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ARTICLE

Bird records in the northwestern and central portions of the Amazon Basin highlight the needs for inventories and long-term monitoring in the region

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ABSTRACT: Field records are critical to understand the bird species distribution in ecological and evolutionary contexts, especially in regions with high species diversity such as the Amazon Basin. Here we describe notable bird species records in areas with difficult access, sites monitored from long-term and human-impacted regions in the central and northwestern portions of the Amazon Basin. We present information for 35 selected species, including birds rarely observed in nature (*e.g. Crypturelus duidae*, *Ammonastes pelzelni*, *Cyanocorax heilprini*), species common in other biomes but rare in the Amazon (*e.g. Vanellus chilensis*, *Elaenia flavogaster*), and species apparently reported for the first time for the Amazonas state, Brazil (*e.g. Hydropsalis roraimae*, *Myrmeciza longipes*). Our records suggest recent colonization of central Amazon by some species, likely favored by the increasing environmental degradation in the region. In addition, records of species previously not reported for Amazonas state reinforce the relevance of inventories in poorly sampled regions. These bird records illustrates how biological inventories and long-term monitoring are complementary strategies for a better understand of distribution and dynamics of the Amazon avifauna.

KEY-WORDS: Amazonas state, biological inventories, colonization, dispersal.

INTRODUCTION

The understanding of biota distribution in ecological and evolutionary contexts has been considerably improved with ecological niche modeling, macroecological analysis and bioregionalization proposals (Keith *et al*. 2012, Peterson & Soberón 2012, Holt *et al*. 2013). These advances were only possible because an accumulation of distributional data organized in large public databases (*e.g.* Species Link, Global Biodiversity Facility) and specialized literature (*e.g.* Ridgely & Tudor 2009).

Species distributional data is available mainly from specimens collected and deposited in public natural history museums and documented field observations. The methods applied to inventory bird species have both advantages and limitations in terms of providing distributional data. It is widely accepted that specimen collection is the high-quality way to document species presence at a site. However, documentation by voucher specimens of all species present in an area rarely occurs due to logistic constraints such as time available to sampling avifauna. Consequently, distributional data can be complemented by other forms of documentation, including voice recording, videos, and photographs (Lees *et al*. 2014). Integrating different methods to generate distributional data is especially relevant in regions with high bird diversity such as the Amazon Basin (Lees *et al*. 2014).

Natural history and distributional data are available for a meaningful number of Amazonian birds thanks to the cumulative efforts of ornithologists and citizens interested in birds. Range extensions and new ecological information concerning birds are continuously reported, even for sites monitored for decades (Johnson *et al.* 2010, Lees *et al.* 2013, Rutt *et al*. 2017). Despite these remarkable advances, the geographical distribution of Amazonian birds found in regions with limited access remains poorly documented. Moreover, birds are well known for expanding their ranges and colonizing new regions. Therefore, species reports for sites under long-term monitoring are also strategically to understanding the temporal and spatial dynamics of bird distributions in different parts of the Amazon Basin (Cohn-Haft *et al.* 1997, Johnson *et al.* 2010, Lees *et al.* 2013, Rutt *et al*. 2017).

Over recent years, we have had the opportunities to carry out bird inventories in poorly-investigated regions of the Amazonas state, such as the Rio Negro-Rio Branco interfluve in northwestern Brazilian Amazon (Borges *et al.* 2014), and areas whose avifauna have been monitored for long-term, such as Jaú National Park (Borges *et al.* 2001, Borges & Almeida 2011). Also, we have made field observations in human-impacted landscapes in the Rio Negro-Rio Solimões interfluve, which is crossed by roads and connected to Manaus via a recently constructed bridge. Here, we present the results of these fieldworks, which include birds rarely observed in nature, species common in other biomes but rare in the Amazon, and species apparently reported for the first time for the Amazonas state avifauna.

METHODS

Study regions and methods

We studied avifauna in contrasting landscapes from disturbed side-road habitats to pristine forests and fields. Bird species were recorded in three main regions: i) Negro-Branco interfluve in the northwestern Amazonia, ii) lower course of the Rio Negro near the confluence with the Jaú River, and iii) Negro-Solimões interfluve in central Amazonia (Fig. 1). The natural and anthropogenic landscapes in these regions are very distinct and are described in more detailed below.

Negro-Branco Rivers interfluve: We studied the avifauna of the Aracá region during a series of short fieldwork visits between 2007 and 2010, and the results of the field expeditions were used to generate a preliminary checklist of 400 bird species (Borges *et al.* 2014). Sites visited by the authors in the Aracá River valley and the Serra do Aracá regions varied in altitude from 50 to 1200 m a.s.l. (Fig. 1). We sampled birds in all major habitats in the region, but gave special attention to extensive natural areas of open vegetation growing over sandy soils (white-sand campinas) and forests and high-altitude grasslands (tepuis). Serra do Aracá is a low mountain with maximum altitude of 1200 m a.s.l covered by vegetation typical of Venezuelan tepuis, with numerous endemic plant species (Prance & Johnson 1992). Our sampling effort on the Serra do Aracá was low compared to white-sand campinas in lowlands due difficulties of staying in the field for extended periods. Here we present a species-by-species analysis of selected records as a complement to the general faunistic analysis available in Borges *et al.* (2014), which details methods, sampling effort, habitat description and sites visited.

Negro and Jaú Rivers confluence: the avifauna of Jaú National Park (JNP) on the lower Negro River has been monitored since 1993 (Borges *et al.* 2001, Borges & Almeida 2011). In recent years, field efforts have

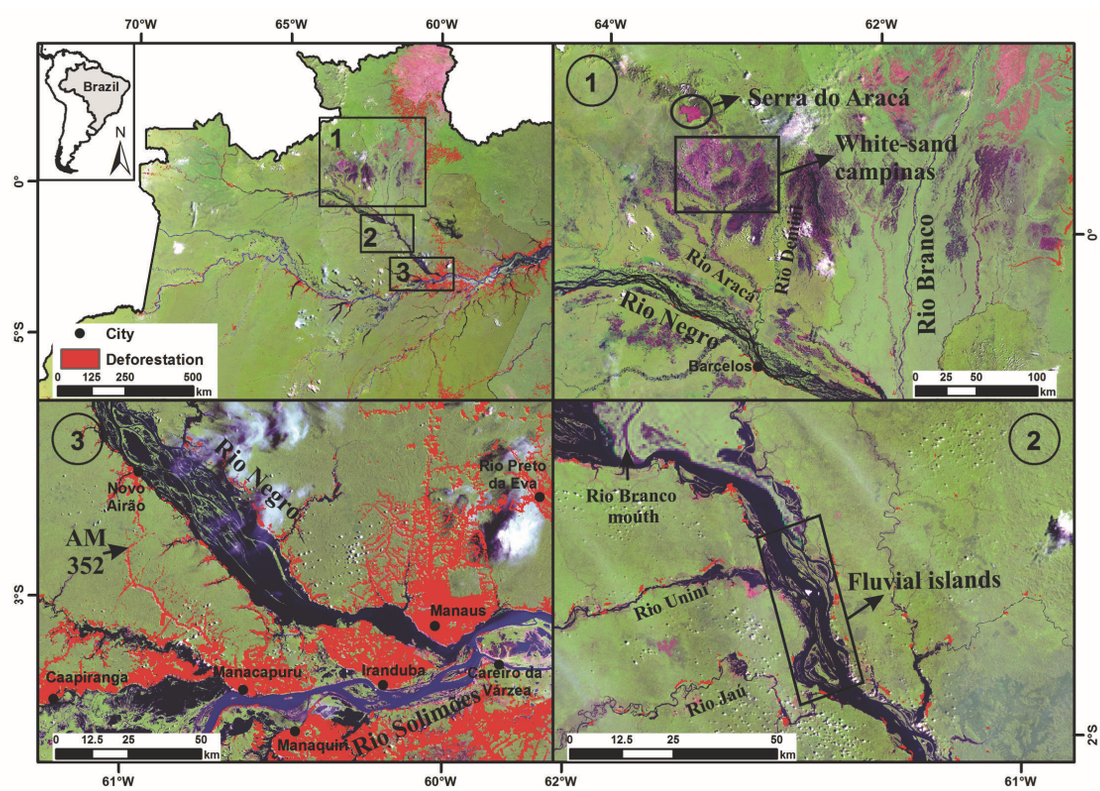

Figure 1. Landsat images of the studied regions in northwestern and central Amazon showing the major landscape and habitats where bird inventories were undertaken. Green tones represent different types of forests, mainly *terra firme* forest and flooded forests. See text for more detailed description of the landscapes.

focused on characterizing the avifauna of Negro River fluvial islands and of the patches of white-sand campinas located at the confluence of Jaú and Negro Rivers (Fig. 1). Fluvial islands vary from small sand bars of a few hectares covered with sparse vegetation, to large forested islands of thousands hectares in extent (Fig. 1). In contrast to the fluvial islands, white-sand campinas were located far from large rivers and have a very dense vegetation structure (Borges *et al.* 2016a). The general methodology used for sampling birds on islands and in white-sand campina patches included captures with mist-nets and qualitative censuses using tape recorders, photographs and sporadic specimen collections to document regional species presence. A quantitative analysis of bird assemblages on the Negro River islands is in preparation and will be presented elsewhere.

Negro-Solimões River interfluve: between 2009 and 2012 we sampled birds along the AM 070 and AM 352 state highways as well the secondary roads that cross the Negro/Solimões interfluve (Fig. 1). A recently inaugurated bridge provided a terrestrial connection between Manaus (the state capital) and the right margin of Negro River. It is likely that the sudden increase in accessibility to this part of the Negro River is causally linked to the increase in deforestation rates in the region (Fig. 1). The landscape along the AM 070 highway includes seasonally flooded grassland and forests, large fragments of secondary forests, active and abandoned pastures and agricultural fields. In contrast, the landscapes bordering the AM 352 highway are composed primarily of large tracts of lowland tropical rainforest with varying degrees of local disturbance, ranging from small-scale agricultural fields to forest subject to illegal logging (Fig. 1). Small patches of active and abandoned pasture are also present along this highway. In addition to these main study regions, we also include selected bird records from Uatumã River and Viruá National Park.

Bird species records were documented through voice recording, photographs or voucher specimens deposited in the Bird Collection of National Institute of Amazonian Research (INPA), Manaus, Amazonas. In most cases, the photographs and bird voices records have been made available at the wikiaves website (http://www.wikiaves.com.br). We searched both old and recent literature to confirm the presence of bird species in Amazonas state (Phelps & Phelps-Jr. 1947, Friedmann 1948, Phelps-Jr. 1972, Cohn-Haft *et al*. 1997, Mestre *et al.* 2010). We also made a systematic search of species at the wikiaves and xenocanto sites (http://www.wikiaves.com.br/, http://www.xeno-canto.org/), since these public databases has been proven to be important sources of scientific data (Lees & Martin 2015). Species taxonomic arrangement follows the Brazilian Ornithological Records Committee (Piacentini *et al*. 2015).

RESULTS

Below we detail the records of 35 selected bird species, most of them new records for Amazonas state or range extensions. To make the data easily available to other applications (*e.g.* reviews of species distribution maps), the individual records data were presented as a list in the Appendix I.

Gray-legged Tinamou - *Crypturellus duidae* Zimmer, 1938: this little tinamou is endemic to northwestern Amazonia with extensions of its range to northern Peru and central Amazonia in Jaú National Park (Novaes 1978, Alonso & Whitney 2003, Borges & Almeida 2011). Andrew Whittaker (A.W.) recorded the calls of at least four individuals in forests growing on sandy soil in the Aracá region. On that occasion A.W. had a good view of one individual and observed all the field marks typical of the species, notably its gray tarsus. S.H.B. also tape recorded an individual in a small patch of white-sand campina near the foot of Serra do Aracá (wikiaves - WA 2422641), and another in a secondary forest near the mouth of Demini River. Unfortunately, in both occasions S.H.B. was not able to observe the vocalizing individuals. In the Aracá region, Gray-legged Tinamou was recorded in forests growing over sandy soils similar to those in Peru and Jaú National Park (Alonso & Whitney 2003, Borges & Almeida 2011). Apparently, Gray-legged Tinamou is replaced by its congeneric *C. erythropus* (Red-legged Tinamou) in the eastern margin of Branco River where it uses habitats similar to that found in the Aracá region (Naka *et al.* 2006, Laranjeiras *et al.* 2014).

Comb Duck - *Sarkidiornis sylvicola* Ihering & Ihering, 1907: A.W. observed a female of this species on a sand bank along the Aracá River in 14 December 2014. Unfortunately this observation could not be documented through photographs or tape records. There are few records of this species in the Amazon Basin. The INPA Bird Collection has a male Comb Duck (INPA 699), collected in August 1985 on Janauacá Lake, central Amazon. Until recently, this species was considered a race of *Sarkidiornis melanotos*, but now is recognized as a full species (del Hoyo & Collar 2014).

Southern Lapwing - *Vanellus chilensis* (Molina, 1782): Southern Lapwing was frequently observed in pairs or small groups of four to six individuals in the grassy open fields along the Aracá River where several photographs and tape records were obtained. Near Manaus, Southern Lapwing is irregularly observed along rivers at small farms with active pastures (*e.g.* WA2422295). S.H.B. observed this species in several pastures and small farms in Iranduba and Manacapuru municipalities (WA2422303 and WA2422305). These central Amazon records for Southern Lapwing are suggestive of recent range expansion and colonization.

Indeed, numerous photographs documented the presence of this bird in municipalities such as Manaus, Iranduba, Careiro da Várzea and Manacapuru (www.wikiaves.com.br, accessed on 24 August 2016).

Laughing Gull - *Leucophaeus atricilla* (Linnaeus, 1758): A.W. observed and tape recorded an individual in a river beach in the Aracá River in December 2004. This migratory bird is rarely recorded in inland parts of the Amazon Basin, with most occurrences reported along the coastal regions of Pará and Maranhão states (Valente *et al.* 2011). Mestre *et al.* (2010) reported a banded individual of Laughing Gull recovered at an unspecified location at Amazonas state. There are several photographic records of Laughing Gull in the coastal regions of Amapá, and Pará states, at the mouth of Amazon River, but no previous ones from the central portion of the Amazon Basin (www.wikiaves.com.br, accessed in 24 August 2016).

Band-Tailed Pigeon - *Patagioenas fasciata* (Say, 1823): Ricardo Almeida (R.A.) observed a pigeon under good lighting condition perched in a tree in border of a forest fragment at the summit of Serra do Aracá at 1200 m a.s.l. Although this record was not documented, the main field marks of Band-Tailed Pigeon (general gray color and white neck collar) were observed. This pigeon species is typical of Venezuelan tepuis, with few records from Brazilian Amazon, most from Roraima state (Phelps & Phelps-Jr. 1947, Phelps-Jr. 1972, Sick 1997, Naka *et al.* 2006). Band-Tailed Pigeon was collected on the Venezuelan side of Cierro de la Neblina (Willard *et al.* 1991), but apparently was not recorded for Amazonas state, Brazil.

Burrowing Owl - *Athene cunicularia* (Molina, 1782): S.H.B. photographed a Burrowing Owl in a white-sand campina on the Aracá River (WA 1826686). In addition, several records of this owl were obtained in the central Amazon, along the AM 010 and AM 352 highways in the Novo Airão (WA 1826694) and Iranduba municipalities (WA 1826689). Pairs of this owl have been consistently recorded from 2010 to 2014 along these roads, always associated with active or abandoned pastures (Fig. 2). The earliest records of this species for central Amazon are likely those reported between 1992 and 1994 from farms located 80 km north of Manaus (Cohn-Haft *et al.* 1997). It seems probable that Burrowing Owls are colonizing the central portion of the Amazon by dispersing along roads, as has been suggested by Cohn-Haft *et al.* (1997), and then using the pastures as breeding habitats. However, we never observed active nests or nestling in our study region to confirm successful colonization, but photographs in Manaus region have documented young birds (www.wikiaves.com.br, accessed on 24 August 2016).

White-Tailed Hawk - *Geranoaetus albicaudatus* (Vieillot, 1816): there are few records of this hawk in the central Amazon, which is reported as rare in the area north of Manaus (Cohn-Haft *et al.* 1997). S.H.B. photographed a juvenile in the Manacapuru municipality in an active pasture (WA 1828172 and WA 1828173). Visual records of individuals overflying the AM 356 near Novo Airão and Manaus could be also referred to this species. The abundance of White-Tailed Hawk also could be increasing in the central Amazon due to progressive forest degradation in the region, as suggested by records of this species in Manaus and Presidente Figueiredo (www.wikiaves.com.br, accessed on 24 August 2016).

Peregrine Falcon - *Falco peregrinus* Tunstall, 1771: in the central Amazon, Peregrine Falcon is most frequently recorded in the white-water environments or *várzea* forests of the Solimões River (Stotz *et al.* 1992, Petermann 1997). S.H.B. photographed a juvenile Peregrine Falcon (WA 1826674 and WA 1825456) perched on the border of a fluvial island on 2 November 2014, within the boundaries of JNP. This was the first record of this species for JNP, an area whose avifauna have been monitored for decades (Borges & Almeida 2011). There are few records of Peregrine Falcon in *várzea* forest along the Rio Branco (Naka *et al.* 2006) but no record is available for Anavilhanas Archipelago on the lower reaches of Negro River (Cintra *et al.* 2007).

Band-Winged Nightjar - *Hydropsalis roraimae* (Chapman, 1929): R.A. photographed this nightjar at a rock outcrop on the Serra do Aracá around 1100 m a.s.l. The images clearly show the drop-like marks in the neck typical for this species (photograph available in Borges *et al.* 2014). This nightjar species was considered restricted to the Guyana Highlands (tepuis) with the only Brazilian records coming from Roraima state (Naka *et al.* 2006, see a photograph by Robson Czaban WA 52254). Based on the literature consulted (Phelps & Phelps-Jr. 1947, Friedmann 1948, Phelps-Jr. 1972, Sick 1997), this is likely the first record of Band-Winged Nightjar for the Amazonas state.

Sand-Colored Nighthawk - *Chordeiles rupestris* (Spix, 1825): S.H.B. obtained several images of a group of more than 40 individuals *C. rupestris* perched in a leafless tree near the mouth of Jaú River in May 2015 (WA 1826675). This represented the first record of this species for the JNP avifauna (Borges & Almeida 2011). This nighthawk species appears to be common in sand beaches in white-water rivers, with some records in riverine habitats in Roraima state (Naka *et al.* 2006). However, there is no record of *C. rupestris* for the Anavilhanas Arquipelagos in the lower Negro River, even though huge sand beaches have been observed there during the dry season (Cintra *et al.* 2007).

Blue-Fronted Lancebill - *Doryfera johannae* (Bourcier, 1847): two individuals of this hummingbird species were captured and photographed at the summit of the Serra do Aracá at 1200 m a.s.l. This species was

commonly netted on Cierro de la Neblina on the border between Venezuela and Amazonas state in Brazil (Willard *et al*. 1991). In Brazil, *D. johannae* has previously been recorded only for Roraima state (Sick 1997, Naka *et al.* 2006).

Buff-Breasted Sabrewing - *Campylopterus duidae* Chapman, 1929: this very distinctive hummingbird was captured in the edge of open field and a forest fragment at the summit of Serra do Aracá (photograph in Borges *et al.* 2014). This hummingbird was reported as one of the most common birds in all habitats present on Cierro de la Neblina (Willard *et al.* 1991). It is likely the second record of *C. duidae* for the Amazonas state, since a photograph of this species taken in São Gabriel da Cachoeira is available on wikiaves (Robson Czaban WA 70464). In Brazil, this species was previously reported only for Roraima state (Sick 1997, Naka *et al.* 2006).

Brown Violetear - *Colibri delphinae* (Lesson, 1839): an adult male *C. delphinae* was collected and deposited in the INPA Bird Collection (INPA 2432, collected in 8 August 2007, see also photograph in Borges *et al.* 2014). The individual was netted at a forest edge on the Serra do Aracá. Willard *et al.* (1991) did not record this bird during their expedition to Cierro de la Neblina, but reported specimens collected on the Brazilian side of the mountain.

Green-Bellied Hummingbird - *Amazilia viridigaster* (Bourcier, 1843): this is another hummingbird species captured and photographed on the top of Serra do Aracá, as well as in a small patch of white-sand campina on the piedmont (images in Borges *et al.* 2014). It is reported as common on the Cierro de la Neblina at 750 m a.s.l., but less so at higher altitudes (Willard *et al.* 1991). Taxonomic status of this hummingbird is debated (Remsen-Jr. *et al.* 2016), with some authors recognizing the tepui populations (*A. v. cupreicauda*) as a full species (Weller 2000, Grantsau 2010).

Barred Antshrike - *Thamnophilus doliatus* (Linnaeus, 1764): this antbird species was frequently observed in shrubby campinas along the Aracá River, and several individuals were netted and photographed. We also observed this species on the top of Serra do Aracá where a pair was collected and deposited in the INPA Bird Collection (INPA 2433 collected on 7 August 2007 and INPA 4920 collected on 29 July 07). This antbird is widely distributed in the Neotropics, with 12 different subspecies recognized (Zimmer & Isler 2003). In the Amazon Basin, Barred Antshrike apparently has preference for habitats associated with white-water rivers. This antbird was reported as common in the *várzea* forests and white-sand campinas of Viruá National Park (Laranjeiras *et al.* 2014), but has not been reported from JNP and Anavilhanas National Park (Cintra *et al*. 2007, Borges & Almeida 2011).

White-Browed Antbird - *Myrmoborus leucophrys* (Tschudi, 1844): S.H.B. photographed a male White-Browed Antbird in a secondary forest in the Demini River region (Borges *et al.* 2014). Apparently this species has few records from the Negro River Basin (Ridgely & Tudor 2009), and it appears absent from the lower course of this river (Cintra *et al.* 2007, Borges & Almeida 2011). However, White-Browed Antbird is common in a variety of forest habitats in the Viruá National Park (Laranjeiras *et al.* 2014).

White-Bellied Antbird - *Myrmeciza longipes* (Swainson, 1825): White-Bellied Antbird was frequently observed in lowland forests near the foot of Serra do Aracá, with several individuals captured and photographed (images in Borges *et al.* 2014). This species appears not to have been previously reported for the Amazonas state avifauna (Phelps & Phelps-Jr. 1947, Friedmann 1948, Phelps-Jr. 1972, see also maps in Zimmer & Isler 2003 and Ridgely & Tudor 2009). We suspect that in part of its geographic distribution, this species shows a preference for the montane environment.

Gray-Bellied Antbird - *Ammonastes pelzelni* (Sclater, 1890): S.H.B. record the voice, captured and photographed an adult male of this species in a small patch of white-sand campina located near the foot of Serra do Aracá (see images in Borges *et al.* [2014] and tape record in WA2422618). S.H.B. made several unsuccessful playback trails of Gray-Bellied Antbird in apparently suitable habitat (*i.e.* vegetation growing over sandy soils) suggesting that this species is rare even within its known geographic distribution. This antbird is one of the few genuine endemic species that give support to the Imeri Area of Endemism (Borges & Silva 2012), not being recorded in the white-sand vegetation in the lower Negro River or Branco River (Borges & Almeida 2011, Laranjeiras *et al.* 2014).

Yapacana Antbird - *Aprositornis disjuncta* (Friedmann, 1945): the only record of the Yapacana Antbird in the Serra do Aracá region is a female captured in in a patch of flooded white-sand campina, and partially eaten by a Rufescent Tiger Heron (*Tigrisoma lineatum*). The individual was prepared as a voucher specimen and deposited in the INPA Bird Collection (INPA 2081 collected on 13 August 2010). We also collected four other Yapacana Anbird specimens in two small patches (< than 50 ha) of white-sand campinas in JNP (INPA 4676, 4678, 4679, 4680, all collected in October 2010). We have not found this species in other patches of white-sand campinas near Novo Airão or Iranduba municipalities, suggesting that southern limit of its range coincide with the Jaú River region (Fig. 2). The Yapacana Antbird has been reported as common in Viruá National Park (Laranjeiras *et al.* 2014).

Pearly-Vented Tody-Tyrant - *Hemitriccus*

margaritaceiventer (d'Orbigny & Lafresnaye, 1837): this flycatcher species was commonly recorded in white-sand campinas in the Aracá River region, and also from the edge of forest fragments on the summit of Serra do Aracá (Borges *et al*. 2014). We also captured individuals of this species at several sites in Viruá National Park, where the species is reported as common (Laranjeiras *et al.* 2014). The Pearly-Vented Tody-Tyrant is a polytypic species composed of nine subspecies, with overall fragmented distribution in open area vegetation across the Amazon (Fig. 2) (Fitzpatrick *et al*. 2004, Aleixo & Poletto 2007, Pacheco *et al*. 2007, Santos *et al*. 2011, Laranjeiras *et al*. 2014). Smaller patches of open vegetation in the central portion of Amazon Basin are not occupied by Pearly-Vented Tody-Tyrant (Sanaiotti & Cintra 2001, Borges & Almeida 2011, Vasconcelos *et al*. 2011, Borges *et al.* 2016a) suggesting that the size and connectivity of habitat patches are important when predicting the occurrence of this species in the Amazon Basin.

Pelzeln's Tody-Tyrant - *Hemitriccus inornatus* (Pelzeln, 1868): this species was rediscovered, near Manaus, more than 100 years after its original description (Whittaker 1994). S.H.B. heard some individuals and recorded its vocalization in a patch of white-sand campinas at base of Serra do Aracá (WA2423832 and WA2423831). Additionally, the species has been reported from white-sand campina on the Uatumã River, and at several sites in Viruá National Park (Fig. 2). Together, these field records added evidence that this species has a preference for vegetation growing on white-sand soil, as does its congener *H. minimus* (Borges *et al.* 2016a). Pelzeln's Tody-Tyrant has also been recorded from savannas in Suriname (Zyskowski *et al.* 2011).

Yellow-Bellied Elaenia - *Elaenia flavogaster* (Thunberg, 1822): this flycatcher is known from a few records in the central portion of the Amazon Basin (Ridgley & Tudor 2009). We tape recorded several individuals of *E. flavogaster* in the municipalities of Iranduba and Novo Airão, where birds were associated with abandoned pastures, disturbed vegetation and urban environments (WA2422630). Additionally, a tape recording of this species, made in Presidente Figueiredo municipality, 100 km north of Manaus, is available at the xeno-canto website (Dan Lane, XC286573). Although there are difficulties in identifying *Elaenia* species only by plumage and body shape, numerous images apparently of *E. flavogaster* are available on the wikiaves website from several municipalities in the central Amazon. From the abundance of records it would appear that the Yellow-Bellied Elaenia is becoming progressively more common in the central Amazon, with its dispersal favoring by the increase of degraded areas along the roads and rivers (Fig. 3).

Large Elaenia - *Elaenia spectabilis* Pelzeln, 1868: this species was recorded at two points along the AM 365 state highway in middle August and late September 2011. There is also an additional undocumented record of *E. spectabilis* in disturbed vegetation at JNP, this being the first record of this species for this protected area (Borges & Almeida 2011).

Lesser Wagtail-Tyrant - *Stigmatura napensis* Chapman, 1926: a juvenile Lesser Wagtail-Tyrant had its vocalization recorded from sparse vegetation growing on a sand bank on an islet in the Negro River within the boundaries of JNP on 4 October 2012 (WA2423839 and WA2423833). We failed to find the species again after monitoring the same spot in subsequent years, suggesting the individual was a vagrant to the region. The Lesser Wagtail-tyrant is considered to be a specialist in fluvial islands at the initial stages of succession (Rosenberg 1990). This species has been recorded on fluvial islands on the Branco River (Naka *et al.* 2007), but has not been previously reported for the same habitat in the Negro River main channel (Cintra *et al.* 2007, Borges & Almeida 2011).

Cliff Flycatcher - *Hirundinea ferruginea* (Gmelin, 1788): Marcelo Moreira (M.M.) photographed an individual of this species in the Serra do Aracá (Fig. 3) (WA 2292408, WA 2292411, WA 2292412). Although recorded in the Venezuelan side of Cierro de la Neblina (Willard *et al*. 1991), apparently this bird species was not previously recorded for the Amazonas state avifauna (Sick 1997).

Orange-bellied Manakin - *Lepidothrix suavissima* (Salvin & Godman, 1882): a pair of this manakin was captured and collected in a low-canopy forest near the top of Serra do Aracá (INPA 2435 and 2436, both collected on 5 August 2007, see also images in Borges *et al.* 2014). Friedmann (1948) reported two specimens collected in the Serro Imeri not far from northern limit of Serra do Aracá within Amazonas state.

Scarlet-Horned Manakin - *Ceratopipra cornuta* (Spix, 1825): two Scarlet-horned Manakin individuals were captured in the same spot where we recorded Orange-bellied Manakin and a male was collected (INPA 2437 collected on 5 August 2007, see also images in Borges *et al.* 2014). S.H.B. observed one adult male and three females or immature males performing typical manakin dancing behavior. We were unable to find any mention of this species for Amazonas state in the literature (Friedmann 1948, Sick 1997), but a photograph of a male taken in São Gabriel da Cachoeira is available in wikiaves website (Robson Czaban WA71868).

Tepui Greenlet - *Vireo sclateri* (Salvin & Godman, 1883): S.H.B. capture and collected an individual of Tepui Greenlet at the edge of a forest fragment on the top of Serra do Aracá (INPA 2438 collected on 7 August 2007, see also image in Borges *et al.* 2014). This bird species was commonly heard in montane forest canopy on the summit of Serra do Aracá, sometimes following

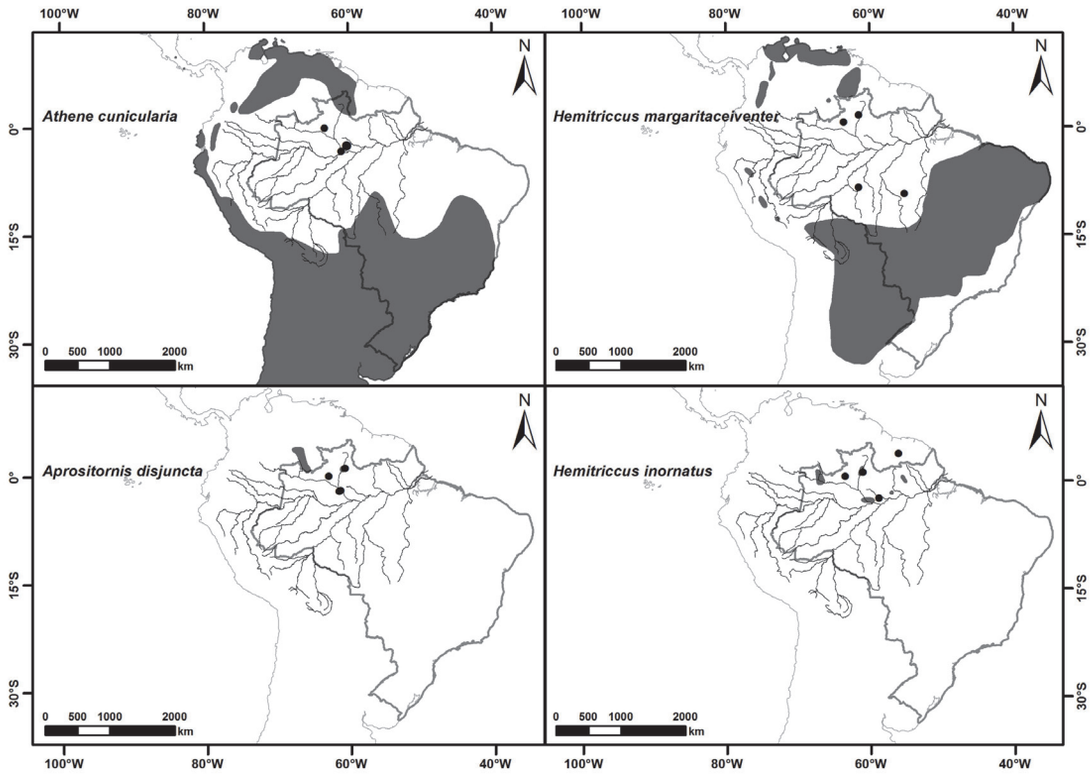

Figure 2. Distribution maps of some species reported in this study based in BirdLife International & NatureServe (2015). Points represents our records and also those reported by Naka *et al.* (2006) (*Aprositornis disjuncta*), Laranjeiras *et al.* (2014) (*A. disjuncta*, *Hemtriccus margaritaceiventer*, *H. inornatus*), Aleixo & Poletto (2007) (*H. margaritaceiventer*), Santos *et al.* (2011) (*H. margaritaceiventer*), Whittaker (1994) (*H. innornatus*) and Zyskowski *et al.* (2011) (*H. inornatus*).

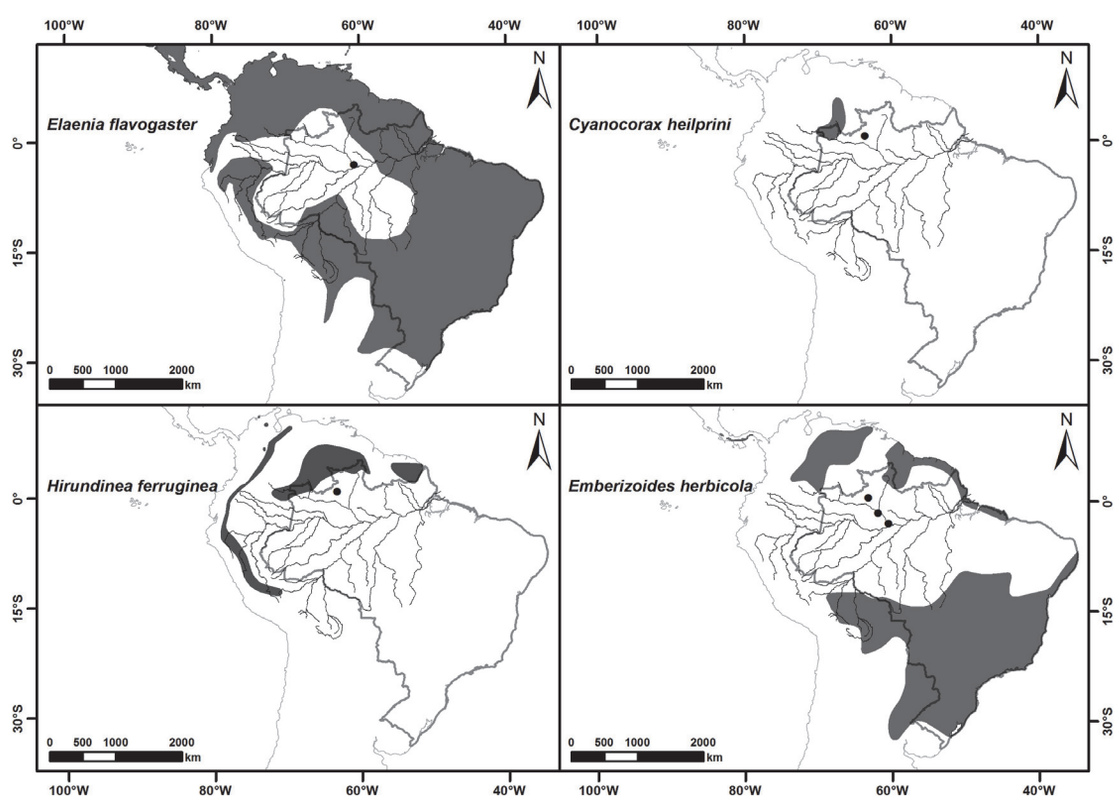

Figure 3. Distribution maps of some species reported in this study based in BirdLife International & NatureServe (2015). Points represents our records and also those reported by Borges *et al.* (2001) for *Emberezoides herbicola*.

mixed flocks of birds. In Brazil, Tepui Greenlet is otherwise known only from Roraima state (Naka *et al.* 2006, Sick 1997).

Brown-Headed Greenlet - *Hylophilus brunneiceps* Sclater, 1866: this species was commonly found in the more forested areas of white-sand campinas in the Aracá region, where it was recorded at several localities. It is a bird usually associated with lowlands, although S.H.B. captured and collected one individual in the Serra do Aracá at 1200 m a.s.l. (INPA 2439 collected on 7 August 2007, see also image in Borges *et al.* 2014). Although the Brown-headed Greenlet was formerly considered endemic to northwestern Amazonia (Ridgely & Tudor 2009), we recorded this species in the central Amazon only 50 km from Manaus. Its close association with vegetation growing in the margins of black-water rivers probably contributes to the dispersal capabilities of this greenlet species.

Azure-Naped Jay - *Cyanocorax heilprini* Gentry, 1885: Azure-naped Jay is endemic to northwestern Amazonia and gives support to Imeri Area of Endemism (Fig. 3) (Haffer 1978, Cracraft 1985). We recorded this species in the Aracá River region on three occasions, during which we were able to photograph (WA 1824922 to 1824924), tape recorded the vocalization, and collect an adult male (INPA 2000 collected on 04 August 2010). This jay was commonly observed in small flocks of three to eight individuals moving through shrubby areas of white-sand campinas or in the canopy of white-sand forests. S.H.B. also observed a flock of six individuals moving through flooded forests along the Aracá River. This species is absent from patches of white-sand campinas or forests in both lower Negro and Branco Rivers (Borges & Almeida 2011, Laranjeiras *et al.* 2014). In Viruá National Park, *C. helprini* apparently is substituted by two congenerics, *C. violaceus* and *C. cayanus*, in habitats similar to those found at Aracá (Laranjeiras *et al.* 2014).

Black-Billed Thrush - *Turdus ignobilis* Sclater, 1858: this thrush species was commonly found on the white-sand campinas in the Aracá River, where we captured and collected two individuals (INPA 2072, 2073 collected in 29 and 26 July 2010, respectively). We also collected an adult male in a small patch of shrub campina in the JNP (INPA 4621 collected on 23 October 2012) which represent the first record of this species for this protected area (Borges & Almeida 2011). Black-billed Thrush was also common in white-sand campinas on the Uatumã River. The observed birds likely belong to *T. i. arthuri*, a taxon associated with white-sand campinas (Oren 1981). Recently, it was suggested that this taxon could be recognized as a full species (Cerqueira *et al*. 2016, Avendaño *et al*. 2017). In the Serra do Aracá summit (1200 m a.s.l.), S.H.B. photographed individuals of this thrush with plumage entirely brownish, and so in complete contrast with the grayish individuals of the white-sand campinas in the lowlands of the same region (see images in Borges *et al.* 2014). It is possible that this individual was *T. i. murinus* which is a taxon found on tepuis in northern South America (Restall *et al.* 2006).

Tropical Mockingbird - *Mimus gilvus* (Vieillot, 1807): S.B.H. photographed and collected a specimen (INPA 2440 collected on 25 July 2007, see image in Borges *et al.* 2014) of this species in a white-sand campina of the Aracá River. Apparently this species was not abundant, since it was observed at only three sites. The Tropical Mockingbird is a common species in the Roraima savannas (Naka *et al.* 2006), and in white-sand campinas in the Viruá National Park (Laranjeiras *et al.* 2014), but apparently has not been previously reported for Amazonas state.

Rufous-Collared Sparrow - *Zonotrichia capensis* (Statius Muller, 1776): S.H.B. captured and photographed this species at 1100 m a.s.l. in the Serra do Aracá (images in Borges *et al.* 2014). We also recorded this species in two lowland sites in the white-sand campinas on Aracá River. In the Amazon lowlands, Rufous-collared Sparrow is only recorded from areas with rock outcrops such as Serra dos Carajás and Serra do Cachimbo (Pacheco *et al.* 2007, Santos *et al.* 2011). In the northern Amazonia this species is associated with tepuis in Venezuela and neighboring parts of Brazil, where it is represented by the taxon *Z. c. roraimae* (Sick 1997, Naka *et al.* 2006, Restall *et al.* 2006). This species was not previously recorded for Amazonas state, although it is considered a common species in the Venezuelan side of Cierro de la Neblina (Willard *et al.* 1991).

Wedge-Tailed Grass-Finch - *Emberizoides herbicola* (Vieillot, 1817): we recorded this bird through photographs, voice recordings and specimen collection at several localities in the Serra do Aracá, both in highland (1100 m a.s.l.) and lowlands (two unregistered specimens in the INPA Bird Collection collected on July 2007, INPA 2078 collected on 26 July 2010, INPA 2079 collected on 12 August 2010). This is a very common bird in large and connected patches of white-sand campinas, but is absent from small isolated patches of this habitat at Novo Airão and on the Uatumã River (Laranjeiras *et al.* 2014, Borges *et al.* 2016b). Recently, S.H.B. found a population of *E. herbicola* in a small patch of degraded savanna called Campo Amélia, only 50 km from Manaus, which was documented by tape recording and photographs (WA 1845892 and 1845893). This is the most central record in the geographic distribution of this bird species (Fig. 3) (Ridgely & Tudor 2009).

Plumbeous Seedeater - *Sporophila plumbea* (Wied, 1830): a small group of 12 Plumbeous Seedeaters was observed on July 2007 feeding in grass seeds growing in crevices in a rock outcrop (inselberg) in the Aracá River.

Here, we collected one adult and two juvenile males (INPA 2441, 2442 and 24431, see also images in Borges *et al.* 2014). In Viruá National Park, the Plumbeous Seedeater is reported as common bird in white-sand campina and human-altered habitats (Laranjeiras *et al.* 2014). In Amazonas state there are records of this species in Manicoré (Aleixo & Poletto 2007, Edson Lopes WA 1443383) and Humaitá (Robson Czaban WA 1130066 and WA 516809), both municipalities located in the south portion of the state.

DISCUSSION

The Amazon Basin is experiencing major alterations in its landscape and ecosystems, affecting the regional biodiversity (Davidson *et al.* 2012, Barlow *et al.* 2016). Birds are important biological indicators for monitoring the dynamic and complex interactions between environmental changes and biodiversity distribution (Moura *et al.* 2013). Although obtained through qualitative sampling, our bird records suggest that the environmental modifications currently underway in the central portion of the Amazon are affecting bird species distribution.

Cumulative records of *V. chilensis*, *E. flavogaster*, *A. cunicularia* and *G. albicaudatus*, for example, indicate the colonization of this region by bird species not normally associated with the Amazonian Biome. Such colonization processes are likely favored by the increasing environmental degradation as already occurred in other parts of the basin (Less *et al.* 2013). However, details on how these species are adapting and increasing their populations require quantitative data collected at the appropriate scale.

Indeed, for a full understanding of ecological distribution of birds (and other elements of biodiversity) and their relationships with environmental disturbance, it will be necessary to implement biological monitoring programs in several parts of the Amazon Basin. Unfortunately, such programs are currently very scarce in the region. For example, of the 36 sites of the Long Duration Ecological Research Program implemented in Brazil, only five are located in the Brazilian Amazon (Barbosa 2013).

Our distribution records also indicate that avifauna monitoring could be useful to understand bird dispersal in landscapes with low to moderate anthropogenic influence. Records of species normally associated with white water rivers habitats (*e.g. S. napensis* and *C. rupestris*) on the lower course of Negro River suggests that rare events of dispersal could be important for connecting bird populations apparently isolated in the *várzea*s of the Branco and Solimões Rivers (Naka *et al.* 2007).

In complement of biological monitoring programs, inventories are still vital part of biodiversity investigation making important contributions in the documenting the distribution of bird species and assemblages. Our records of species previously unreported to the Amazonas state shows that even for such large territory, biological inventories in areas with difficult accesses have an important contribution to characterized the Amazonian biodiversity.

Most species records described in this study were well documented and are potentially useful when reviewing the geographic distribution of the individual species, as well as other applications, such as ecological niche modeling. Unfortunately, due to short time available to fieldwork and small size of ornithologist teams, only 14 out of 35 species were properly documented with collected specimens. This is especially unfortunate for the Serra do Aracá, a tepui whose endemic bird species are poorly represented in bird collections. Consequently, the Branco and Negro Rivers interfluve remains a priority region for bird collection. Also, it is recommended that specimens of birds that have recently occupied the central Amazon, such as *E. flavogaster* and *A. cunicularia*, be collected to improve understanding of this colonization processes.

The birds recorded in this study emphasize that biological inventories in areas with difficult access, and bird monitoring in sectors of the Amazon with different levels of habitat modification, are complementary strategies to achieving a full understand of Amazon biodiversity and its distribution.

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REFERENCES

Aleixo A. & Poletto F. 2007. Birds of an open vegetation enclave in southern Brazilian Amazonia. *Wilson Journal of Ornithology* 119: 610–630.

Alonso J.A. & Whitney B.M. 2003. New distributional records of birds from white-sand forests of the northern Peruvian Amazon, with implications for biogeography of northern South America. *Condor* 105: 552–566.

Avendaño J.E., Arbeláez-Cortés E. & Cadena C.D. 2017. On the importance of geographic and taxonomic sampling in phylogeography: a reevaluation of diversification and species limits in a Neotropical thrush (Aves, Turdidae). *Molecular Phylogenetics and Evolution* 111: 87–97.

Barbosa F.A.R. 2013. Uma breve história do Programa de Pesquisas Ecológicas de Longa Duração (PELD–CNPq) do Brasil: da semente ao fruto, p. 15–29, In: Tabarelli M., Rocha C.F.D., Romanowski H.P., Rocha O. & Lacerda L.D. (eds.). *PELD–CNPq - dez anos do Programa de Pesquisas Ecológicas de Longa Duração no Brasil: achados, lições e perspectivas*. Recife: Editora Universitária UFPE.

Barlow J., Lennox G.D., Ferreira J., Berenguer E., Lees A.C., MacNally R., Thomson J.R., Ferraz S.F.B., Louzada J., Oliveira V.H.F., Parry L., Solar R.R.C.,Vieira I.C.G., Aragão L.E.O.C., Begotti R.A., Braga R.F., Cardoso T.M., Oliveira-Jr. R.C., Souza-Jr. C.M., Moura N.G., Nunes S.S., Siqueira J.V., Pardini R., Silveira J.M., Vaz-de-Mello F.Z., Veiga R.C.S., Venturieri A. & Gardner T.A. 2016. Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature* 535: 144–147.

BirdLife International & NatureServe. 2015. Bird species distribution maps of the world, version 5.0. Cambridge & Arlington: BirdLife International & NatureServe.

Borges S.H. & Almeida R.A.M. 2011. Birds of the Jaú National Park and adjacent areas, Brazilian Amazon: new species records with reanalysis of a previous checklist. *Revista Brasileira de Ornitologia* 19: 108–133.

Borges S.H. & Silva J.M.C. 2012. A new area of endemism for Amazonian birds in the Rio Negro Basin. *Wilson Journal of Ornithology* 124: 15–23.

Borges S.H., Cohn-Haft M., Carvalhaes A.M.P., Henriques L.M., Pacheco J.F. & Whittaker A. 2001. Birds of Jaú National Park, Brazilian Amazon: species check-list, biogeography and conservation. *Ornitología Neotropical* 12: 109–140.

Borges S.H., Whittaker A. & Almeida R.A.M. 2014. Bird diversity in the Serra do Aracá region, northwestern Brazilian Amazon: preliminary check-list with considerations on biogeography and conservation. *Zoologia* 31: 343–360.

Borges S.H., Cornelius C., Ribas C., Almeida R., Guilherme E., Aleixo A., Dantas S., Santos M.P., & Moreira M. 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., Vargas C. & Almeida R. 2016b. Bird communities in Amazonian white-sand vegetation patches: effects of landscape configuration and biogeographic context. *Biotropica* 48: 121–131.

Cerqueira P.V., Santos M.P.D. & Aleixo A. 2016. Phylogeography, inter-specific limits and diversification of *Turdus ignobilis* (Aves: Turdidae). *Molecular Phylogenetics and Evolution* 97: 177–186

Cintra R., Sanaiotti T.M. & Cohn-Haft M. 2007. Spatial distribution and habitat of the Anavilhanas Archipelago bird community in the Brazilian Amazon. *Biodiversity and Conservation* 16: 313–336.

Cohn-Haft M., Whittaker A. & Stouffer P.C. 1997. A new look at the "species-poor" central Amazon: the avifauna north of Manaus, Brazil. *Ornithological Monographs* 48: 205–235.

Cracraft J. 1985. Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemism. *Ornithological Monographs* 36: 49–84.

Davidson E.A., Araújo A.C., Artaxo P., Balch J.K., Brown I.F., Bustamante M.M.C., Coe M.T., DeFries R.S., Keller M., Longo M., Munger J.W., Schroeder W., Soares-Filho B.S., Souza-Jr. C.M. & Wofsy C.W. 2012. The Amazon Basin in transition. *Nature* 481: 321–328.

del Hoyo J. & Collar N. 2014. *HBW and BirdLife International illustrated checklist of the birds of the world, v. 1 (non-passerines).* Barcelona: Lynx Editions.

Fitzpatrick J.W., Bates J.W., Bostwick K.S., Caballero I.C., Clock B.M., Farnsworth A., Hosner P.A., Joseph L., Langham G.M., Lebbin D.J., Mobley J.A., Robbins M.B., Scholes E., Tello J.G., Walther B.A. & Zimmer K.J. 2004. Family Tyrannidae (tyrant-flycatchers). In: del Hoyo J., Elliot A. & Christie D.A. (eds.). *Handbook of the birds of the world, v. 9 (cotingas to pipits and wagtails)*. Barcelona: Lynx Editions.

Friedmann H. 1948. Birds collected by the National Geographic Society's expeditions to northern Brazil and southern Venezuela. *Proceedings of the United States National Museum* 97: 373–570.

Grantsau R. 2010. *Guia completo para identificação das aves do Brasil, v. 1*. São Carlos: Vento Verde.

Haffer J. 1978. Distribution of Amazon Forest birds. *Bonner Zoologische Beiträge* 29: 38–78.

Holt B.G., Lessard J.-P., Borregaard M.K., Fritz S.A., Araújo M.B., Dimitrov D., Fabre P.-H., Graham C.H., Graves G.R., Jønsson K.A., Nogués-Bravo D., Wang Z., Whittaker R.J., Fjeldså J. & Rahbek C. 2013. An update of Wallace's zoogeographic regions of the world. *Science* 339: 74–78.

Johnson E.I., Vargas C.F., Costa T.V.V. & Andretti C.B. 2010. A range extension and ecology of Boat-billed Tody-Tyrant *Hemitriccus josephinae* in central Amazonian Brazil. *Bulletin of the British Ornithologists' Club* 130: 266–272.

Keith S.A., Webb T.J., Böhning-Gaese K., Connoly S.R., Dulvy N.K., Eigenbrod F., Jones K.E., Price T., Redding D.W., Owens I.P.F. & Isaac N.J.B. 2012. What is macroecology? *Biology Letters* 8: 904–906.

Laranjeiras T.O., Naka L.N., Bechtoldt C.L., Costa T.V.V., Andretti C.B., Cerqueira M.C., Torres M.F., Rodrigues G.L., Santos M.P.D., Vargas C.F., Pacheco A.M.F., Sardelli C.H., Mazar-Barnett J. & Cohn-Haft M. 2014. The avifauna of Viruá National Park, Roraima, reveals megadiversity in northern Amazonia. *Revista Brasileira de Ornitologia* 22: 138–171.

Lees A.C. & Martin R.W. 2015. Exposing hidden endemism in a Neotropical forest raptor using citizen science. Ibis 157: 103–114.

Lees A.C., Zimmer K.J., Marantz C.A.., Whittaker A., Davis B.J.W. & Whitney B.M. 2013. Alta Floresta revisited: an updated review of the avifauna of the most intensively surveyed locality in south-central Amazonia. *Bulletin of the British Ornithologists' Club* 133: 178–239.

Lees A.C., Naka L.N., Aleixo A., Cohn-Haft M., Piacentini V.Q., Santos M.P.D. & Silveira L.F. 2014. Conducting rigorous avian inventories: Amazonian case studies and a roadmap for improvement. *Revista Brasileira de Ornitologia* 22: 107–120.

Mestre L.A.M., Roos A.L. & Nunes M.F. 2010. Análise das recuperações no Brasil de aves anilhadas no exterior entre 1927 e 2006. *Ornithologia* 4: 15–35.

Moura N.G., Lees A.C., Andretti C.B., Davis B.J.W., Solar R.R.C., Aleixo A., Barlow J., Ferreira J. & Gardner T.A. 2013. Avian biodiversity in multiple-use landscapes of the Brazilian Amazon. *Biological Conservation* 167: 339–348.

Naka L.N., Cohn-Haft M., Mallet-Rodrigues F., Santos M.P.D. & Torres M.F. 2006. The avifauna of the Brazilian state of Roraima: bird distribution and biogeography in the Rio Branco Basin. *Revista Brasileira de Ornitologia* 14: 197–238.

Naka L.N., Cohn-Haft M., Whittaker A., Barnett J.M. & Torres

M.F. 2007. Avian biogeography of Amazonian flooded forests in the Rio Branco Basin, Brazil. *Wilson Journal of Ornithology* 119: 439–449.

Novaes F.C. 1978. Sobre algumas aves pouco conhecidas da Amazônia brasileira II. *Boletim do Museu Paraense Emílio Goeldi, Nova Série* 90: 1–16.

Oren D.C. 1981. *Zoogeographic analysis of the white sand campina avifauna of Amazonia*. Ph.D. Thesis. Cambridge: Harvard University.

Pacheco J.F., Kirwan G.M., Aleixo A., Whitney B.M., Whittaker A., Minns J., Zimmer K.J., Fonseca P.S.M., Lima M.F.C. & Oren D.C. 2007. An avifaunal inventory of the CVRD Serra dos Carajás Project, Pará, Brazil. *Cotinga* 27: 15–30.

Petermann P. 1997. The birds, p. 419–452. In: Junk W.J. (ed.). *The central Amazon floodplain, ecology of a pulsing system*. Berlin: Springer-Verlag.

Peterson A.T. & Soberón J. 2012. Species distribution modeling and ecological niche modeling: getting the concepts right. *Natureza & Conservação* 10: 102–107.

Phelps W.H. & Phelps-Jr. W.H. 1947. Descripción de seis aves nuevas de Venezuela y notas sobre veinticuatro adiciones a la avifauna del Brasil. *Boletín de la Sociedad Venezolana de Ciencias Naturales* 71: 53–74

Phelps-Jr. W.H. 1972. Adiciones a las listas de aves de Sur América, Brasil y Venezuela y notas sobre aves venezolanas. *Boletin de la Sociedad Venezolana de Ciências Naturales* 30: 23–40.

Piacentini V.Q., Aleixo A., Agne C.E., Maurício G.N., Pacheco J.F., Bravo G.A., Brito G.R.R., Naka L.N., Olmos F., Posso S., Silveira L.F., Betini G.S., Carrano E. Franz I., Lees A.C., Lima L.M., Pioli D., Schunck F., Amaral F.R., Bencke G.A., Cohn-Haft M., Fiqueiredo L.F.A., Straube F.C. & Cesari E. 2015. Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee. *Revista Brasileira de Ornitologia* 23: 91–298.

Prance G.T. & Johnson D.M. 1992. Plant collections from the Plateau of Serra do Aracá (Amazonas, Brazil) and their phytogeographic affinities. *Kew Bulletin* 47: 1–24.

Remsen-Jr. J.V., Areta J.I., Cadena C.D., Claramunt S., Jaramillo A., Pacheco J.F., Pérez-Emán J., Robbins M.B., Stiles F.G., Stotz D.F. & Zimmer K.J. 2016. *A classification of the bird species of South America.* American Ornithologists' Union. http://www.museum.lsu.edu/~Remsen/SACCBaseline.htm (accessed on 18 de December 2016).

Restall R., Rodner C. & Lentino M. 2006. *Birds of northern South America - an identification guide, v. 1 & 2*. New Haven: Yale University Press.

Ridgely R.S. & Tudor G. 2009. *Field guide to the songbirds of South America – the Passerines*. Austin: University of Texas Press.

Rosenberg G.H. 1990. Habitat specialization and foraging behavior by birds of Amazonian River islands in northeastern Peru. *Condor* 92: 427–443.

Rutt C.L., Jirinec V., Johnson E.I., Cohn-Haft M., Vargas C.F. & Stouffer P.C. 2017. Twenty years later: an update to the birds of the Biological Dynamics of Forest Fragments Project, Amazonas, Brazil. *Revista Brasileira de Ornitologia* 25(4): in press.

Sanaiotti T.M. & Cintra R. 2001. Breeding and migrating birds in an Amazonian savanna. *Studies on Neotropical Fauna and Environment* 36: 23–32.

Santos M.P.D., Silveira L.F. & Silva J.M.C. 2011. Birds of Serra do Cachimbo, Pará state, Brazil. *Revista Brasileira de Ornitologia* 19: 244–259.

Sick H. 1997. *Ornitologia brasileira*. Rio de Janeiro: Editora Nova Fronteira.

Stotz D.F., Bierregaard R.O., Cohn-Haft M., Petermann P., Smith J., Whittaker A. & Wilson S.V. 1992. The status of North American migrants in central Amazonian Brazil. *Condor* 94: 608–621.

Valente R.M., Silva J.M.C., Straube F.C. & Nascimento J.L.X. (eds.) 2011. *Conservação de aves migratórias Neárticas no Brasil*. Belém: Conservação Internacional.

Vasconcelos M.F., Dantas S.M. & Silva J.M.C. 2011. Avifaunal inventory of the Amazonian savannas and adjacent habitats of the Monte Alegre region (Pará, Brazil), with comments on biogeography and conservation. *Boletim do Museu Paraense Emílio Goeldi, Ciências Naturais* 6: 119–145.

Weller A.-A. 2000. A new hummingbird subspecies from southern Bolívar, Venezuela, with notes on the biogeography and taxonomy of the *Saucerottia viridigaster-cupreicauda* species group. *Ornitología Neotropical* 11: 143–155.

Whittaker A. 1994. The rediscovery of Pelzeln's Tody-Tyrant *Hemitriccus inornatus* after 161 years! *Cotinga* 2: 10.

Willard D.E., Foster M.S., Barrowclough G.F., Dickerman R.W., Cannell P.F., Coats S.L., Cracraft J.L. & O'Neill J.P. 1991. The birds of Cerro de la Neblina, Territorio Federal Amazonas, Venezuela. *Fieldiana (Zoology)* 65: 1–80.

Zimmer K.J. & Isler M.L. 2003. Family Thamnophilidae (typical antbirds). In: del Hoyo J., Elliot A. & Christie D.A. (eds.). *Handbook of the birds of the World, v. 8 (broadbills to tapaculos).* Barcelona: Lynx Editions.

Zyskowski K., Mittermeier J.C., Ottema O., Rakovic M., O'Shea B.J., Lai J.E., Hochgraf S.B., León J. & Au K. 2011. Avifauna of the easternmost Tepui, Tafelberg in central Suriname. *Bulletin of the Peabody Museum of Natural History* 52: 153–180.

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APPENDIX I

List of bird records with information on habitat, study regions and geographic coordinates in decimal degrees.

Species	Habitats	Study regions	Latitud	Longitud
Crypturellus duidae	white sand forest	Interfluve Negro-Branco	-0.3276	-62.9691
Crypturellus duidae	secondary forest	Interfluve Negro-Branco	-0.2763	-62.7442
Crypturellus duidae	white sand forest	Interfluve Negro-Branco	0.8655	-63.4690
Sarkidiornis sylvicola	river beach	Interfluve Negro-Branco	-0.3276	-62.9691
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.1422	-63.1836
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.6101	-63.4274
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.4748	-63.4716
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.3929	-63.4074
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.3837	-63.3520
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.3267	-63.2623
Vanellus chilensis	white sand campinas	Interfluve Negro-Branco	0.4553	-63.2586
Vanellus chilensis	pasture	Interfluve Solimões-Negro	-3.2217	-60.2825
Vanellus chilensis	pasture	Interfluve Solimões-Negro	-3.1622	-60.0936
Vanellus chilensis	pasture	Interfluve Solimões-Negro	-2.7225	-60.9428
Vanellus chilensis	pasture	Uatumã River	-2.2865	-58.9560
Leucophaeus atricilla	river beach	Interfluve Negro-Branco	-0.3276	-62.9691
Patagioenas fasciata	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Athene cunicularia	white sand campinas	Interfluve Negro-Branco	0.1424	-63.1837
Athene cunicularia	pasture	Interfluve Solimões-Negro	-2.9197	-60.9658
Athene cunicularia	agriculture field	Interfluve Solimões-Negro	-2.9686	-60.9465
Athene cunicularia	agriculture field	Interfluve Solimões-Negro	-3.1901	-60.6026
Athene cunicularia	agriculture field	Fazenda Dimona (PDBFF)	-2.3333	-60.0833
Geranoaetus albicaudatus	agriculture field	Interfluve Solimões-Negro	-3.1901	-60.6026
Falco peregrinus	fluvial island	Confluence Jaú-Negro	-1.8128	-61.3925
Hydropsalis roraimae	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Chordeiles rupestris	igapó flooded forest	Confluence Jaú-Negro	-1.8614	-61.4197
Doryfera johannae	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Campylopterus duidae	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Colibri delphinae	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Amazilia viridigaster	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Amazilia viridigaster	white sand campinas	Interfluve Negro-Branco	0.8655	-63.4690
Thamnophilus doliatus	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	-0.3276	-62.9691
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.4054	-63.4066
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.5686	-63.2430
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.4751	-63.4285
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.3579	-63.2590
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.3238	-63.2630
Thamnophilus doliatus	white sand campinas	Interfluve Negro-Branco	0.1424	-63.1837
Thamnophilus doliatus	secondary forest	Interfluve Solimões-Negro	-2.9793	-60.6044
Thamnophilus doliatus	secondary forest	Interfluve Solimões-Negro	-2.9696	-60.6162

Species	Habitats	Study regions	Latitud	Longitud
Myrmoborus leucophrys	secondary forest	Interfluve Negro-Branco	-0.2763	-62.7442
Myrmeciza longipes	piedmont forest	Interfluve Negro-Branco	0.8824	-63.4480
Myrmeciza longipes	piedmont forest	Interfluve Negro-Branco	0.8665	-63.4537
Myrmeciza longipes	piedmont forest	Interfluve Negro-Branco	0.8778	-63.4702
Ammonastes pelzelni	white sand forest	Interfluve Negro-Branco	0.8655	-63.4690
Aprositornis disjuncta	white sand campinas	Interfluve Negro-Branco	0.3267	-63.2623
Aprositornis disjuncta	white sand campinas	Confluence Jaú-Negro	-1.7572	-61.6150
Aprositornis disjuncta	white sand campinas	Confluence Jaú-Negro	-1.7303	-61.5353
Aprositornis disjuncta	white sand campinas	Confluence Jaú-Negro	1.3312	-60.9741
Aprositornis disjuncta	white sand campinas	Confluence Jaú-Negro	1.3312	-60.9741
Aprositornis disjuncta	white sand campinas	Viruá National Park	1.3312	-60.9741
Aprositornis disjuncta	white sand campinas	Viruá National Park	0.9589	-61.1592
Aprositornis disjuncta	white sand campinas	Viruá National Park	1.4096	-60.9878
Aprositornis disjuncta	white sand campinas	Confluence Jaú-Negro	-1.9134	-61.5918
Aprositornis disjuncta	igapó flooded forest	Confluence Jaú-Negro	-1.9088	-61.7049
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.5511	-63.5000
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.5686	-63.2431
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.5451	-63.4583
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.4748	-63.4716
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.4095	-63.4074
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.3837	-63.3520
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.3267	-63.2623
Hemitriccus margaritaceiventer	white sand campinas	Interfluve Negro-Branco	0.4553	-63.2586
Hemitriccus margaritaceiventer	white sand campinas	Viruá National Park	1.4146	-60.9895
Hemitriccus margaritaceiventer	white sand campinas	Viruá National Park	1.3312	-60.9741
Hemitriccus margaritaceiventer	white sand campinas	Viruá National Park	1.6582	-60.9364
Hemitriccus margaritaceiventer	white sand campinas	Serra do Cachimbo	-9.2833	-55.1667
Hemitriccus margaritaceiventer	white sand campinas	Manicoré	-8.6500	-61.4167
Hemitriccus inornatus	white sand campinas	Interfluve Negro-Branco	0.5451	-63.4583
Hemitriccus inornatus	white sand campinas	Interfluve Negro-Branco	0.8653	-63.4689
Hemitriccus inornatus	white sand campinas	Uatumã River	-2.2720	-58.6746
Hemitriccus inornatus	white sand campinas	Uatumã River	-2.2863	-58.8640
Hemitriccus inornatus	white sand campinas	Virua National Park	1.4096	-60.9878
Hemitriccus inornatus	white sand campinas	Virua National Park	0.9937	-61.2566
Hemitriccus inornatus	white sand campinas	Virua National Park	1.4173	-60.8462
Hemitriccus inornatus	savanna	Suriname	3.7933	-56.1483
Elaenia flavogaster	degraded landscape	Interfluve Solimões-Negro	-3.1622	-60.0936
Elaenia flavogaster	degraded landscape	Interfluve Solimões-Negro	-3.1667	-60.0928
Elaenia flavogaster	degraded landscape	Interfluve Solimões-Negro	-2.6750	-60.9433
Elaenia flavogaster	degraded landscape	Interfluve Solimões-Negro	-3.1600	-60.0947
Elaenia flavogaster	degraded landscape	Interfluve Solimões-Negro	-3.1625	-60.0978
Elaenia flavogaster	secondary forest	Interfluve Solimões-Negro	-2.9793	-60.6044
Elaenia flavogaster	urban habitat	Interfluve Solimões-Negro	-2.6311	-60.9458
Elaenia flavogaster	pasture	Interfluve Solimões-Negro	-3.2230	-60.2822

Species	Habitats	Study regions	Latitud	Longitud
Elaenia spectabilis	degraded landscape	Interfluve Solimões-Negro	-3.1589	-60.0997
Elaenia spectabilis	degraded landscape	Interfluve Solimões-Negro	-3.1622	-60.0936
Elaenia spectabilis	secondary forest	Confluence Jaú-Negro	-1.8276	-61.6110
Stigmatura napensis	fluvial island	Confluence Jaú-Negro	-1.9119	-61.4075
Hirundinea ferruginea	tepui	Interfluve Negro-Branco	0.9491	-63.4395
Lepidothrix suavissima	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Lepidothrix suavissima	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Ceratopipra cornuta	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Vireo sclateri	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Hylophilus brunneiceps	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Hylophilus brunneiceps	white sand campinas	Interfluve Negro-Branco	-0.3276	-62.9691
Hylophilus brunneiceps	white sand campinas	Interfluve Negro-Branco	0.8655	-63.4690
Hylophilus brunneiceps	white sand campinas	Interfluve Solimões-Negro	-3.0573	-60.7621
Hylophilus brunneiceps	white sand campinas	Interfluve Solimões-Negro	-3.0444	-60.7275
Hylophilus brunneiceps	igapó flooded forest	Interfluve Solimões-Negro	-2.9659	-60.7275
Cyanocorax heilprini	igapó flooded forest	Interfluve Negro-Branco	0.5451	-63.4583
Cyanocorax heilprini	white sand forest	Interfluve Negro-Branco	0.6101	-63.4274
Cyanocorax heilprini	white sand campinas	Interfluve Negro-Branco	0.4748	-63.4716
Cyanocorax heilprini	white sand campinas	Interfluve Negro-Branco	0.4095	-63.4074
Cyanocorax heilprini	white sand campinas	Interfluve Negro-Branco	0.8653	-63.4689
Turdus ignobilis	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	-0.3276	-62.9691
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.4552	-63.2586
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.4054	-63.4066
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.5686	-63.2430
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.4751	-63.4285
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.3579	-63.2590
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.3238	-63.2630
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.1424	-63.1837
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.4189	-63.3840
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.5453	-63.4983
Turdus ignobilis	white sand campinas	Interfluve Negro-Branco	0.5556	-63.3840
Turdus ignobilis	white sand campinas	Confluence Jaú-Negro	-1.7534	-61.6804
Turdus ignobilis	white sand campinas	Uatumã River	-2.2812	-59.0300
Turdus ignobilis	white sand campinas	Uatumã River	-2.2780	-59.0632
Turdus ignobilis	white sand campinas	Uatumã River	-2.2865	-58.9560
Turdus ignobilis	white sand campinas	Uatumã River	-2.2720	-58.6746
Turdus ignobilis	white sand campinas	Virua National Park	1.3312	-60.9741
Turdus ignobilis	white sand campinas	Virua National Park	1.6006	-61.0347
Turdus ignobilis	white sand campinas	Virua National Park	1.6582	-60.9364
Turdus ignobilis	white sand campinas	Virua National Park	1.3566	-60.6047
Mimus gilvus	white sand campinas	Interfluve Negro-Branco	0.4054	-63.4066
Mimus gilvus	white sand campinas	Interfluve Negro-Branco	0.4751	-63.4285
Zonotrichia capensis	tepui	Interfluve Negro-Branco	0.9176	-63.4462

Species	Habitats	Study regions	Latitud	Longitud
Zonotrichia capensis	white sand campinas	Interfluve Negro-Branco	0.4054	-63.4066
Zonotrichia capensis	white sand campinas	Interfluve Negro-Branco	0.3579	-63.2590
Emberizoides herbicola	tepui	Interfluve Negro-Branco	0.9176	-63.4462
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.4552	-63.2586
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.4054	-63.4066
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.3238	-63.2630
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.1424	-63.1837
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.4751	-63.4285
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.4751	-63.4285
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.3267	-63.2622
Emberizoides herbicola	white sand campinas	Interfluve Negro-Branco	0.5511	-63.5001
Emberizoides herbicola	savanna	Interfluve Solimões-Negro	-3.0363	-60.5986
Emberizoides herbicola	white sand campinas	Confluence Jaú-Negro	-1.8183	-61.7581
Sporophila plumbea	rock outcrop	Interfluve Negro-Branco	0.4189	-63.3840
Sporophila plumbea	rock outcrop	Interfluve Negro-Branco	0.4189	-63.3840
Sporophila plumbea	rock outcrop	Interfluve Negro-Branco	0.4189	-63.3840