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Phylogenetic Diversity and Evolutionary Distinctiveness of Amazonian Floodplain Forest Birds

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Abstract

The Amazon basin contains one-fifth of all free-flowing fresh water on the planet and is home to the largest tropical rainforest on Earth. However, the region is not homogenous and is interspersed with several different forest types. Floodplain forests are formed from the seasonal rainfall that spills over the banks of the rivers and inundate vast areas. In the Amazon basin, várzea are formed from the whitewater rivers that carry sediment eroded from the Andes and deposited on the floodplains. They are the most fertile of the floodplain forest types. Forests inundated on a seasonal basis by either black- or clear-water rivers are collectively known as igapó. They are of lower fertility than várzea. The differences in floristic composition of the floodplain forests affects the faunal composition.

There is a high species richness of birds in the floodplain forests due to the availability of resources such as fruits, flowers, insects, habitat niches and special foraging substrates. To examine the richness, I used the indices of Phylogenetic Diversity to calculate the amount of evolutionary history and Evolutionary Distinctiveness, to find the most evolutionarily unique species from a compiled list of floodplain forest bird species.

The results show that the seasonally flooded forests contain some species of very early origin and many species of more recent origin. Species that have a long evolutionary history are some of the most evolutionarily unique species and are the only representatives of a single family. This therefore offers an opportunity to examine if conservation efforts are sufficiently protecting evolutionarily unique species.

Disturbance of the flood pulse in the Amazonian floodplains through infrastructure development (e.g., hydroelectric dams) or global climate change (in the form of extreme floods or droughts) can pose a serious threat to the ecology of the seasonally flooded forests across Amazonia. There is, therefore, a pressing need to better our understanding of biodiversity patterns and community assemblages across the Amazonian floodplains.

1. Introduction

The Amazon river and its tributaries dissect parts of Brazil, Bolivia, Ecuador, Peru, Colombia, Venezuela, Guyana, Suriname and French Guiana, creating the largest hydrographical basin in the world – of which more than 65% is in Brazil (Junk et al., 2011). The basin contains one-fifth of all free-flowing fresh water on the planet and is home to the largest tropical rainforest on Earth. However, the region is not homogenous and is interspersed with several different forest types (Remsen & Parker, 1983). For example, the basin contains large areas of flooded forest. In contrast to upland terra firme forest that never flood, flooded forests are situated on the floodplains of rivers and lakes. As the seasonal rainfall fills rivers, they spill over their banks and inundate the adjoining forested floodplains that can be from a few metres to several kilometres across. Certain areas remain submerged for only a short period of time, while others may remain flooded for over 6 months of the year (Junk et al., 2011).

Floodplain forests are thus governed by the annual flood pulse (Junk, 1997) and oscillate between terrestrial and aquatic ecosystems. They therefore share the common denominator of being inundated on an annual basis, but several different forest types can be recognized based on their hydrochemical (Sioli, 1968) and floristic (Prance, 1979) differences. This classification has been further expanded by Junk et al. (2011). Water colour is perhaps the most common way to differentiate the floodplains. White-water rivers (such as the Amazon mainstem, Purus and Madeira) are so named for their light brown colour and muddy disposition due to the high amounts of sediments that they erode and carry from the Andes. These rivers deposit their fertile sediments on the floodplains that are locally known as várzea. Due to the seasonal influx of nutrients, the várzeas are diverse ecosystems containing highly productive terrestrial and aquatic plant communities. Forests inundated on a seasonal basis by either black- or clear-water rivers are collectively known as igapó. These rivers (e.g., Negro, Tapajós and Tocantins) carry less inorganic material than white-water rivers and igapó forests are therefore nutrient poor compared to várzea. Consequently, the igapó flora differs from várzea and support fewer terrestrial and aquatic plant species. A final floodplain forest type is paleo-várzea forest (Assis et al., 2014). These forests are located on alluvial deposits from the Andes that have been abandoned by white-water rivers, located in Central Amazonia. They are flooded by small or intermediate black-water rivers (south of lower Rio Amazonas and between Juruti, Obidos and Santarem), which transport these once-deposited Andean paleo-sediments (Irion et al., 2010). Paleo-várzeas therefore resemble present day várzea, are less fertile than várzea, but more fertile than igapó. Their floristic composition also lies intermediate between várzea and igapó. Altogether, these floodplain forests constitute approximately 2% of the Brazilian Amazon (Melack & Hess, 2011).

The fluctuations and periodicity of flooding have major effects on the ecology of the floodplains. Where flooding is of short duration, herbaceous vegetation is dominant, whereas wetlands inundated for longer durations can support a greater diversity of flood-tolerant species (Junk, 1997). This extended inundation creates an environment where biota are forced to adapt to and respond to conditions of stress, through morphological, anatomical, physiological, phenological and/or ethological adaptations, thereby creating unique community assemblages (Junk et al., 1989). In fact, studies from several taxa such as mammals (Haugaasen & Peres, 2005a), trees (Wittmann & Junk, 2004) and avifauna (Haugaasen & Peres, 2008; Laranjeiras et al., 2020; Naka et al., 2007), show that floodplain forest community assemblages differ significantly from those in terra firme.

The Amazon River basin contains the highest bird species richness in the world (Remsen & Parker, 1983). Species restricted to river-created habitats, such as those found in floodplain forests, account for approximately 15% of the Amazonian avifauna (Remsen & Parker, 1983). The reasons for this high species richness may be due to the availability of resources such as fruits, flowers, insects, habitat niches and diverse foraging substrates (Remsen & Parker, 1983). Indeed, many bird species are endemic to floodplain forests and are year-round residents in these highly seasonal habitats (Laranjeiras et al., 2020). Some floodplain forest birds are also restricted to one type of floodplains or the other (Naka et al., 2007).

Given the high species richness in Amazonian floodplain forests, these areas are important areas for conservation and as reservoirs of genetic diversity. However, a key knowledge gap is how genetically unique these forests are. In other words, how much phylogenetic diversity and evolutionary history is contained within these floodplain forest areas? Birds are good candidates for evaluating this as they have a determined phylogeny based on fully analyzed genetic data of 6,663 species (Jetz et al., 2012). This global phylogeny therefore contains approximately two-thirds of the world's known avian species. Two metrics commonly used are phylogenetic diversity (PD) and evolutionary distinctiveness (ED). Phylogenetic diversity measures the total evolutionary history of the species occurring in a sample (Faith, 1992) and provides insights into patterns of community assembly (Pavoine & Bonsall, 2011; Webb et al., 2002). Evolutionary distinctiveness is the unique evolutionary data that a single species contributes to its clade (Jetz et al., 2014). Species that have few or no close relatives in a sample contribute more to the overall measure than do species with multiple relatives (Cadotte & Davies, 2010).

PD and ED are related metrics that can be used to prioritize conservation efforts. Earlier conservation efforts drew on the assumption that all species had the same value. However, focusing on phylogenetic diversity highlights the evolutionary history of studied species assemblages and can therefore secure that a large proportion of evolutionary history is conserved. In turn, this will decrease the chance of unique phenotypic and ecological traits being lost (Jetz et al., 2014) and provide benefits for ecosystem function and stability (Cadotte et al., 2012). This is important since conservation funding and efforts are unlikely to cover all individual species, necessitating prioritization. Yet, no study has investigated PD and ED of species occupying Amazonian floodplain forest.

In this study, I used a comprehensive literature review to compile a list of avian species that are endemic to Amazonian floodplain forests. I then used the available global bird phylogeny (Jetz et al., 2012) to examine PD and ED of these Amazonian floodplain birds. I discuss the findings in light of other published work and provide some comments on conservation implications of the findings.

2. Methods

I compiled an initial list of floodplain forest birds using Stotz et al. (1996) as the primary source, which builds on earlier research conducted by Remsen and Parker (1983). Bird lists from Laranjeiras et al. (2020), Haugaasen & Peres (2008), Naka et.al. (2007) and Cintra et al. (2007) helped to supplement my initial list. Once this list was created, I conducted keyword searches in Web of Science, Google Scholar and ResearchGate to supplement ongoing research on birds in the Amazonian floodplain habitats. I used keyword searches combining "*Amazon*", "*Amazonia*", "*floodplain forests*", "*flooded forests*", "*várzea*" and "*igapó*" to find peer-reviewed articles that research birds in the floodplain forests. The major white-water, black-water and clear-water rivers in the Amazon basin are shown in

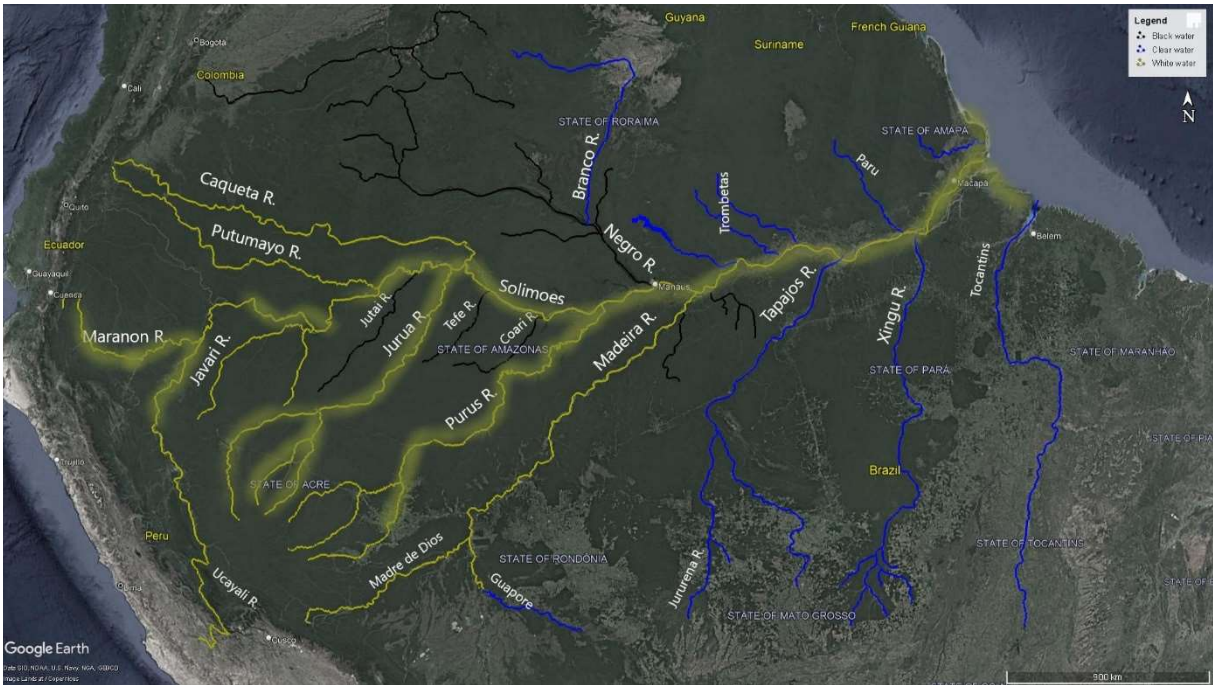

Figure 1.

Thereafter, I reviewed every bird species that was present in my list in https://birdsoftheworld.org/ (*Birds of the World*, 2022). This website is an international repository for all bird species that have been classified and provided details on taxonomy, habitat, and distribution for each species. Since my study focused on species that are resident in the floodplain forests, I eliminated some species from the initial list. I also expanded the species list to include Order and Family for each species. Through this process, I constructed and finalised my comprehensive bird species list.

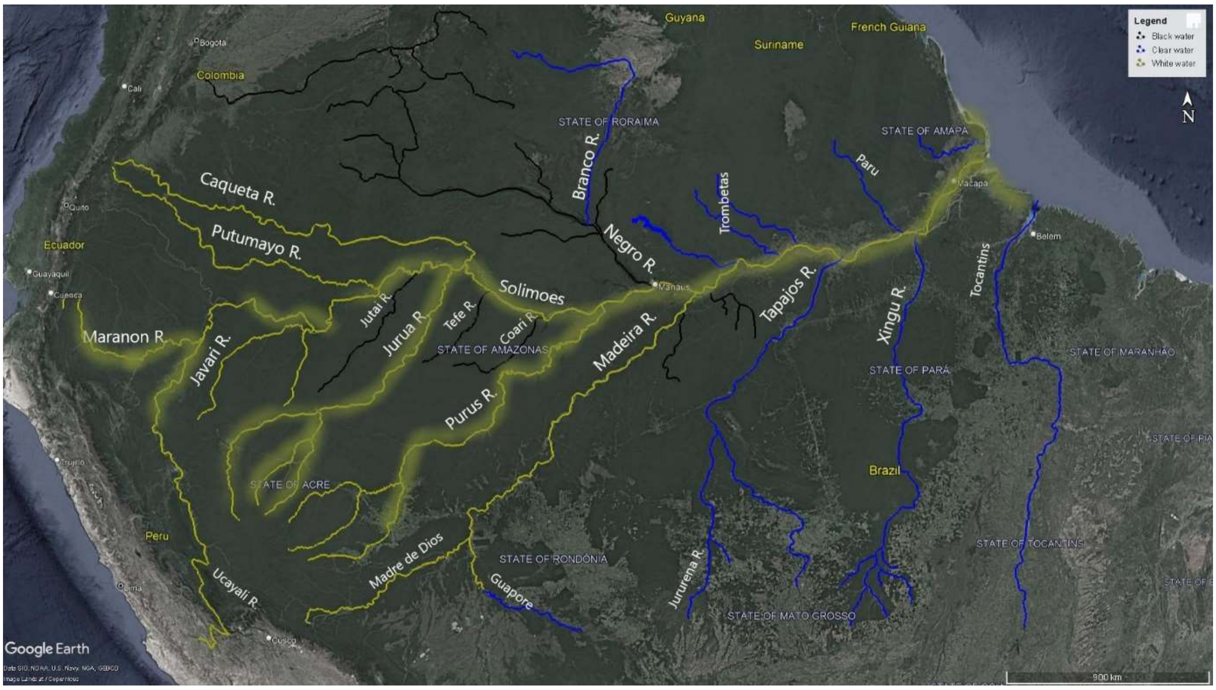

Figure 1. Distribution of major white-water, black-water, and clear-water rivers in the Amazon basin. Areas in light yellow show the distribution of white-water floodplains.

Phylogenetic Diversity

I used the website https://birdtree.org/ (Jetz et al., 2012; Jetz et al., 2014) to derive phylogenies for my bird species list. This website creates relaxed clock molecular trees for avian clades with a fossil calibrated backbone with representatives from each clade (for details see Supplementary Methods section Jetz et al. (2012)). All species are assigned to one of 158 clades. Relaxed-clock trees are generated for each clade. Species for whom genetic information does not exist are assigned to clades based on a combination of consensus trees from relaxed-clock trees per clade and available taxonomic information. These species are then assigned to a clade consistent with partial constraints and a pure birth model of diversification.

Before entering the species names into *birdtree.org*, I corrected the genus and species names for 27 species using the master taxonomy recommended by the website's authors (available for download from *birdtree.org*). This ensured that all species that I collected in my list also appeared in the phylogeny. For example, *Buteogallus schistaceus* (Slate-colored Hawk) is *Leucopternis schistaceus* in the taxonomy provided by *birdtree.org* (See

Supplementary Information

Table S1 for all corrections).

After entering the species into *birdtree.org*, I downloaded 250 phylogenies for my species list using the Hackett backbone of 9,993 species (Hackett et al., 2008) and 250 phylogenies using the Ericson backbone of 9,993 species (Ericson et al., 2006). The backbone trees were constructed with dated distributions by Jetz et al. (2012), each containing 158 tips. Each tip was representative of a crown clade in the complete avian tree. This backbone now contained 129 avian crown clades with more than four species and 29 with fewer than four species (for detailed methods see Supplementary Methods section in Jetz et al. (2012)).

The phylogenies were derived in the NEXUS format, with branch lengths and nodes for each species and read by *diversitree* (FitzJohn, 2012) in R (RStudio Team, 2020). The R packages *Picante* (Kembel et al., 2010), *vegan* (Oksanen et al., 2022) and *ape* (Paradis & Schliep, 2019), were used to visualize the phylogeny as a cladogram using the Hackett backbone with species name, family, order and suborders for Passeriformes species.

A cladistic distribution of birds in the floodplain forests was derived using Family as the tip labels. The central point shows an origin root for all bird species, both extinct and extant lineages. The lines radiating from the centre indicate diversification. The split between Passeriformes into suborders Oscines and Suboscines was noted.

I calculated PD values for each of the 250 trees with Hackett backbone and 250 trees with Ericson backbone using the Picante package (Kembel et al., 2010). A mean PD value was calculated to present in this study. PD is the sum of the evolutionary history contained in a dataset in millions of years (Faith, 1992) and is calculated by adding the branch lengths from the phylogeny (Cadotte & Davies, 2016).

Evolutionary Distinctiveness

ED measures the quantity of unique evolutionary history that a single species contributes to the phylogenetic tree (Jetz et al., 2014). Using the Picante package (Kembel et al., 2010), I calculated ED for each species through Fair Proportion such that partition branch lengths in the phylogeny were divided by the total number of species subtending it, not just the branches that occurred directly below (Cadotte & Davies, 2016).

3. Results

A total 230 bird species from 43 families were identified as endemic to the Amazonian floodplain forests (

Supplementary Information

Table S1). Of these, Passeriformes comprised 161 species where the Suboscines contained 126 species and the Oscines 35 species.

Of the 230 floodplain specialist bird species, 134 are present only in várzea, 19 only in igapó, and 77 occur in both habitats (

Supplementary Information

Table S1).

Phylogenetic Diversity

A cladistic distribution of birds in the floodplain forests is displayed using Family as the tip labels in Figure 2.

The Suboscines were distributed among 8 families (Figure 2). The most species rich family within this suborder was Thamnophilidae (antbirds; 40 species) followed by Furnaridae (ovenbirds; 35 species) and Tyrannidae (tyrant flycatchers; 30 species). Pipridae (manakins) had 7 species, Tityridae (tityras and allies) 6 species, Cotingidae (cotingas) 5 species, and Formicariidae (anththrushes) had 3 species.

The most species rich family among the Oscines was Thraupidae (tanagers; 12 species). Vireonidae (vireos) and Turdidae (thrushes) had 4 species each, while Hirundinidae (swallows), Troglodytidae (New World wrens) and Icteridae (New World blackbirds) had 3 species each. Fringillidae (finches) had 2 species and Corvidae (crows), Polioptilidae (gnatchatchers), Passerellidae (New World sparrows) and Cardinalidae (cardinals) had one species each (Figure 2).

Amongst all other Neoaves, Psittacidae (parrots) had 10 species, Picidae (woodpeckers) 9 species and Trochilidae (hummingbirds), Bucconidae (puffbirds) and Accipitridae (hawks) had 5 species each. Galbulidae (jacamars) and Cracidae (ortalis) had 4 species each, while Cuculidae (cuckoos) and Ramphastidae (toucans) had 3 species each (Figure 2). Caprimulgidae (nightjars), Ardeidae (herons) and Alcedinidae (kingfishers) had 2 species each. Eurypygidae (Bittern), Nyctibiidae (potoos), Apodidae (swifts), Columbidae (pigeons and doves), Opisthocomidae (Hoatzin), Theskironithidae (ibis), Rallidae (rails), Strigidae (owls), Trogonidae (trogons), Capitonidae (New World barbets) and Falconidae (falcons) all had one species each (Figure 2).

Paleognath Tinamidae had 3 species, while Neognath Anatidae had one species.

Figure 2 also shows that Tinamidae, Anatidae, Eurypygidae, Nyctibiidae, Columbidae, Opisthocomidae, Threskiornithidae, Ardeidae, Rallidae, Strigidae, Trogonidae and Falconidae have an origin from more than 40 million years ago. Most other bird families have evolved in the last 10 – 15 million years, with all Passeriformes, Psittacidae and Picidae showing a more recent diversification.

A mean value for PD was calculated from 500 phylogenies, indicating an accrued 4989,84 million years of evolutionary history.

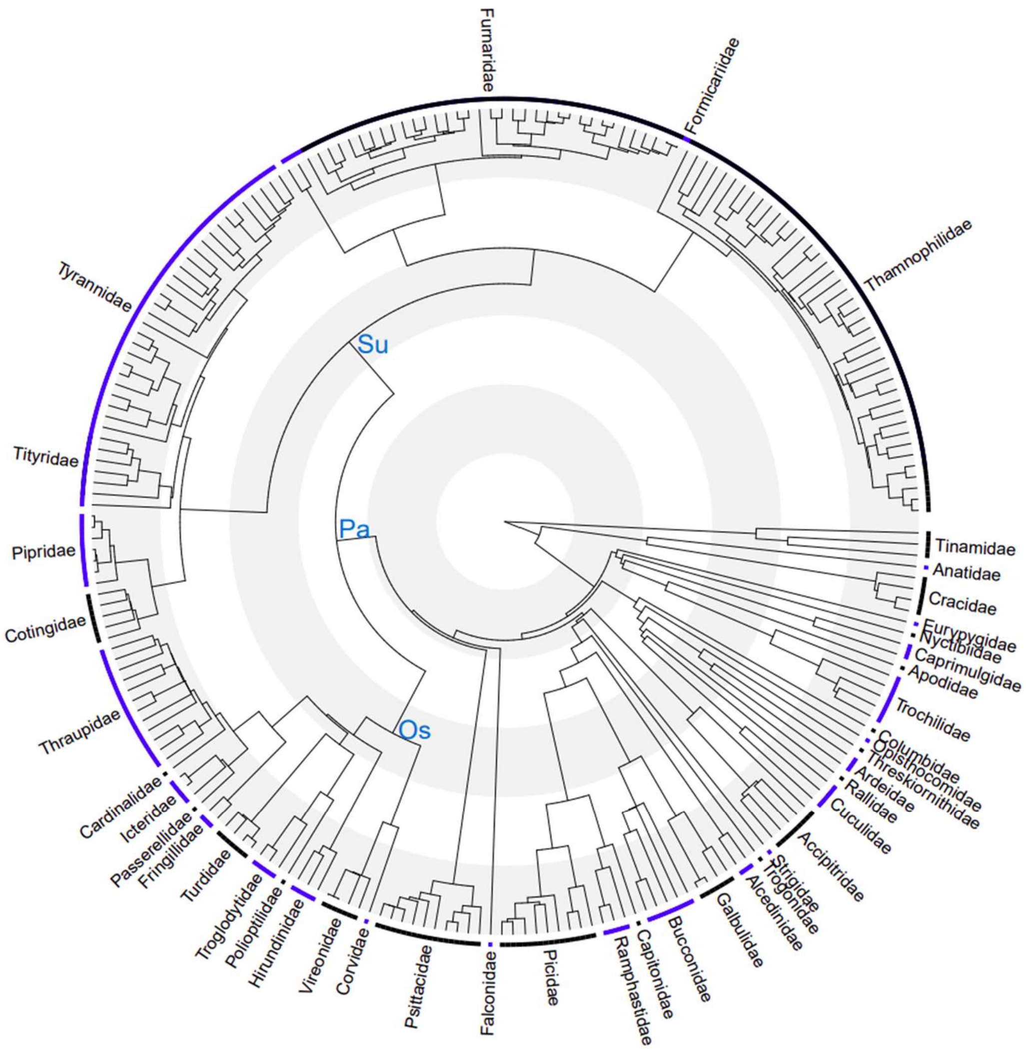

Figure 2. Maximum Likelihood Phylogenetic Cladogram showing distribution of Amazonian floodplain forest birds. Major nodes indicate Passerines (Pa), Oscines (Os) and Suboscines (Su). Tip labels denote Family. Central root shows split between Paleognathae (Tinamidae) and Neognathae (Anatidae) and Neoaves (all other families). Concentric circles show time from the present in 20 million years intervals.

Evolutionary Distinctiveness

Oressochen jubatus, the Orinoco Goose (Figure 3A) was the most evolutionarily distinct species. Other species with high evolutionary distinctiveness are *Eurypyga helias*, *Leptotila rufaxilla*, *Daptrius ater*, *Nyctibius grandis*, *Pulsatrix perspicillata*, *Opisthocomus hoazin*, *Trogon curucui*, *Aramides cajaneus* and *Crotophaga major* (Figure 3A-J,

Table 1). Each of these species is the only representative of a single family (Figure 2).

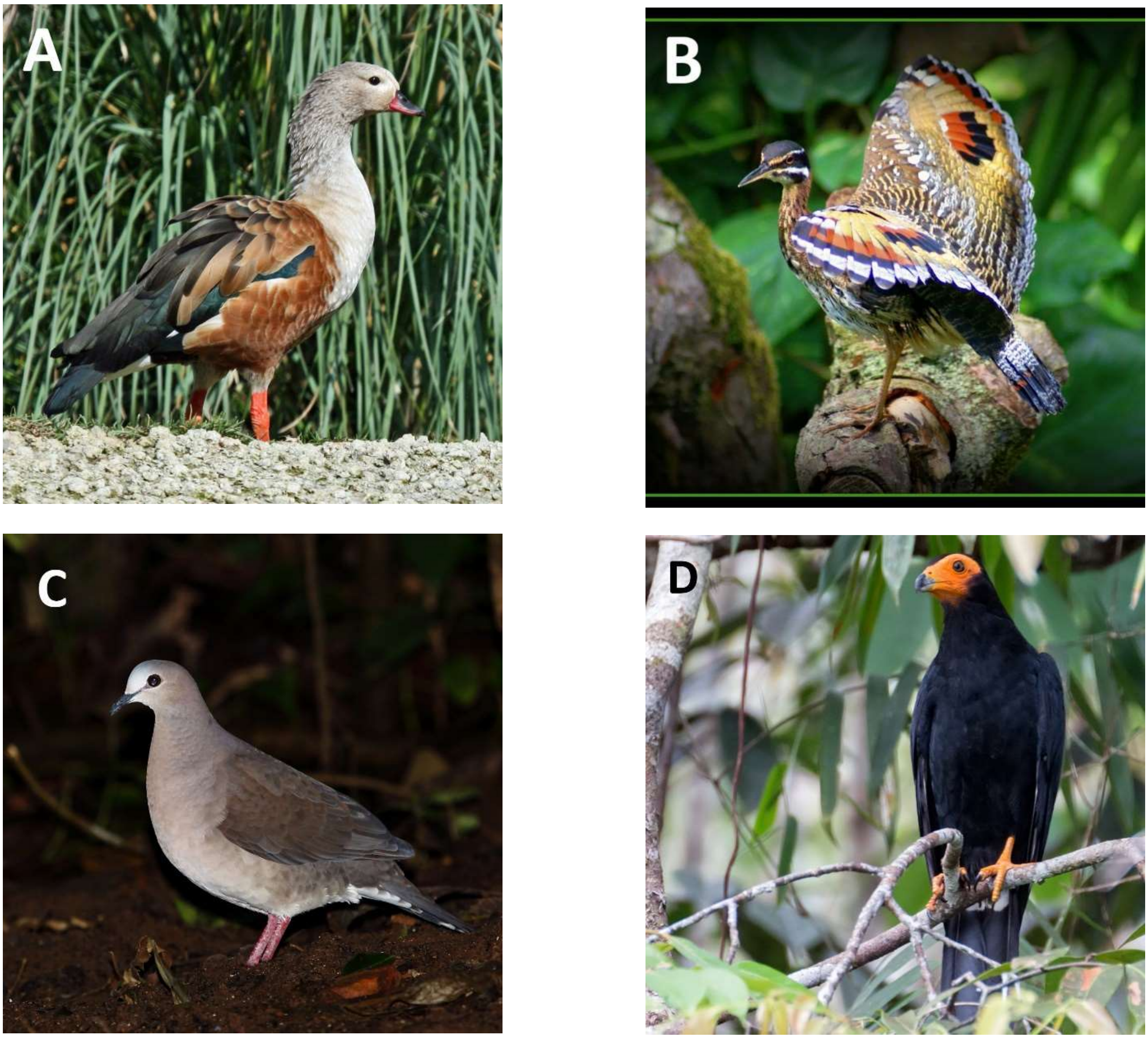

Figure 3. Ten most evolutionary distinctive birds. A – Orinoco Goose (Oressochen jubatus); B – Sun bittern (Eurypyga helias); C – Gray-fronted Dove (Leptotila rufaxilla); D – Black Caracara (Daptrius ater); E – Great Potoo (Nyctibius grandis); F – Spectacled Owl (Pulsatrix perspicillata); G – Hoatzin (Opisthocomus hoazin); H – Blue-crowned Trogon (Trogon curucui); I – Grey-cowled Wood Rail (Aramides cajaneus); J – Greater Ani (Crotophaga major)

(Credits A, C-J: Wikimedia commons; B - Flickr)

Table 1. Mean evolutionary distinctiveness (ED) values for 10 most evolutionarily distinct species found in várzea (VZ) and igapó (IG). Mean ED for each species calculated from 500 phylogenies. IUCN category NT = Near Threatened, LC = Least Concern.

SPECIES (birdtree)	**UPDATED TAXONOMY**	**FAMILY**	**COMMON NAME**	**MEAN ED**	**HABITAT**	**IUCN CATEGORY**
Neochen jubata	*Oressochen jubatus*	Anatidae	Orinoco goose	83,35	VZ	NT
Eurypyga helias	*Eurypyga helias*	Eurypygidae	Sun bittern	82,83	VZ/IG	LC
Leptotila rufaxilla	*Leptotila rufaxilla*	Columbidae	Gray-fronted dove	80,74	VZ	LC
Daptrius ater	*Daptrius ater*	Falconidae	Black caracara	79,76	VZ/IG	LC
Nyctibius grandis	*Nyctibius grandis*	Nyctibiidae	Great Potoo	79,20	VZ/IG	LC
Pulsatrix perspicillata	*Pulsatrix perspicillata*	Strigidae	Spectacled owl	78,80	VZ/IG	LC
Opisthocomus hoazin	*Opisthocomus hoazin*	Opisthocomidae	Hoatzin	77,41	VZ	LC
Trogon curucui	*Trogon curucui*	Trogonidae	Blue-crowned Trogon	75,42	VZ	LC
Aramides cajanea	*Aramides cajaneus*	Rallidae	Grey-cowled woodrail	74,19	VZ/IG	LC
Crotophaga major	*Crotophaga major*	Cuculidae	Greater Ani	73,94	VZ/IG	LC

4. Discussion

I identified 230 Amazonian floodplain specialist bird species. This is around 17% of the approximately 1,300 species present in the Amazon (Eisemberg & Reynolds, 2017).

The results in this study showed high numbers of Passeriformes species consistent with earlier research on floodplain forests and river-created habitats (Haugaasen & Peres, 2008; Laranjeiras et al., 2020; Naka et al., 2007; Remsen & Parker, 1983). The extent of river-bound distributions of taxa in Amazonia is unparalleled (Naka & Brumfield, 2018), and provides opportunities for species to exploit open niches (Cadotte et al., 2012). Groups of closely-related species tend to occupy niches that are similar (Cadotte et al., 2012; Futuyma, 2010), which may explain the large number of Passeriformes that have evolved to occupy flooded forest habitats.

The most species-rich family was Thamnophilidae with 40 species (

Supplementary Information

Table S1). Most species are restricted to few habitats and microhabitats and are generally bound within specific habitat requirements (Remsen & Parker, 1983; Terborgh et al., 1990). These restrictions may support specialization to flooded forest habitats and explain their richness (Bravo, 2012).

Thamnophilids, or antbirds, are generally mid-storey or under-storey birds, much of whose habitat will be covered during flooding. A response of these birds to the flooding regime could be vertical migration (Beja et al., 2010; Rowedder et al., 2021), thereby adapting to seasonal flooding regimes. Other families that occupy mid- and under-storeys may also adapt by migrating vertically, thereby continuing their presence in the flooded forests and maintaining species richness despite seasonal flooding (Sherry et al., 2020). However, obligate ant-followers may migrate between terra firme and floodplain forests (Beja et al., 2010).

In this study, 10 species of macaw (family Psittacidae), were also present in floodplain forests, consistent with an earlier study (Haugaasen & Peres, 2008). The presence of macaws is correlated with fruit availability in these habitats, especially of the rubber tree (*Hevea spruceana*, Euphorbiaceae). The presence of the rubber tree in both várzea and igapó forests supports the presence of 10 species of macaws in this study (Haugaasen & Peres, 2008).

The presence of kingfishers within the flooded forest is also consistent with a study by Beja et al. (2010). Associated with seasonal flooding is the migration of fish into floodplain forests seeking food and shelter and kingfishers follow prey through resource tracking. Influx of kingfishers into várzea was higher than igapó (Beja et al., 2010; Saint-Paul et al., 2000), showing a difference between white and black-water river created habitats. Other aquatic birds also track food resources into flooded areas (Beja et al., 2010).

There is an influx of nectarivores into flooded areas during the low water season. It has been found that differences in flooding regimes creates an asynchronized timing of leafing, flowering and fruiting, further shaping the seasonality of food resource availability (Haugaasen & Peres, 2005b; Haugaasen & Peres, 2007). There are peaks in fruiting in flooded forests during the inundation periods (Haugaasen & Peres, 2005b). During the dry season, when the ground becomes exposed, the fruits are deposited onto the ground (Haugaasen & Peres, 2007). As the waters recede, new growth emerges and flowers and nectar become readily available to nectarivores (Beja et al., 2010; Haugaasen & Peres, 2007). Hummingbirds were more abundant in flowering season when nectar availability was higher and the waters receded (Beja et al., 2010).

It has also been suggested (Remsen & Parker, 1983) that birds that occupy river-created habitats must be excellent dispersers compared to terra firme forest birds. Reports of migrating antbirds (family Formicariidae), a family generally considered to be sedentary, and Tinamous, considered poor dispersers has further supported this theory (Remsen & Parker, 1983). The species richness could perhaps be maintained by their dispersal over long distances. However, geographic isolation may have provided an opportunity for genetic differentiation and endemism in várzea forests (Naka et al., 2007).

The Amazonian floodplain forests are dependent on rivers for the flooding cycle and the species that inhabit the region are historically linked to the drainage system, which in turn may have impacted their distribution, and potential isolation (Naka & Brumfield, 2018). Most phylogeographic and taxonomic breaks within Amazonian avian lineages are in association with rivers (Naka & Brumfield, 2018). Further study can provide more information about how traits and genetic diversity are related (Harvey et al., 2017).

Of the 230 floodplain forest species, 134 are present only in várzea, 19 only in igapó and 77 occur in both habitats. Upland forests (terra firme) are interspersed with flooded forests, of which várzea are the most extensive, while in contrast igapó floodplain forests are less so (Junk, 1997). The larger areal extent of várzea (

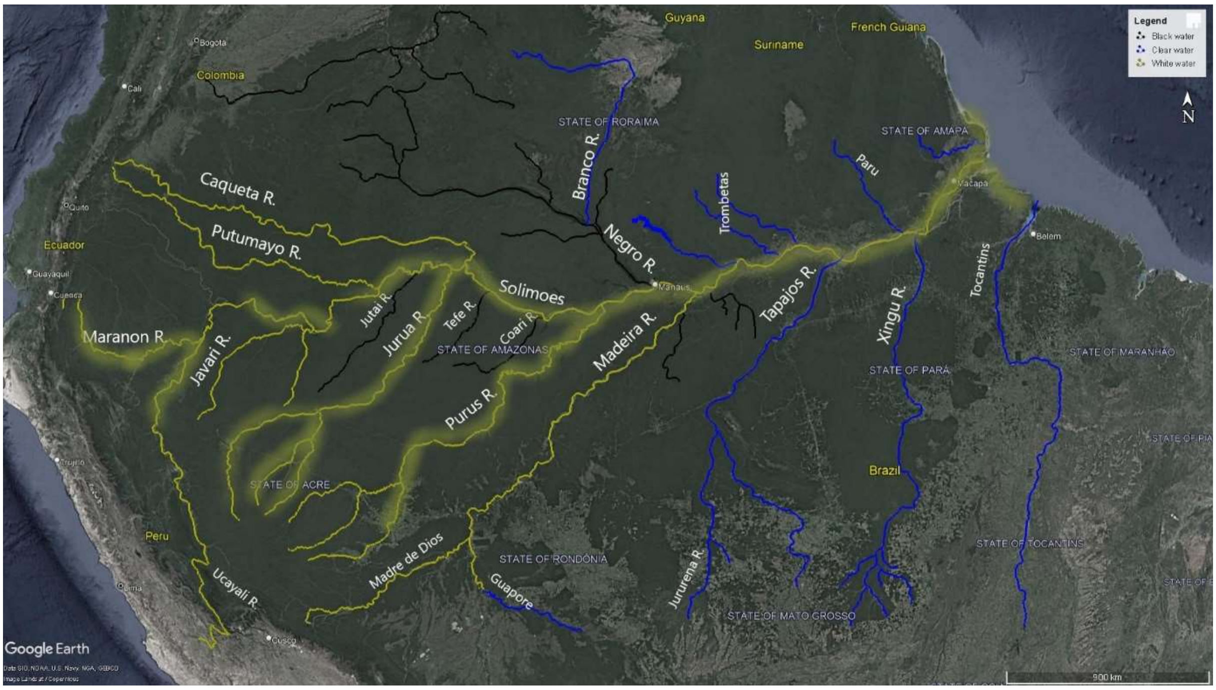

Figure 1) explains the relative species richness of these flooded forests (Remsen & Parker, 1983).

The differentiation of species in várzea may have been created by geographic isolation from terra firme forests, thereby restricting species to these habitats (Remsen & Parker, 1983) and explaining their higher species richness (Del-Rio et al., 2020; Gilmore, 2020; Haugaasen & Peres, 2008) relative to igapó. For example, the river Juruá (

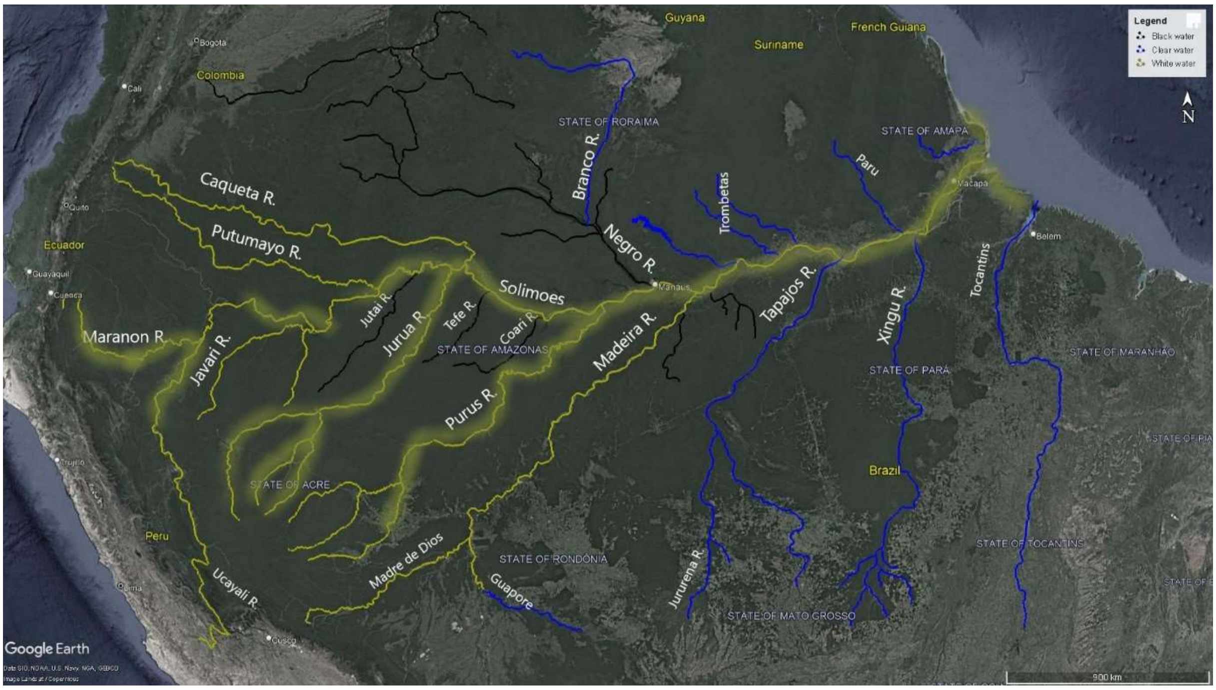

Figure 1), a white water river, being rather narrow, does not traditionally act as a geographic barrier across its banks (Del-Rio et al., 2020). However, the extensive várzea forest may act as a barrier to terra firme birds, as the distance between terra firme forests on opposite sides of the Juruá river was almost 20 km (Del-Rio et al., 2020).

In a study by Borges and Carvalhes (2000), bird species richness was found to be lower in igapó than terra firme in the lower Rio Negro region. Vegetation heterogeneity is lower in igapó than in both várzea and terra firme. A lack of under-storey plants in igapó may cause a change in bird species composition. For instance, Thamnophilids avoid igapó due to the lack of this under-storey. However, nectarivores, insectivores and bark insectivores were captured with similar frequency in the study in both igapó and terra firme (Borges & Carvalhes, 2000).

The assemblages of understorey birds in terra firme and flooded forests have been identified as vastly different, whereas differences between várzea and igapó have been only marginally significant (Beja et al., 2010; Haugaasen & Peres, 2008; Remsen & Parker, 1983). Várzea and igapó share species that are absent or scarce elsewhere and the results in this study show that there are 77 shared species between várzea and igapó. This may be explained by the fact that flooding is the primary environmental filter that allows for similarity in species between várzea and igapó, while this is completely absent in terra firme (Beja et al., 2010).

Major river confluences have an impact on the distribution of species. The Rio Negro is a blackwater river draining into the main stem of the Amazon (

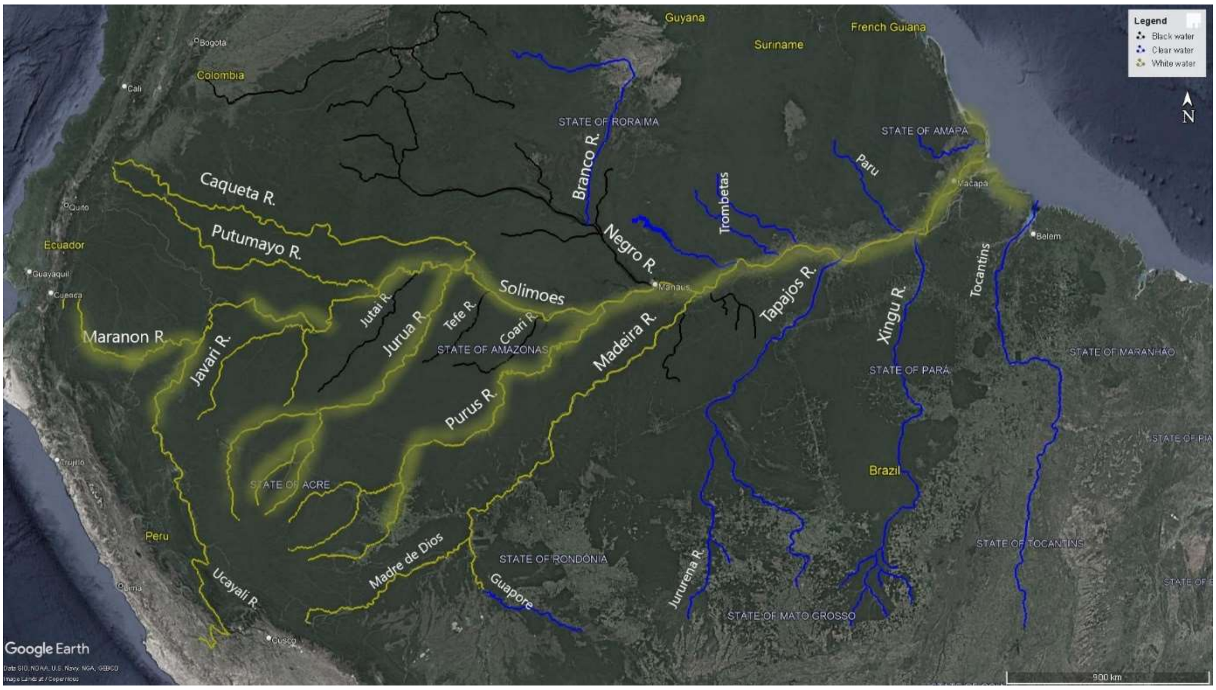

Figure 1), which is a whitewater river, forming what could be inferred as different floodplain forests. Here, species expected to occur in white-water floodplain forests are found along the muddy parts of the river confluence. A major finding of the study by Laranjeiras et al. (2020) showed that river type in this system has an impact on distribution of avifauna. Typical black-water species occur in the black-water part of the river, while influx of sediments from the Rio Branco promotes co-occurrence of species downstream of the confluence. This mixing of waters can further change species occurrences (Laranjeiras et al., 2020). Confluences need careful study as they could play a major role in limiting the distribution of certain species, thereby affecting the patterns of diversity in the Amazon floodplains.

Phylogenetic diversity

The Amazonian floodplain avifauna contain a large amount of phylogenetic diversity. Faith's PD for the species list (

Supplementary Information

Table S1) in this study was found to be 4989,84 million years of accrued evolutionary information. This is based on adding the branch lengths from the phylogeny, scaled in units of time - in this case, millions of years (Cadotte & Davies, 2010).

In Figure 2, the Maximum Likelihood phylogenetic cladogram displays relationships between families, while at the same time revealing evolutionary information about the clades. Jetz et al. (2012) have determined that birds have undergone a significant and rapid diversification, especially from about 50 million years ago to at least 5 million years ago. The largest clades are formed by Suboscines and Oscines from order Passeriformes, revealing a more recent and rapid evolution with morphological and behavioral adaptations (Ericson et al., 2003; Hackett et al., 2008; Jetz et al., 2012).

The primary split between Paleognathae and Neognathae, (estimated 165 million years ago (Ericson et al., 2006)) and the subsequent split between Galloansares (chickens, ducks, etc.) and the Neoaves has received consistent support through molecular and morphological phylogenetic studies. Ericson et al. (2006) have confirmed the Neoaves - Galloansares split in the mid-Cretaceous and the majority of diversification of Neoaves around or soon after the Cretaceous-Paleogene boundary (k/t boundary or K-Pg boundary), estimated 65 million years ago.

Resolving the phylogeny of the Neoaves continues to remain a challenge (Hackett et al., 2008). The reason for this is attributed to rapid temporal and spatial diversification, resulting in short internodes (Jetz et al., 2012; Prum et al., 2015). On a global scale, Passeriformes form the largest clade in Neoaves (Figure 2). Recent molecular phylogenetic studies and phylogeographic studies linking landscape evolution and species evolution have better developed to show consistent findings that the most current Amazonian species have originated during the Pliocene (5.33 to 2.58 million years ago) and the Pleistocene (2.58 million years ago to 11,700 years ago) (Ribas & Aleixo, 2019; Simspon & Haffer, 1978), which can explain the geographic patterns of Passeriformes (Jetz et al., 2012). The more recent origin of the Amazon drainage system (less than 10 million years ago) and its dynamic history, i.e. emergence and fluctuations of wetland and forest breeding habitats, may have had a strong influence on the recent evolution of species in flooded environments, a theory which received confirmation through genomic analysis of parrots and Passeriformes (Jetz et al., 2012; Ribas & Aleixo, 2019).

Phylogenetic diversity provides an understanding of cladistic relationships which is important for understanding lineages. It was determined (Hackett et al., 2008) that flighted Tinamous were not monophyletic. They are found within flightless Struthioniformes (ostriches and allies). The clade formed within Caprimulgiformes is made of families Apodidae, Trochilidae and Caprimulgidae, consistent with findings from Hackett et al.(2008) and Ericson et al. (2006). This suggests that diurnal Apodiformes evolved from a radiation of nocturnal ancestors. Their analysis also found that Falconidae and Accipitridae (raptor families) formed separate clades (Hackett et al., 2008).

Sun bittern was placed outside of the order Gruiformes and placed within Eurypygiformes in family Eurypygidae with relation to kagu, a species endemic to New Caledonia. The evolutionary position of the Hoatzin has yet to be resolved and further genetic and evolutionary studies are needed (Hackett et al., 2008).

The phylogeny and its representation in Figure 2, and the accrued evolutionary history, provide a partial understanding of the current taxonomic diversity and evolutionary relationships amongst taxa. In future studies, using abundance values and including presence/absence and species' associations with specific habitats can provide answers about the relationship between PD and habitat, providing greater support to habitat conservation.

Evolutionary Distinctiveness

The Amazonian floodplain forests contain several species with high evolutionary distinctiveness. These include some monotypic species that contain unique evolutionary data not found elsewhere in the phylogeny (Martyn et al., 2012).

Orinoco Goose, *Oressochen jubatus* (Figure 3A), is currently the only species in the genus Neochen in the family Anatidae. While primarily associated with open habitats along rivers and associated with sand beaches with grass stands, it requires large size trees with cavities for successful breeding (Del-Rio et al., 2020; Endo et al., 2014), found in flooded forests. Due to its large size and preference for open spaces, it remains conspicuous and easily hunted, cited as the main cause for its decline. It has a status of Near Threatened (IUCN, 2016). Expansion of protected areas to include riverbanks and sandy beaches can potentially improve the conservation status of the species (Endo et al., 2014).

Sun Bittern, *Eurypyga helias* (Figure 3B), is the only member of Family Eurypygidae. The species occurs along muddy banks of freshwater rivers and builds its nests in trees, making the floodplain forest important habitats for the bitterns. In addition, their sole presence in the

Neotropics within the family Eurypygiformes, further increases their evolutionary importance (Furo et al., 2015; MacLean, 2020).

Gray-fronted Dove, *Leptotila rufaxilla* (Figure 3C), in the family Columbidae is found in humid forests and occupies both várzea and terra firme and may be classified as a habitat generalist, with a large range. Further study is necessary to get a complete understanding of the species (Baptista et al., 2020).

Black caracara, *Daptrius ater* (Figure 3D), is a monotypic, distinctive member of the Amazonian raptor community in the family Falconidae, prominent in the lowlands and primarily associated with riverine habitats (Bierregaard et al., 2020). It is a naturally rare species found associated with forest edges and rivers (Peres, 1996).

Great Potoo, *Nyctibius grandis* (Figure 3E), is a monotypic species of genus Nyctibius, family Nyctibiidae, endemic to South and Central America, occupying a large range and found at lower elevations, often in tree canopies alongside bodies of water (Cohn-Haft, 1999). An enigmatic species, their life histories are cryptic and further study is required to clarify distributions and discovery of newer populations (Cohn-Haft, 1999).

Spectacled owl, *Pulsatrix perspicillata* (Figure 3F), in the family Strigidae, is a presumed common resident in different types of habitats in the tropical forests and has six recognized subspecies found in terra firme and gallery edge forests associated with igapó (Holt et al., 2020; Laranjeiras, 2019).

Hoatzin, *Opisthocomus hoazin* (Figure 3G), is a monotypic member of the genus Opisthocomus and family Opisthocomidae, endemic to the Americas and found in lowlands throughout South America. They are commonly found in riparian corridors along the Amazon and Orinoco River basins. They show year-round territories in permanently flooded areas. Substantial research has been conducted on the life histories of these charismatic bird species; however, their evolutionary history remains open to investigation. The Hoatzin has been linked as sister clade to a large group of land-birds, including Passeriformes, Piciformes, Coraciiformes, Psittaciformes, Accipitriformes and Strigiformes. Its status as the only extant species from the oldest lineage of birds places it in a unique position for further study within genetics and evolutionary uniqueness (Billerman, 2020; Prum et al., 2015).

Blue-crowned trogon, *Trogon curucui* (Figure 3H), in the family Trogonidae, is associated with riverine habitats, especially in the canopy and sub-canopy of várzea forests and is also present in other habitats like savanna woodland and dry deciduous forest. It is not threatened and is common in most territories (Collar, 2020).

Grey-cowled woodrail, *Aramides cajaneus* (Figure 3I), is considered the most widespread species of genus Aramides in the Rallidae family and occupies a large range in swampy forests and forest edges, and along the edges of forest streams. The species may be affected adversely by habitat destruction, but is adaptable (Taylor, 2020).

Greater Ani, *Crotophaga major* (Figure 3J), from the Cuculidae family is one of its most social members. They are widely distributed in the lowlands of South America and especially in forested habitats near water. Cladistic relationships have been well established and placed Guira cuckoo and other Anis (*Crotophaga* spp.) together in a monophyletic clade. The species is dependent on forests for nesting and breeding, and habitat changes can have negative consequences (Riehl, 2020).

Species with high ED have relatively ancient-recorded speciation events and lack close relatives. On the other hand, low ED species have had more recent divergences and are clearly not relics of the past (Jetz et al., 2014). In this study, the presence of evolutionarily distinct species offers an opportunity to examine if conservation efforts are targeting evolutionarily important species and protecting them sufficiently.

5. Conservation Implications

In this study, I identified 230 bird species as endemic to the Amazonian floodplain forests. The contribution of flooded forests to overall Amazonian bird species richness and the number of species restricted to these habitats has important implications for conservation, as established in earlier studies (Beja et al., 2010; Haugaasen & Peres, 2005a; Haugaasen & Peres, 2005b; Haugaasen & Peres, 2006; Haugaasen & Peres, 2008; Remsen & Parker, 1983). These habitats also comprise birds that capture a large amount of evolutionary history. Through this study, I have attempted to highlight the vital role that floodplain forests play with their contribution to total avian evolutionary history and evolutionarily unique species.

However, disturbance of the flood pulse in the Amazonian floodplains through infrastructure development (e.g. hydroelectric dams) or global climate change (in the form of extreme floods or droughts) can pose a serious threat to the ecology of the seasonally flooded forests across Amazonia (Latrubesse et al., 2017). There is therefore a pressing need to better our understanding of biodiversity patterns and community assemblages across the Amazonian floodplains.

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Supplementary Information

Table S1: Compiled list of 230 floodplain forest species. (Rows in bold indicate taxonomy corrections for use in birdtree.org. Suborder shows Suboscine and Oscine differentiation only for species within order Passeriformes. For all non-Passeriform species, order and suborder are same. Habitat shows species presence in one type of habitat, várzea or igapó, or both.)*

SPECIES (FOR BIRDTREE USE)	UPDATED TAXONOMY	COMMON NAME	ORDER	SUBORDER*	FAMILY	HABITAT (igapó/várzea/ both)
Agamia agami	*Agamia agami*	Agami heron	PELECANIFORMES	Pelecaniformes	Ardeidae	both
Amazona amazonica	*Amazona amazonica*	Orange-winged parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Amazona festiva	*Amazona festiva*	Festive parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	both
Amazona ochrocephala	*Amazona ochrocephala*	Yellow-crowned parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Ammodramus aurifrons	*Ammodramus aurifrons*	Yellow-browed sparrow	PASSERIFORMES	Oscines	Passerellidae	várzea
Ancistrops strigilatus	*Ancistrops strigilatus*	Chestnut-winged hookbill	PASSERIFORMES	Suboscines	Furnaridae	várzea
Ara ararauna	*Ara ararauna*	Blue-and-yellow macaw	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Ara severus	*Ara severus*	Chestnut-fronted macaw	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Aramides cajanea	***Aramides cajaneus***	**Gray-cowled Wood-rail**	**GRUIFORMES**	**Gruiformes**	**Rallidae**	**both**
Aratinga leucophthalma	***Psittacara leucophthalmus***	**White-eyed parakeet**	**PSITTACIFORMES**	**Psittaciformes**	**Psittacidae**	**várzea**
Atticora fasciata	*Atticora fasciata*	White-banded swallow	PASSERIFORMES	Oscines	Hirundinidae	várzea
Atticora melanoleuca	***Pygochelidon melanoleuca***	**Black-collared swallow**	**PASSERIFORMES**	**Oscines**	**Hirundinidae**	**várzea**
Attila bolivianus	*Attila bolivianus*	Dull-capped attila	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Attila cinnamomeus	*Attila cinnamomeus*	Cinnamon attila	PASSERIFORMES	Suboscines	Tyrannidae	both

Automolus infuscatus	*Automolus infuscatus*	Olive-backed Foliage gleaner	PASSERIFORMES	Suboscines	Furnaridae	várzea
Automolus melanopezus	*Automolus melanopezus*	Brown-rumped foliage gleaner	PASSERIFORMES	Suboscines	Furnaridae	both
Automolus rufipileatus	*Automolus rufipileatus*	Chestnut-crowned Foliage gleaner	PASSERIFORMES	Suboscines	Furnaridae	várzea
Bucco macrodactylus	*Bucco macrodactylus*	Chestnut-capped puffbird	GALBULIFORMES	Galbuliformes	Bucconidae	várzea
Bucco tamatia	*Bucco tamatia*	Spotted Puffbird	GALBULIFORMES	Galbuliformes	Bucconidae	both
Busarellus nigricollis	*Busarellus nigricollis*	Black-collared hawk	ACCIPITRIFORMES	Accipitriformes	Accipitridae	igapó
Campylorhamphus trochilirostris	*Campylorhamphus trochilirostris*	Red-billed Scythebill	PASSERIFORMES	Suboscines	Furnaridae	várzea
Capito aurovirens	*Capito aurovirens*	Scarlet-crowned barbet	PICIFORMES	Piciformes	Capitonidae	várzea
Capsiempis flaveola	*Capsiempis flaveola*	Yellow tyrannulet	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Celeus elegans	*Celeus elegans*	Chestnut woodpecker	PICIFORMES	Piciformes	Picidae	várzea
Celeus flavus	*Celeus flavus*	Cream-colored woodpecker	PICIFORMES	Piciformes	Picidae	both
Celeus grammicus	*Celeus grammicus*	Scale-breasted woodpecker	PICIFORMES	Piciformes	Picidae	várzea
Celeus torquatus	*Celeus torquatus*	Ringed woodpecker	PICIFORMES	Piciformes	Picidae	várzea
Cephalopterus ornatus	*Cephalopterus ornatus*	Amazonian umbrella bird	PASSERIFORMES	Suboscines	Cotingidae	both
Cercomacra carbonaria	*Cercomacra carbonaria*	Rio Branco antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Cercomacra nigrescens	***Cercomacroides nigrescens***	**Blackish antbird**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**várzea**
Cercomacra serva	***Cercomacroides serva***	**Black antbird**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**várzea**

Chaetura cinereiventris	*Chaetura cinereiventris*	Gray-rumped Swift	CAPRIMULGIFORMES	Caprimulgiformes	Apodidae	igapó
Chlorestes notata	*Chlorestes notata*	Blue-chinned sapphire	CAPRIMULGIFORMES	Caprimulgiformes	Trochilidae	both
Chloroceryle aenea	*Chloroceryle aenea*	American Pygmy Kingfisher	CORACIIFORMES	Coraciiformes	Alcedinidae	várzea
Chloroceryle inda	*Chloroceryle inda*	Green-and-rufous kingfisher	CORACIIFORMES	Coraciiformes	Alcedinidae	igapó
Chondrohierax uncinatus	*Chondrohierax uncinatus*	Hook-billed Kite	ACCIPITRIFORMES	Accipitriformes	Accipitridae	both
Clypicterus oseryi	***Cacicus oseryi***	**Casqued Cacique**	**PASSERIFORMES**	**Oscines**	**Icteridae**	**várzea**
Cnemotriccus fuscatus	*Cnemotriccus fuscatus*	Fuscous flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Coccycua minuta	*Coccycua minuta*	Little cuckoo	CUCULIFORMES	Cuculiformes	Cuculidae	várzea
Coccyzus melacoryphus	*Coccyzus melacoryphus*	Dark-billed cuckoo	CUCULIFORMES	Cuculiformes	Cuculidae	igapó
Colaptes punctigula	*Colaptes punctigula*	Spot-breasted woodpecker	PICIFORMES	Piciformes	Picidae	both
Conirostrum bicolor	*Conirostrum bicolor*	Bicolored conebill	PASSERIFORMES	Oscines	Thraupidae	várzea
Conirostrum speciosum	*Conirostrum speciosum*	Chestnut - vented conebill	PASSERIFORMES	Oscines	Thraupidae	várzea
Conopias trivirgatus	*Conopias trivirgatus*	Three-striped flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Cotinga maynana	*Cotinga maynana*	Plum-throated cotinga	PASSERIFORMES	Suboscines	Cotingidae	várzea
Cranioleuca gutturata	*Cranioleuca gutturata*	Speckled spinetail	PASSERIFORMES	Suboscines	Furnaridae	várzea
Cranioleuca muelleri	*Cranioleuca muelleri*	Scaled spinetail	PASSERIFORMES	Suboscines	Furnaridae	várzea
Cranioleuca vulpina	*Cranioleuca vulpina*	Rusty-backed spinetail	PASSERIFORMES	Suboscines	Furnaridae	várzea
Crax globulosa	*Crax globulosa*	Wattled curassow	GALLIFORMES	Galliformes	Cracidae	várzea
Crotophaga major	*Crotophaga major*	Greater Ani	CUCULIFORMES	Cuculiformes	Cuculidae	both

Crypturellus brevirostris	*Crypturellus brevirostris*	Rusty tinamou	TINAMIFORMES	Tinamiformes	Tinamidae	várzea
Crypturellus cinereus	*Crypturellus cinereus*	Cinereus tinamou	TINAMIFORMES	Tinamiformes	Tinamidae	várzea
Crypturellus undulatus	*Crypturellus undulatus*	Undulated tinamou	TINAMIFORMES	Tinamiformes	Tinamidae	both
Cyanerpes caeruleus	*Cyanerpes caeruleus*	Purple honeycreeper	PASSERIFORMES	Oscines	Thraupidae	várzea
Cyanocorax violaceus	*Cyanocorax violaceus*	Violaceous Jay	PASSERIFORMES	Oscines	Corvidae	várzea
Cyphorhinus arada	*Cyphorhinus arada*	Musician wren	PASSERIFORMES	Oscines	Troglodytidae	várzea
Dacnis flaviventer	*Dacnis flaviventer*	Yellow-bellied dacnis	PASSERIFORMES	Oscines	Thraupidae	both
Daptrius ater	*Daptrius ater*	Black caracara	FALCONIFORMES	Falconiformes	Falconidae	both
Deconychura longicauda	*Deconychura longicauda*	Long tailed woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	várzea
Dendrexetastes rufigula	*Dendrexetastes rufigula*	Cinnamon-throated woodpecker	PASSERIFORMES	Suboscines	Furnaridae	both
Dendrocincla merula	*Dendrocincla merula*	White-chinned woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Dendrocolaptes certhia	*Dendrocolaptes certhia*	Amazonian Barred-Woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Dendrocolaptes picumnus	*Dendrocolaptes picumnus*	Black-banded Woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Dendroplex kienerii	*Dendroplex kienerii*	Zimmer's woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Dendroplex picus	*Dendroplex picus*	Straight-billed Woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Epinecrophylla ornata	*Epinecrophylla ornata*	Ornate stipplethroat	PASSERIFORMES	Suboscines	Thamnophilidae	both
Eucometis penicillata	*Eucometis penicillata*	Gray-headed Tanager	PASSERIFORMES	Oscines	Thraupidae	várzea
Euphonia chrysopasta	*Euphonia chrysopasta*	Golden-bellied Euphonia	PASSERIFORMES	Oscines	Fringillidae	várzea
Euphonia rufiventris	*Euphonia rufiventris*	Rufous-bellied Euphonia	PASSERIFORMES	Oscines	Fringillidae	várzea
Eurypyga helias	***Eurypyga helias helias***	**Sun bittern**	**EURYPYGIFORMES**	**Eurypygiformes**	**Eurypygidae**	**both**
Formicarius analis	*Formicarius analis*	Black-faced antthrush	PASSERIFORMES	Suboscines	Formicariidae	both

Formicarius colma	*Formicarius colma*	Rufous-capped antthrush	PASSERIFORMES	Suboscines	Formicariidae	várzea
Furnarius leucopus	*Furnarius leucopus*	Pale-legged Hornero	PASSERIFORMES	Suboscines	Furnaridae	várzea
Furnarius torridus	*Furnarius torridus*	Pale-billed hornero	PASSERIFORMES	Suboscines	Furnaridae	várzea
Galbalcyrhynchus leucotis	*Galbalcyrhynchus leucotis*	White-eared Jacamar	PICIFORMES	Piciformes	Galbulidae	várzea
Galbalcyrhynchus purusianus	*Galbalcyrhynchus purusianus*	Purus Jacamar	PICIFORMES	Piciformes	Galbulidae	várzea
Galbula galbula	*Galbula galbula*	Green-tailed jacamar	PICIFORMES	Piciformes	Galbulidae	both
Galbula tombacea	*Galbula tombacea*	White chinned jacamar	PICIFORMES	Piciformes	Galbulidae	várzea
Geranospiza caerulescens	*Geranospiza caerulescens*	Crane Hawk	ACCIPITRIFORMES	Accipitriformes	Accipitridae	both
Glyphorynchus spirurus	*Glyphorynchus spirurus*	Wedge-billed woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Granatellus pelzelni	*Granatellus pelzelni*	Rose-breasted Chat	PASSERIFORMES	Oscines	Cardinalidae	both
Graydidascalus brachyurus	*Graydidascalus brachyurus*	Short-tailed parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Gymnoderus foetidus	*Gymnoderus foetidus*	Bare-necked fruitcrow	PASSERIFORMES	Suboscines	Cotingidae	igapó
Gymnopithys salvini	***Oneillornis salvini***	**White-throated Antbird**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**both**
Helicolestes hamatus	*Helicolestes hamatus*	Slender-billed Kite	ACCIPITRIFORMES	Accipitriformes	Accipitridae	várzea
Hemitriccus minor	*Hemitriccus minor*	Snethlage's Tody-Tyrant	PASSERIFORMES	Suboscines	Tyrannidae	igapó
Herpsilochmus dorsimaculatus	*Herpsilochmus dorsimaculatus*	Spot-backed antwren	PASSERIFORMES	Suboscines	Thamnophilidae	igapó
Heterocercus aurantiivertex	*Heterocercus aurantiivertex*	Orange-crowned manakin	PASSERIFORMES	Suboscines	Pipridae	both
Heterocercus flavivertex	*Heterocercus flavivertex*	Flame-crowned manakin	PASSERIFORMES	Suboscines	Pipridae	igapó
Heterocercus linteatus	*Heterocercus linteatus*	Ladder-tailed nightjar	PASSERIFORMES	Suboscines	Pipridae	várzea

Hydropsalis climacocerca	*Hydropsalis climacocerca*	Ladder-tailed Nightjar	CAPRIMULGIFORMES	Caprimulgiformes	Caprimulgidae	várzea
Hyloctistes subulatus	***Automolus subulatus***	**Striped Woodhaunter**	**PASSERIFORMES**	**Suboscines**	**Furnaridae**	**várzea**
Hylophilus brunneiceps	*Hylophilus brunneiceps*	Brown-headed greenlet	PASSERIFORMES	Oscines	Vireonidae	igapó
Hylophilus hypoxanthus	***Pachysylvia hypoxantha***	**Dusky-capped Greenlet**	**PASSERIFORMES**	**Oscines**	**Vireonidae**	**várzea**
Hylophilus semicinereus	*Hylophilus semicinereus*	Gray-chested greenlet	PASSERIFORMES	Oscines	Vireonidae	várzea
Hylophilus thoracicus	*Hylophilus thoracicus*	Lemon-chested greenlet	PASSERIFORMES	Oscines	Vireonidae	várzea
Hylophylax naevius	*Hylophylax naevius*	Spot-backed Antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Hylophylax punctulatus	*Hylophylax punctulatus*	Dot-backed antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Hypocnemis peruviana	*Hypocnemis peruviana*	Peruvian Warbling-Antbird	PASSERIFORMES	Suboscines	Thamnophilidae	both
Hypocnemoides maculicauda	*Hypocnemoides maculicauda*	Band-tailed antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Hypocnemoides melanopogon	*Hypocnemoides melanopogon*	Black-chinned antbird	PASSERIFORMES	Suboscines	Thamnophilidae	both
Inezia subflava	*Inezia subflava*	Amazonian tyrannulet	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Knipolegus poecilocercus	*Knipolegus poecilocercus*	Amazonian Black-tyrant	PASSERIFORMES	Suboscines	Tyrannidae	igapó
Lampropsar tanagrinus	*Lampropsar tanagrinus*	Velvet-fronted grackle	PASSERIFORMES	Oscines	Icteridae	both
Lepidocolaptes albolineatus	*Lepidocolaptes albolineatus*	Guianan woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Leptotila rufaxilla	*Leptotila rufaxilla*	Gray-fronted Dove	COLUMBIFORMES	Columbiformes	Columbidae	várzea
Leucopternis schistaceus	***Buteogallus schistaceus***	**Slate-coloured Hawk**	**ACCIPITRIFORMES**	**Accipitriformes**	**Accipitridae**	**igapó**
Lipaugus vociferans	*Lipaugus vociferans*	Screaming Piha	PASSERIFORMES	Suboscines	Cotingidae	both

Lophotriccus galeatus	*Lophotriccus galeatus*	Helmeted Pygmy-tyrant	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Mesembrinibis cayennensis	*Mesembrinibis cayennensis*	Green Ibis	PELECANIFORMES	Pelecaniformes	Threskiornithidae	both
Microrhopias quixensis	*Microrhopias quixensis*	Dot-winged antwren	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Mionectes macconnelli	*Mionectes macconnelli*	McConnell's Flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Mitu tomentosum	***Pauxi tomentosa***	**Crestless Curassow**	**GALLIFORMES**	**Galliformes**	**Cracidae**	**both**
Monasa atra	*Monasa atra*	Black Nunbird	GALBULIFORMES	Galbuliformes	Bucconidae	várzea
Monasa nigrifrons	*Monasa nigrifrons*	Black-fronted nunbird	GALBULIFORMES	Galbuliformes	Bucconidae	both
Myiarchus ferox	*Myiarchus ferox*	Short-crested Flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	both
Myiodynastes maculatus	*Myiodynastes maculatus*	Streaked Flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	both
Myiopagis flavivertex	*Myiopagis flavivertex*	Yellow-crowned Elaenia	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Myiornis ecaudatus	*Myiornis ecaudatus*	Short-tailed Pygmy-Tyrant	PASSERIFORMES	Suboscines	Tyrannidae	igapó
Myiozetetes luteiventris	*Myiozetetes luteiventris*	Dusky-chested Flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Myrmeciza atrothorax	*Myrmophylax atrothorax*	Black-throated Antbird	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmeciza goeldii	***Akletos goeldii***	**Goeldi's Antbird**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**várzea**
Myrmeciza hyperythra	***Myrmelastes hyperythrus***	**Plumbeous antbird**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**várzea**
Myrmeciza melanoceps	***Akletos melanoceps***	**White-shouldered Antbird**	**PASSERIFORMES**	**Suboscines**	**Formicariidae**	**várzea**
Myrmoborus leucophrys	*Myrmoborus leucophrys*	White-browed antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Myrmoborus lugubris	*Myrmoborus lugubris*	Ash-breasted antbird	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmoborus melanurus	*Myrmoborus melanurus*	Black-tailed antbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea

Myrmotherula assimilis	*Myrmotherula assimilis*	Leaden antwren	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmotherula axillaris	*Myrmotherula axillaris*	White-flanked Antwren	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Myrmotherula brachyura	*Myrmotherula brachyura*	Pygmy antwren	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Myrmotherula cherriei	*Myrmotherula cherriei*	Cherrie's antwren	PASSERIFORMES	Suboscines	Thamnophilidae	igapó
Myrmotherula hauxwelli	***Isleria hauxwelli***	**Plain-throated Antwren**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**both**
Myrmotherula klagesi	*Myrmotherula klagesi*	Klages' Antwren	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmotherula longipennis	*Myrmotherula longipennis*	Long-winged Antwren	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmotherula multostriata	*Myrmotherula multostriata*	Amazonian Streaked-Antwren	PASSERIFORMES	Suboscines	Thamnophilidae	both
Myrmotherula surinamensis	*Myrmotherula surinamensis*	Guianan-streaked antwren	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Nasica longirostris	*Nasica longirostris*	Long-billed woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Nemosia pileata	*Nemosia pileata*	Hooded Tanager	PASSERIFORMES	Oscines	Thraupidae	várzea
Neochen jubata	***Oressochen jubatus***	**Orinoco Goose**	**ANSERIFORMES**	**Anseriformes**	**Anatidae**	**várzea**
Neoctantes niger	*Neoctantes niger*	Black Bushbird	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Nonnula amaurocephala	*Nonnula amaurocephala*	Chestnut-headed Nunlet	GALBULIFORMES	Galbuliformes	Bucconidae	igapó
Nyctibius grandis	*Nyctibius grandis*	Great Potoo	CAPRIMULGIFORMES	Caprimulgiformes	Nyctibiidae	both
Nyctiprogne leucopyga	*Nyctiprogne leucopyga*	Band-tailed nighthawk	CAPRIMULGIFORMES	Caprimulgiformes	Caprimulgidae	both
Ochthornis littoralis	*Ochthornis littoralis*	Drab water Tyrant	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Ocyalus latirostris	***Cacicus latirostris***	**Band-tailed Oropendola**	**PASSERIFORMES**	**Oscines**	**Icteridae**	**várzea**
Opisthocomus hoazin	*Opisthocomus hoazin*	Hoatzin	OPISTHOCOMIFORM ES	Opisthocomiformes	Opisthocomidae	várzea
Ortalis motmot	*Ortalis motmot*	Variable Chachalaca	GALLIFORMES	Galliformes	Cracidae	várzea

Pachyramphus minor	*Pachyramphus minor*	Pink-throated Becard	PASSERIFORMES	Suboscines	Tityridae	várzea
Pachyramphus polychopterus	*Pachyramphus polychopterus*	White-winged becard	PASSERIFORMES	Suboscines	Tityridae	várzea
Pachyramphus rufus	*Pachyramphus rufus*	Cinereus becard	PASSERIFORMES	Suboscines	Tityridae	várzea
Paroaria gularis	*Paroaria gularis*	Red-capped Cardinal	PASSERIFORMES	Oscines	Thraupidae	várzea
Phaeomyias murina	*Phaeomyias murina*	Mouse-colored Tyrannulet	PASSERIFORMES	Suboscines	Tyrannidae	igapó
Phaethornis hispidus	*Phaethornis hispidus*	White-bearded hermit	CAPRIMULGIFORMES	Caprimulgiformes	Trochilidae	várzea
Phaethornis ruber	*Phaethornis ruber*	Reddish Hermit	CAPRIMULGIFORMES	Caprimulgiformes	Trochilidae	várzea
Phaethornis rupurumii	*Phaethornis rupurumii*	Streak-throated Hermit	CAPRIMULGIFORMES	Caprimulgiformes	Trochilidae	both
Philydor erythrocercum	*Philydor erythrocercum*	Rufous-rumped Foliage-gleaner	PASSERIFORMES	Suboscines	Furnaridae	várzea
Philydor erythropterum	***Dendroma erythroptera***	**Chestnut-winged Foliage-gleaner**	**PASSERIFORMES**	**Suboscines**	**Furnaridae**	**várzea**
Philydor pyrrhodes	*Philydor pyrrhodes*	Cinnamon-rumped foliage gleaner	PASSERIFORMES	Suboscines	Furnaridae	várzea
Philydor ruficaudatum	***Anabacerthia ruficaudata***	**Rufous-tailed Foliage-gleaner**	**PASSERIFORMES**	**Suboscines**	**Furnaridae**	**várzea**
Phlegopsis nigromaculata	*Phlegopsis nigromaculata*	Black-spotted Bare eye	PASSERIFORMES	Suboscines	Thamnophilidae	both
Piculus flavigula	*Piculus flavigula*	Yellow-throated woodpecker	PICIFORMES	Piciformes	Picidae	várzea
Picumnus lafresnayi	*Picumnus lafresnayi*	Lafresnaye's Piculet	PICIFORMES	Piciformes	Picidae	igapó
Picumnus rufiventris	*Picumnus rufiventris*	Rufous-breasted piculet	PICIFORMES	Piciformes	Picidae	both
Picumnus várzeae	*Picumnus várzeae*	Várzea Piculet	PICIFORMES	Piciformes	Picidae	várzea
Pionites melanocephalus	*Pionites melanocephalus*	Black-headed Parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Pionus menstruus	*Pionus menstruus*	Blue-headed Parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea

Pipile cumanensis	*Pipile cumanensis*	Blue-throated piping Guan	GALLIFORMES	Galliformes	Cracidae	várzea
Pipra aureola	*Pipra aureola*	Crimson-headed manakin	PASSERIFORMES	Suboscines	Pipridae	várzea
Pipra fasciicauda	*Pipra fasciicauda*	Band-tailed Manakin	PASSERIFORMES	Suboscines	Pipridae	várzea
Pipra filicauda	*Pipra filicauda*	Wire-tailed manakin	PASSERIFORMES	Suboscines	Pipridae	both
Pitangus lictor	***Philohydor lictor***	**Lesser Kiskadee**	**PASSERIFORMES**	**Suboscines**	**Tyrannidae**	**both**
Platyrinchus coronatus	*Platyrinchus coronatus*	Golden-crowned spadebill	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Poecilotriccus senex	*Poecilotriccus senex*	Buff-cheeked Tody flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	igapó
Poecilotriccus sylvia	*Poecilotriccus sylvia*	Slate-headed Tody-flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Porphyrolaema porphyrolaema	*Porphyrolaema porphyrolaema*	Purple-throated cotinga	PASSERIFORMES	Suboscines	Cotingidae	both
Pteroglossus azara	*Pteroglossus azara*	Ivory-billed Aracari	PICIFORMES	Piciformes	Ramphastidae	both
Pteroglossus inscriptus	*Pteroglossus inscriptus*	Lettered Aracari	PICIFORMES	Piciformes	Ramphastidae	várzea
Pulsatrix perspicillata	*Pulsatrix perspicillata*	Spectacled Owl	STRIGIFORMES	Strigiformes	Strigidae	both
Pygiptila stellaris	*Pygiptila stellaris*	Spot-winged antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both
Pyrilia barrabandi	*Pyrilia barrabandi*	Orange-cheeked Parrot	PSITTACIFORMES	Psittaciformes	Psittacidae	várzea
Ramphocaenus melanurus	*Ramphocaenus melanurus*	Long-Billed Gnatwren	PASSERIFORMES	Oscines	Polioptilidae	várzea
Ramphocelus nigrogularis	*Ramphocelus nigrogularis*	Masked Crimson Tanager	PASSERIFORMES	Oscines	Thraupidae	várzea
Rhynchocyclus olivaceus	*Rhynchocyclus olivaceus*	Olivaceous Flatbill	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Sakesphorus canadensis	*Sakesphorus canadensis*	Black-crested antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both

Sakesphorus melanothorax	***Thamnophilus melanothorax***	**Band-tailed Antshrike**	**PASSERIFORMES**	**Suboscines**	**Thamnophilidae**	**both**
Saltator grossus	*Saltator grossus*	Slate-colored grosbeak	PASSERIFORMES	Oscines	Thraupidae	várzea
Schiffornis major	*Schiffornis major*	Várzea schiffornis	PASSERIFORMES	Suboscines	Tityridae	várzea
Sclateria naevia	*Sclateria naevia*	Silvered antbird	PASSERIFORMES	Suboscines	Thamnophilidae	both
Selenidera reinwardtii	*Selenidera reinwardtii*	Golden-collared Toucanet	PICIFORMES	Piciformes	Ramphastidae	várzea
Simoxenops ucayalae	***Syndactyla ucayalae***	**Peruvian Recurvebill**	**PASSERIFORMES**	**Suboscines**	**Furnaridae**	**both**
Sittasomus griseicapillus	*Sittasomus griseicapillus*	Olivaceous woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Stigmatura napensis	*Stigmatura napensis*	Lesser Wagtail Tyrant	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Synallaxis gujanensis	*Synallaxis gujanensis*	Plain-crowned Spinetail	PASSERIFORMES	Suboscines	Furnaridae	várzea
Synallaxis propinqua	***Mazaria propinqua***	**White-bellied Spinetail**	**PASSERIFORMES**	**Suboscines**	**Furnaridae**	**várzea**
Tachycineta albiventer	*Tachycineta albiventer*	White-winged Swallow	PASSERIFORMES	Oscines	Hirundinidae	both
Tachyphonus luctuosus	***Loriotus luctuosus***	**White-shouldered Tanager**	**PASSERIFORMES**	**Oscines**	**Thraupidae**	**várzea**
Tangara mexicana	*Tangara mexicana*	Turqoise tanager	PASSERIFORMES	Oscines	Thraupidae	both
Tangara schrankii	*Tangara schranki*	Green-and-gold Tanager	PASSERIFORMES	Oscines	Thraupidae	várzea
Taraba major	*Taraba major*	Great Antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	várzea
Terenotriccus erythrurus	*Terenotriccus erythrurus*	Ruddy-tailed flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Thamnomanes caesius	*Thamnomanes caesius*	Cinereous antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both
Thamnomanes schistogynus	*Thamnomanes schistogynus*	Bluish-slate antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	várzea

Thamnophilus amazonicus	*Thamnophilus amazonicus*	Amazonian antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both
Thamnophilus nigrocinereus	*Thamnophilus nigrocinereus*	Blackish-gray Antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both
Thamnophilus praecox	*Thamnophilus praecox*	Cocha Antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	igapó
Thamnophilus schistaceus	*Thamnophilus schistaceus*	Plain-winged Antshrike	PASSERIFORMES	Suboscines	Thamnophilidae	both
Threnetes leucurus	*Threnetes leucurus*	Pale-tailed Barbthroat	CAPRIMULGIFORMES	Caprimulgiformes	Trochilidae	both
Thripophaga fusciceps	*Thripophaga fusciceps*	Plain softtail	PASSERIFORMES	Suboscines	Furnaridae	várzea
Thryothorus griseus	***Cantorchilus griseus***	**Grey Wren**	**PASSERIFORMES**	**Oscines**	**Troglodytidae**	**várzea**
Thryothorus leucotis	***Cantorchilus leucotis***	**Buff-breasted Wren**	**PASSERIFORMES**	**Oscines**	**Troglodytidae**	**both**
Tityra cayana	*Tityra cayana*	Black-tailed Tityra	PASSERIFORMES	Suboscines	Tityridae	várzea
Tityra inquisitor	*Tityra inquisitor*	Black-crowned Tityra	PASSERIFORMES	Suboscines	Tityridae	várzea
Todirostrum maculatum	*Todirostrum maculatum*	Spotted tody flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	both
Tolmomyias poliocephalus	*Tolmomyias poliocephalus*	Gray-crowned flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Tolmomyias sulphurescens	*Tolmomyias sulphurescens*	Yellow-Olive flycatcher	PASSERIFORMES	Suboscines	Tyrannidae	both
Trogon curucui	*Trogon curucui*	Blue-crowned Trogon	TROGONIFORMES	Trogoniformes	Trogonidae	várzea
Turdus albicollis	*Turdus albicollis*	White-necked Thrush	PASSERIFORMES	Oscines	Turdidae	várzea
Turdus fumigatus	*Turdus fumigatus*	Cocoa thrush	PASSERIFORMES	Oscines	Turdidae	várzea
Turdus hauxwelli	*Turdus hauxwelli*	Hauxwell's Thrush	PASSERIFORMES	Oscines	Turdidae	várzea
Turdus lawrencii	*Turdus lawrencii*	Lawrence's thrush	PASSERIFORMES	Oscines	Turdidae	várzea
Tyrannus tyrannus	*Tyrannus tyrannus*	Eastern Kingbird	PASSERIFORMES	Suboscines	Tyrannidae	both
Xenopipo atronitens	*Xenopipo atronitens*	Black Manakin	PASSERIFORMES	Suboscines	Pipridae	várzea
Xenops minutus	*Xenops minutus*	Plain Xenops	PASSERIFORMES	Suboscines	Furnaridae	várzea

Xiphocolaptes promeropirhynchus	*Xiphocolaptes promeropirhynchus*	Strong-billed woodpecker	PASSERIFORMES	Suboscines	Furnaridae	igapó
Xiphorhynchus elegans	*Xiphorhynchus elegans*	Elegant woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	várzea
Xiphorhynchus obsoletus	*Xiphorhynchus obsoletus*	Striped woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	both
Xiphorhynchus ocellatus	*Xiphorhynchus ocellatus*	Ocellated woodcreeper	PASSERIFORMES	Suboscines	Furnaridae	várzea
Zebrilus undulatus	*Zebrilus undulatus*	Zigzag heron	PELECANIFORMES	Pelecaniformes	Ardeidae	both
Zimmerius acer	*Zimmerius acer*	Guianan Tyrannulet	PASSERIFORMES	Suboscines	Tyrannidae	várzea
Zimmerius gracilipes	*Zimmerius gracilipes*	Slender-footed Tyrannulet	PASSERIFORMES	Suboscines	Tyrannidae	várzea

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