnbäck, J.F.; Bosque, C. 2017. An Inventory of the birds of white-sand vegetation of the Guainía/Río Negro basin, Southern Amazonas State, Venezuela. BioLlania Edición Esp. 15:533-560.

Laranjeiras, T.O.; Naka L.N.; Bechtoldt, C.L.; Vieira, T.V.; Costa, D.A.; Andretti, C.B.; *et al.* 2014. The avifauna of Virua National Park, Roraima, reveals megadiversity in northern Amazonia. *Revista Brasileira de Ornitologia* 22: 138–171.

Lima, G.R.; Borges, S.H.; Anciães, M.; Cornelius, C. 2023. Ecomorphology and functional diversity of generalist and specialist bird assemblages in Amazonian white-sand ecosystem habitat patches. *Acta Amazonica* 53: 141-153.

Matos, M.V.; Horta, F.D.; Borges, S.H.; Latrubesse, E.; Cornelius, C.; Cohn-Haft, M.; *et al.* 2016. Comparative phylogeography of two bird species, *Tachyphonus phoenicius* (Thraupidae) and *Polytmus theresiae* (Trochilidae), specialized in Amazonian white-sand vegetation. *Biotropica* 48: 110–121.

Remsen, J. V.Jr.; Cadena C.D.; Jaramillo A.; Nores M.; Pacheco J.F.; Robbins M.B.; *et al.* A classification of the bird species of South America. American Ornithologists' Union. (http://www.museum.lsu.edu/~Remsen/SACCBaseline.htm). Accessed on 05 Mar 2024.

Ridgely, R. S.; Greenfield, P. J. 2001. *The Birds of Ecuador*. Vol. II, Field Guide. Cornell University Press.

Ridgely, R. S.; Tudor, G. 1994. *The birds of South America*. Vol. II. The Suboscine Passerines. University of Texas Press.

Schulenberg, T.S.; Stotz, D.F.; Lane, D.F.; O´Neill, J.P.; Parker III, T.A. 2007. *Birds of Peru*. Princeton University Press.

Socolar, J.B.; Fernando-Castaño, J.; Arango, J. 2022. Noteworthy bird records from the Araracuara area, Amazonas and Caquetá, Colombia. *Ornitología Colombiana* 21: 2–10.

Stiles, F. G.; Avendaño, J.E. 2019. Distribution and status of *Turdus* thrushes in white-sand areas of eastern Colombia, with a new subspecies of *T. leucomelas*. *Zootaxa* 4567: 161–175.

Stiles, F.G.; Telleria, J.L.; Diaz, M. 1995. Observaciones sobre la ecología, composición, taxonómica y zoogeografía de la avifauna de la Sierra de Chiribiquete, Depto. Del Caquetá, Colombia. *Caldasia* 17: 481-500.

Vásquez-Arévalo, F.A.; Grández-Casado, J.A.; Ushiñahua-Alvarez, M.; Gagliardi-Urrutia, G. 2021. Recambio de especies de aves en la transición de bosque sobre arena blanca y arcilla en la Reserva Nacional Allpahuayo Mishana, Loreto, Perú. *Ciencia Amazónica* (Iquitos) 9: 51 – 68.

Whitney, B.M.; Alonso, J.A. 2005. A new species of gnatcatcher from white-sand forests of northern Amazonian Peru with revision of the *Polioptila guianensis* complex. *Wilson Bulletin* 117: 113–127.