

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/225631296>

# Spatial distribution and habitat of the Anavilhanas Archipelago bird community in the Brazilian Amazon

Article in *Biodiversity and Conservation* · February 2007

DOI: 10.1007/s10531-005-0606-x

CITATIONS

20

READS

138

3 authors, including:



**Renato Cintra**

Instituto Nacional de Pesquisas da Amazônia

45 PUBLICATIONS 728 CITATIONS

[SEE PROFILE](#)



**Mario Cohn-Haft**

Instituto Nacional de Pesquisas da Amazônia

48 PUBLICATIONS 989 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



A new species of *Cyanocorax* jay from savannas of the central Amazon [View project](#)



Population and community dynamics of birds in central Amazon: Examining the past and predicting the future [View project](#)

## Spatial distribution and habitat of the Anavilhanas Archipelago bird community in the Brazilian Amazon

RENATO CINTRA\*, TÂNIA M. SANAIOTTI and  
MARIO COHN-HAFT

*Instituto Nacional de Pesquisas da Amazônia – INPA, Coordenação de Pesquisa em Ecologia, C.P. 478, Manaus, AM, 69011-970, Brazil; \*Author for correspondence (e-mail: Cintra@inpa.gov.br; phone: +55-92-6431831; fax: +55-92-6431909)*

Received 28 December 2004; accepted in revised form 24 June 2005

**Key words:** Amazonia, Anavilhanas Archipelago, Bird community, Black water, Brazil, Rio Negro, River islands

**Abstract.** This study is the first to present a quantitative survey of bird species occurring in the archipelago of Anavilhanas, located in the Rio Negro in the Brazilian Amazon and is part of the Anavilhanas Ecological Station. We asked whether bird community composition is similar among the islands, and between islands and areas dominated by the surrounding upland terra firme forest on the left (east) margin of the Rio Negro. The surveys were conducted in November and December of 1988, using two complementary methods with mist nets and boat transects. A total of 232 bird species was found for Anavilhanas including a survey done in 1998. The families Tyrannidae and Thamnophilidae showed the highest number of species (16.4% and 9.0% of the total respectively). Some species not well known or having limited distributions are relatively frequently encountered in the archipelago, such as *Spizastur melanoleucus*, *Mitu tomentosa*, *Phaethornis rufurumii*, *Xiphorhynchus kienerii*, *Thamnophilus nigrocinereus*, *Myrmotherula klagesi*, *Myrmoborus lugubris*, *Pipra filicauda*, and *Cephalopterus ornatus*. Hybrid Multidimensional Scaling (HMDS) ordination analysis indicated that the bird community composition is similar among islands. However, the bird community composition on the islands was significantly different from that in sites of terra firme forest at Rio Negro margins. Anavilhanas is a unique ecological system in the Amazon and has its own avifauna.

### Introduction

River-created habitats make an important contribution to the stunning diversity of bird species found in the Amazon, responsible for some 15% of the Amazonian avifauna according to one estimate (Remsen and Parker 1983). These habitats include periodically flooded vegetation, with unique floristics depending on duration and periodicity of flooding and on water characteristics, and successional vegetation forming on fresh alluvial sediments. It is generally observed that each recognizable plant community (habitat) has some bird species unique to it, consistent with the idea of conspicuous habitat specialization in the tropics (Willis 1977; Terborgh 1985; Bierregaard 1990; Terborgh et al. 1990; Stotz et al. 1992; Sanaiotti and Cintra 2001). Nevertheless, the fine distinctions among avifaunas in different riverine habitats have barely been studied. In particular, suggestions that the avifauna of forests flooded by

sediment-rich, “whitewater” rivers differs from that of acidic, translucent “blackwater” rivers (Remsen and Parker 1983) and that river-island avifaunas differ from those of mainland flooded forests (Rosenberg 1990) require more detailed examination.

The first step in such research, naturally, is the characterization of the avifaunas in numerous river-created sites. Unfortunately, however, very few sites have been studied thoroughly. Rosenberg (1990) studied the bird community of two white-water river islands in the Peruvian Amazon, one in the Amazon River and another in the Napo River. In Brazil, a similar study was conducted on Marchantaria island in the Amazon (Solimões) River near Manaus (Petermann 1997). These studies found many of the same species in common and suggested that whitewater islands have a unique avifauna, including some species apparently rare or absent from similar flooded habitats on the mainland. Borges and Carvalhaes (2000), and Borges et al. (2001), studied the avifauna of a black water river in the Brazilian Amazon and noted considerable differences from the whitewater sites; however, they were unable to distinguish geographic influences from water type from the importance of islands versus mainland flooded forest.

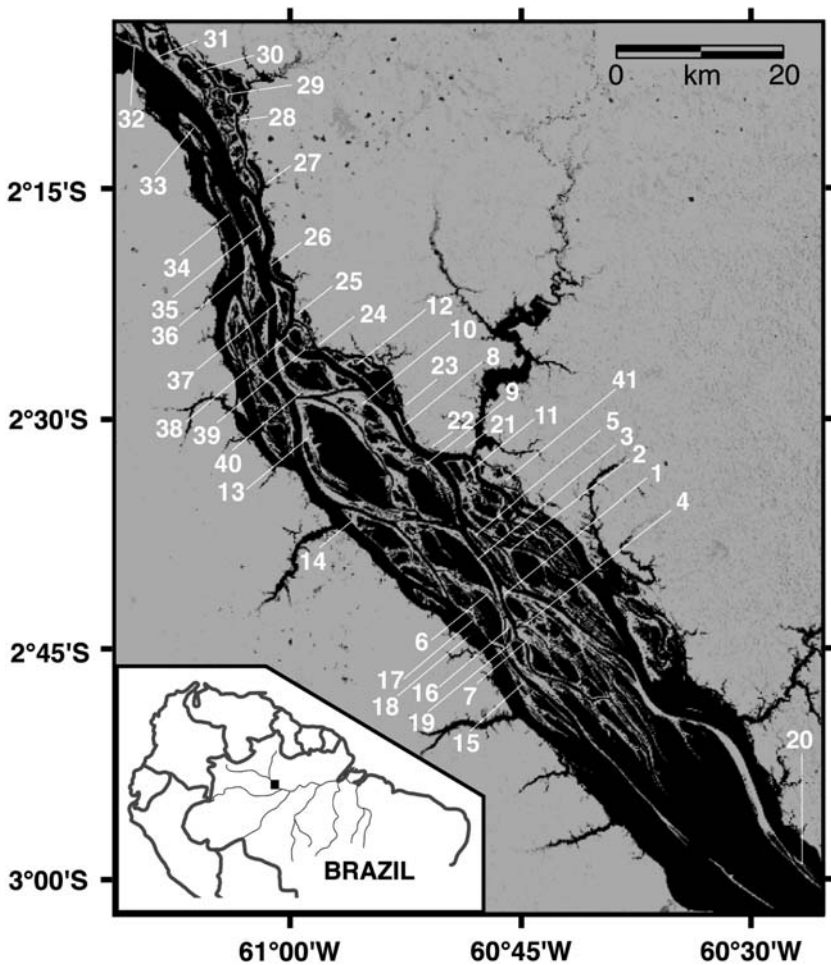
Here, we present the first study of blackwater river islands: the Anavilhanas Archipelago in the Rio Negro in central Amazonian Brazil. Using standardized protocols (mist-netting and boat-based transect censuses), we examine the following questions: Does the avifauna of the islands differ from that of the adjacent mainland? Does the avifauna of the seasonally flooded forest differ from that of the never-flooded terra firme forest? Because the islands in the Rio Negro form an enormous archipelago of hundreds of different-sized islands, we also examine the influence of island size and location on the avifauna. If island species composition were a function of colonization from adjacent mainland, then size and isolation of islands would be expected to influence composition as predicted by island biogeography theory (MacArthur and Wilson 1967). That is, islands near to one another and of similar size should have similar species composition and richness. Alternatively, if islands have a specialized avifauna, then they should be more similar to one another than to the mainland and should show no consistent difference among them with respect to size and position.

The preliminary bird species list presented here is based on our standardized sampling protocols. Additional censuses using a variety of methods will be synthesized and combined with these data in a separate paper for a complete species list for the archipelago and surrounding habitats in the context of their biogeographical significance.

## **Study area**

The Anavilhanas Ecological Station (Estação Ecológica Anavilhanas, hereafter EEA) comprises 350,000 ha, located in the eastern part of the state of

Amazonas in and adjacent to the lower Rio Negro about 40 km northwest of Manaus (between  $02^{\circ}03' S$  and  $03^{\circ}02' S$ ,  $60^{\circ}22' W$  and  $61^{\circ}12' W$ ). The EEA is a conservation unit administered by the Instituto Brasileiro de Meio Ambiente e Recursos Naturais (IBAMA), including the entire Anavilhanas Archipelago of islands within the Rio Negro (see Figure 1) as well as a large area of mainland on the left (east) bank of the Negro. Rainfall is about 2500 mm/year and the mean annual temperature is  $25^{\circ} C$ . The Anavilhanas archipelago itself has approximately 300 islands within an area of 100,000 ha, and the mainland part of the EEA comprises 250,000 ha, mainly covered by “terra firme” (never



*Figure 1.* Anavilhanas Archipelago with locations of bird surveys (see Table 1 for bird species found at each location). Black represents the lower Rio Negro and tributaries; gray represents land, including islands (1–20, 29–41), mainland (21–28); areas 21a and b are too close to one another to distinguish on the map.

flooded) forest. More information on the aquatic characteristics can be found in Junk and Furch (1985).

The archipelago is believed to have been formed due to flocculation of alluvial silt coming from the Rio Branco, a somewhat muddy-water tributary entering the translucent black water of the Rio Negro at the upstream end of this island system. Most islands, which range from less than one km to ca. 50 km in length, have interior lakes surrounded by seasonally flooded forest called “igapó”. Depending on elevation and flood stage, the land floods for some 3–9 months of each year during the high-water season. There is no terra firme on the islands, although a few of the highest spots do not flood every year.

The adjacent mainland banks of the river have a transition from igapó to terra firme, with their recognizably different forest types. Further inland from the Rio Negro, the mainland portion of the EEA contains other vegetation types, including campina, campinarana, and chavascal. These have a unique avifauna, distinct from both the igapó and terra firme. To avoid confounding the results of our comparison, we do not include these sites, which were not surveyed using the same methods, and will discuss their avifauna elsewhere. More details on Amazonian habitat characteristics and descriptions are available in Sioli (1984), Pires and Prance (1985) and Parolin et al. (2003).

## Methods

*Mist-net surveys* – During the 1988 and 1989 surveys, we randomly-selected 8 islands (located within an 80 km long section of the archipelago), and placed 10 ornithological mist nets (12×3 m, 2.5 cm mesh) forming a continuous line of 120 m through forest. Net lines ran perpendicular to the river bank, beginning 10 m from the island’s edge. Mist nets were used in both forest island habitats and terra firme forest of the river margins (see below). At each site, nets were opened for 7 hours per day (from 06:00 to 13:00) during two days.

In 1989, the nets were used to survey birds in many other islands and they were opened at different times of the year. To remove “a priori” effects of seasonality or period of sampling (different years) and also because we did not have samples from other islands with the same sampling time, we decided to use only data from November-December of 1988. These data represent bird surveys from eight islands, on three of those islands 1, 2, and 3 (see Figure 1) the nets were open between November 18 and 23, and on sites 5, 6, 7, 8, 15 and 16 – using the same sampling effort made on December 31, 1988. Two teams, of two researchers each, simultaneously conducted bird netting in two areas of upland terra firme forest along the left margin of the Rio Negro. The two areas 21-a and 21-b were located 1 km up- and 2 km down-river in relation to Anavilhanas Station facilities and within 1 km of the river margins; the location of these two areas corresponds to site 21 in Figure 1 (because they are too close for the scale of the map). All birds captured were identified using field

guides (Meyer de Schauensee and Phelps 1978), weighed and tagged with numbered aluminum bands provided by CEMAVE-Center for study of migrant birds (IBAMA).

*General bird surveys in 1988* – The bird species general surveys were conducted during ten trips to Anavilhanas varying from 3 to 10 days each. We started in 1988 in areas of terra firme forest and in the forest surrounding the lakes on the islands.

*General bird surveys in 1989* – An aluminum outboard boat (15 HP) was used to run transects of 10 km each (10 km/h) about 20 m from and along the island borders. All birds species recorded were identified using binoculars (Zeiss 8×30) or a Nikon Scope (30×). In 1989, two of us (RC and MC) and a field assistant conducted a 9-h survey in one day, visiting almost the entire upper half of the archipelago, completing about 80 km of transects. Bird species and abundance were plotted on a map (1:100,000) showing the location of all islands.

*General bird surveys in 1997* – In 1997, we conducted surveys on islands and sites that were not previously visited. The surveys, using a boat for transects, covered island borders, river and lake margins, and a few visits were also done to the streams (igarapés) of the upland “terra firme” forest where possible. At this time we started to use a GPS (Geographical Position System) to record the geographical coordinates for each bird species recorded.

All bird species recorded, both through quantitative surveys and scattered observations, are presented in Table 1. However, only species recorded in the net surveys were included in the statistical analysis to compare bird community composition from islands with those from areas in terra firme forest.

To give a general view of the bird abundance of EEA, we considered two types of abundance based on the frequency of records at a given moment of the observations. We used r (= rare) for species recorded <5 times during the whole period of surveys, and c (= common) for species observed ≥ 5 times in a given period, or every day, or participating in large flocks. For these data we use a summarized version of the classification commonly used in bird lists available in ornithological publications (see Terborgh et al. 1984; Cintra and Yamashita 1990; Cohn-Haft et al. 1997).

## Statistical analysis

In order to investigate the degree of similarity in the bird community composition (richness and abundance) among islands the general survey data on species composition from the islands surveyed were subjected to a multivariate analysis with an ordination technique called semi-strong Hybrid Multi-dimensional Scaling (HMDS) that is available in the program PATN (Belbin 1982). This analysis can summarize more information on one or two axes than some other indirect ordination techniques and is more robust to non-linear effects (Minchin 1987). We constructed a quantitative matrix with species/

Table 1. Bird species observed at Anavilhanas Ecological Station (using mist nets and boat transects).

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<b>Tinamidae</b>						
<i>Tinamus major</i>	21-b		S	F, SF	c	Nambu-galinha
<i>Crypturellus undulatus</i>	21-b		S	F, SF	c	Macucau
<i>Crypturellus variegatus</i>	21-b		S	F, SF	r	Nambu-relogio
<b>Phalacrocoracidae</b>						
<i>Phalacrocorax olivaceus</i>	5, 7, 35, 41		C,G	FF, I	c	Mergulhão
<b>Anhingiidae</b>						
<i>Anhinga anhinga</i>	1, 3, 9, 10, 11,12, 13, 14, 16, 17, 22, 31, 40	2,4	S,C	FF, B	c	Carará
<b>Ardeidae</b>						
<i>Bubulcus ibis</i>	12		C,G	SF, FF	r	Garça vaqueira
<i>Butorides striatus</i>	21-a, 21-b, 30	2,4	S	FF	c	Socoi
<i>Egretta thula</i>	16, 24	4	S,G	FF, B	c	Garça-branca-pequena
<i>Ardea alba</i>	3, 6, 11, 13, 16, 20, 29	2,4	S,G	FF, B, I	c	Garça branca-grande
<i>Ardea cocoi</i>	1,3,4,5,6,9,10,11,12,13,16, 17,19,20,22,29,30,31,33,35,37,40	2,4	S,G	FF	c	Manguari
<b>Ciconiidae</b>						
<i>Mycteria americana</i>	17	2,4	G	FF	c (s)	Jaburu
<b>Threskiornithidae</b>						
<i>Mesembrinibis cayennensis</i>	1, 2, 3, 5,10, 11, 12, 13, 23, 28, 31, 40	2,4	S,C	I	r	Corocoró
<b>Anatidae</b>						
<i>Cairina moschata</i>	3, 9, 10, 11, 12, 13, 16, 20, 23, 27, 34, 35, 37	2,4	S,C	FF, I	c	Pato-do-mato
<b>Cathartidae</b>						
<i>Cathartes aura</i>	5, 21-b		S	AR	c	Urubu-cabeça-vermelha
<i>Cathartes melambrotus</i>	2, 3, 11, 27, 30, 31, 34, 35, 40	2,4	S	AR	c	Urubu-da-mata
<i>Coragyps atratus</i>	1, 21-b		S,G	AR	c	Urubu preto

Accipitridae									
<i>Pandion haliaetus</i>	1, 3, 7, 10, 12, 17, 22, 23, 30, 33, 34, 40	2,4	S	AR	r (s)	Gavião caipira			
<i>Elanoides forficatus</i>	27	4	G	AR	r	Gavião tesoura			
<i>Ictinia plumbea</i>	3, 6, 8, 12, 23, 27, 29, 34, 35	2,4	C,G	AR	r(s)	Sovi			
<i>Geranospiza caerulescens</i>	6, 13	2,4	S	SF, FF, I	r	Gavião-pernilongo			
<i>Accipiter striatus</i>	21-b		S	F, SF	r	Gavião-miúdo			
<i>Leucopernis schistacea</i>	1		S	FF	r	Gavião-azul			
<i>Buteogallus urubitinga</i>	6, 29	2,4	S	SF, FF, I	c	Gavião preto			
<i>Buteo nitidus</i>	22		S	F, SF	r	Gavião-pedreês			
<i>Buteo magnirostris</i>	3, 14, 22, 23, 27, 40	2,4	S	SF, FF, I	c	Gavião indaia			
<i>Spizastur melanoleucus</i>	29		S	F, FF	r	Gavião-pato			
Falconidae									
<i>Daptrius ater</i>	30	2,4	C,G	F	r	Cancão-de-anta			
<i>Daptrius americanus</i>	11, 27		C,G	F	r	Cancão-grande			
<i>Milvago chimachima</i>	21-b, 28		S,C	SF	c	Gavião panema			
<i>Micrastur glycolis</i>	20		S	F	r	Falcão-mateiro			
<i>Falco rufifularis</i>	11, 17, 18, 27, 28, 29, 35	2,4	S,C	SF, FF, I	c	Cauré			
<i>Falco deiroleucus</i>	4		S,C	FF	r (s)	Falcão-de-peito-laranja			
Cracidae									
<i>Ortalis motmot</i>	21-b, 23		S, C, G	F, FF, SF	r	Aracua-pequeno			
<i>Penelope jacquacu</i>	21-b, 23		S, C	F, FF, SF	r	Jacú			
<i>Mitu tomentosa</i>	4		S, C	F, FF	r	Mutum			
Psophiidae									
<i>Psophia crepitans</i>	1, 21-b		S, C, G	F, FF, SF	r	Jacamim			
Rallidae									
<i>Aramides cajaneae</i>	5, 8, 9, 12		S, C	FF, I	c	Saracura-três-potes			
Scolopacidae									
<i>Actitis macularia</i>	33, 35		S, G	B	c (s)	Maçarico-pintado			



Table 1. (Continued)

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<b>Laridae</b>						
<i>Phaetusa simplex</i>	12, 20, 33, 34, 40	2,4	S, C, G	B	c	Gaivolta
<i>Sterna supercilii</i>	12, 22, 28	2,4	S, C, G	B	c	Trinta-réis-anão
<b>Rynchopidae</b>						
<i>Rynchops niger</i>	10		S, C, G	B	r	Corta-água
<b>Columbidae</b>						
<i>Columba speciosa</i>	3		S, C	FF	r	Pomba-pedrés
<i>Columba cayennensis</i>	3, 5, 6, 12, 22, 23, 24, 27, 28, 29, 30, 34, 35, 40	2,4	S, C	FF, I, SF	c	Pomba-galega
<i>Columba plumbea</i>	41		S, C	F, FF	r	Pomba-amargosa
<i>Columba subvinacea</i>	2, 7, 8, 9, 12, 22		S, C, G	SF	c	Pomba-botafogo
<i>Columbina passerina</i>	21-b		S, C, G	SF	c	Rolinha-cinzena
<i>Leptotila verreauxi</i>	12, 22		S, C	SF, FF, I	c	Juriti
<i>Leptotila rufaxilla</i>	2, 7*, 41	2,3,4	S, C	SF, FF, I	c	Juriti-gemeadeira*
<b>Psittacidae</b>						
<i>Ara ararauna</i>	2, 3, 5, 12, 16, 23, 27, 28, 29, 30, 31, 32, 37, 39, 40	2,4	S,C,G	F, FF, SF, I	c	Ararauna
<i>Ara chloroptera</i>	1, 21-b		S,C,G	FF	r	Arara-vermelha
<i>Aratinga leucophthalmus</i>	10, 12, 21-b, 35, 39	2,4	C,G	FF, SF	c	Aratinga-de-bando
<i>Aratinga pertinax</i>	29		G	FF, SF	r	Aratinga-de-bochecha-parda
<i>Brotopterus chrysopterus</i>	30	2,4	G	F, FF, SF	c	Periquito-de-asa-dourada
<i>Pionites melanocephala</i>	27	4	C,G	F	r	Marianinha-de-cabeça-preta
<i>Pionus menstruus</i>	3, 6, 12, 21-b, 22, 26, 27, 28, 29	2,4	C,G	F, FF	c	Maitaca-de-cabeça-azul
<i>Amazona autumnalis</i>	1, 24	4	S,C,G	F, FF	r	Papagaio-diadema
<i>Amazona farinosa</i>	14, 23, 25, 26	4	S,C,G	F, FF	c	Papagaio-moleiro
<i>Amazona festiva</i>	3, 5, 6, 8, 10, 11, 12, 14, 17, 21-b, 22, 28, 29, 31, 35, 37	2,4	S,C,G	F, FF, I	c	Papagaio-da-várzea
<i>Amazona amazonica</i>	21-a, 29	4	S,C,G	F, FF	r	Papagaio-grego

<b>Cuculidae</b>						
<i>Coccyzus melacoryphus</i>	1, 6		S	FF	r (s)	Papa-lagarta-acanelado
<i>Playa cayana</i>	2, 5, 7, 9, 21-b	2,4	S	FF	c	Alma-de-gato
<i>Crotophaga major</i>	3, 12, 22, 29, 37	2,4	C,G	FF, I, SF	c	Anu-coroaca
<i>Crotophaga ani</i>	5		C,G	SF	r	Anu-preto
<b>Strigidae</b>						
<i>Otus choliba</i>	1		S,C	SF	c	Corujinha-de-orelha
<i>Otus watsonii</i>	21-b		S,C	F, FF	c	Corujinha-amazônica
<i>Pulsatrix perspicillata</i>	1		S,C	F, FF, I	r	Murucututu
<i>Ciccaba huhula</i>	21-b		S,C	FF	r	Coruja-preta
<b>Nyctibiidae</b>						
<i>Nyctibius griseus</i>	4, 21-b		S	FF, SF	r	Mãe-da-lua
<b>Caprimulgidae</b>						
<i>Nyctiprogne leucopyga</i>	1, 3, 6, 7, 21-b	2,4	S,G	FF	r	Bacurau-d' água
<i>Nyctidromus albicollis</i>	21-b		S	SF, B	c	Curiango-comum
<b>Apodidae</b>						
<i>Streptoprocne zonaris</i>	11		S, G	AR	r	Taperuçu-de-coleira-branca
<i>Chaetura spinicauda</i>	11, 12, 22, 27, 40	2	G	AR	c	Taperá-de-sobre-branco
<i>Chaetura cinereiventris</i>	29		G	AR	r	Taperá-de-barriga-cinza
<i>Chaetura brachyura</i>	3, 9, 35, 40	2	G	AR	c	Taperá-de-cauda-curta
<b>Trochilidae</b>						
<i>Phaethornis superciliosus</i>	2, 21-b*	3	S	F	c	Rabo-branco-de-bigodes*
<i>Phaethornis bourcieri</i>	21-b*	3	S	F, FF	r	Rabo-branco-de-bico-reto*
<i>Phaethornis rupurumii</i>	2*, 11*		S	F	r	Rabo-branco-pequeno*
<i>Chlorestes notatus</i>	4		S	F	r	Safra-de-garganta-azul
<i>Thalurania furcata</i>	21-b*	3	S	FF, SF, I	c	Beija-flor-de-barriga-violeta*
<i>Hylocharis cyanus</i>	4		S	F, FF, SF	r	Beija-flor-roxo
<i>Amazilia fimbriata</i>	5, 6*, 21-b	3	S	FF, SF	c	Beija-flor-de-garganta-verde*
<i>Heliothryx aurita</i>	21-b		S	F	r	Beija-flor-fada

Table 1. (Continued)

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<b>Trogonidae</b>						
<i>Pharomachrus pavoninus</i>	21-b		S,C	F, SF	r	Surucua-pavão
<i>Trogon viridis</i>	1, 3, 7, 10		S,C	F, FF, SF	c	Surucua-de-barriga-dourada
<b>Alcedinidae</b>						
<i>Ceryle torquata</i>	1, 5, 10, 21-b, 24, 27, 40	2,4	S	FF, I	c	Martim-pescador-grande
<i>Chloroceryle amazona</i>	21-b	2	S	FF, I	c	Martim-pescador-verde
<i>Chloroceryle americana</i>	1, 3*, 7, 10, 11, 13, 16, 30, 31, 37, 39	4	S	FF, I	r	Martim-pescador-pequeno*
<i>Chloroceryle inda</i>	1*, 16*	3	S	F, FF, I	r	Martim-pescador-da-mata*
<i>Chloroceryle aenea</i>	2*, 3*, 9*, 11*, 16*	3	S	FF, I	c	Martim-pescador-anão*
<b>Galbulidae</b>						
<i>Galbula albirostris</i>	5		S	FI, FS, I	c	Ariramba-de-bico-amarelo
<i>Galbula galbula</i>	1, 2, 3, 5, 7*, 41		S	F, FS, I	c	Ariramba-da-várzea*
<i>Galbula dea</i>	21-b		S	F, I	r	Jacamaraçu
<b>Bucconidae</b>						
<i>Notharchus tectus</i>	1, 10, 11		S,C	F, FI, I	r	Macuru-pintado
<i>Monasa atra</i>	21-a*	3	S,C,G	F	c	Chora-chuva-de-asa-branca*
<i>Monasa nigrifrons</i>	2, 3*, 6, 7, 10, 11, 12, 14, 15*, 16, 29, 39	2,3,4	S,C,G	F, FI, I	c	Chora-chuva-preto*
<i>Chelidoptera tenebrosa</i>	1, 5, 8, 12, 13, 16, 17, 21-b, 22, 23, 30, 33, 34, 35	2,4	S,C	FI, FS, I	c	Urubuzinho
<b>Ramphastidae</b>						
<i>Pteroglossus aracari</i>	21-b		G	F, FS	r	Araçari-minhoca
<i>Ramphastos vitellinus</i>	9, 10, 21-b		S,C	F	r	Tucano-de-bico-preto
<i>Ramphastos tucanus</i>	1, 3, 6, 8, 9, 10, 12, 13, 14, 21-b, 23, 27, 31, 35, 37, 39	2,4	S,C,G	F, FI	c	Tucano-assoviador
<b>Picidae</b>						
<i>Melanerpes cruentatus</i>	1, 6, 8, 35	2,4	S,G	FI, FS	r	Picapau-de-barriga-vermelha
<i>Piculus flavigula</i>	21-b		S	F	r	Picapau-bufador
<i>Colaptes punctigula</i>	5, 16		S	F	r	Picapau-de-peito-pontilhado

<i>Celeus elegans</i>	6	2, 4	S	F, FF	r	Picapau-chocolate
<i>Celeus flavus</i>	4		S	F, FF	r	Picapau-amarelo
<i>Dryocopus lineatus</i>	29	4	S	F, FF	r	Picapau-de-banda-branca
<i>Campephilus melanoleucus</i>	7, 31		S	F, FF	r	Picapau-de-garaganta-preta
<b>Dendrocolaptidae</b>						
<i>Dendrocincla fuliginosa</i>	21-a*	3	S	F, FF	c	Arapaçu-pardo*
<i>Deconychura longicauda</i>	21-a*, 21-b*	3	S	F, FF	c	Arapaçu-rabudo*
<i>Deconychura stictolaena</i>	21-a*	3	S	F, FF	c	Arapaçu-de-garganta-pintada*
<i>Sittasomus griseicapillus</i>	1, 3, 5		S	F, FF	c	Arapaçu-de-cabeça-cinza
<i>Glyphorhynchus spirurus</i>	21-a*, 21-b*	3	S	F, FF	c	Arapaçu-de-bico-de-cunha*
<i>Nasica longirostris</i>	2, 3, 7, 31		S	F, FF	r	Arapaçu-bicudo
<i>Xiphorhynchus picus</i>	1*, 2, 3*, 7	3	S	F, FF	c	Arapaçu-de-bico-reto*
<i>Xiphorhynchus kienerti</i> (= <i>X. necopinus</i> )	4, 7, 41		S	F, FF	r	Arapaçu-ferrugem
<i>Xiphorhynchus obsoletus</i>	1*, 5*, 6, 7*, 15*, 16*, 37, 41	2, 3, 4	S	F, FF	c	Arapaçu-riscado*
<i>Xiphorhynchus pardalotus</i>	21-a*, 21-b*	3	S	F, FF	r	Arapaçu-assoviador*
<b>Furnariidae</b>						
<i>Synallaxis rutilans</i>	8, 21-b*	3	S, C	FI, SF	c	João-castanho*
<i>Cranioleuca vulpina</i>	4		S, C	FI, SF, I	c	João-do-rio
<i>Cranioleuca gutturata</i>	4		S, C	FF	r	João-pintado
<i>Philydor erythrocerus</i>	1*, 21-b		S, C	F	r	Limpa-folha-de-sobre-ruivo*
<i>Sclerurus caudatus</i>	21-a*		S	F	r	Vira-folha-pardo*
<b>Thamnophilidae</b>						
<i>Saksophorus canadensis</i>	1, 7*, 20		S, C	FF, I	r	Choca-de-crista-preta*
<i>Thamnophilus nigrochlorurus</i>	2, 7*, 4, 11*, 16*, 29	3	S, C	F	r	Choca-preta-e-cinza*
<i>Pygiptila stellaris</i>	4, 41		S, C	FF	r	Choca-cantadora
<i>Thamnomanes ardesiacus</i>	21-a*, 21-b*		S, C	F	r	Uirapuru-de-garganta-preta*
<i>Thamnomanes caesius</i>	2, 21-b*		S, C	F	c	Uirapuru-de-bando*
<i>Myrmotherula klagesi</i>	4, 32, 41		S, C	FF	r	Choquinha-do-tapajós
<i>Myrmotherula guttata</i>	21-a*, 21-b*	3	S, C	F, SF	c	Choquinha-de-barriga-ruiva*
<i>Myrmotherula axillaris</i>	21-a*, 21-b		S, C	F	r	Choquinha-de-flanco-branco*

Table 1. (Continued)

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<i>Myrmotherula longipennis</i>	21-a*		S,C	F	r	Choquinha-de-asa-comprida*
<i>Myrmotherula assimilis</i>	2*, 3*, 4, 6, 7*, 15*, 16*, 41	3	S,C	FF	r	Choquinha-da-várzea*
<i>Cercomacra cinerascens</i>	41		S,C	FF	r	Chororó-pocua
<i>Myrmoborus lugubris</i>	1*, 2*, 3*, 5, 6, 7*, 8, 11*, 14*, 16*, 21-b, 27, 32	3	S,C	F, FF	c	Formigueiro-liso*
<i>Hylophylax poeclinota</i>	21-a*, 21-b*	3	S,C	F	r	Rendadinho*
<i>Hypocnemis cantator</i>	21-a*, 21-b*		S,C	F	c	Cantador-comum*
<i>Hypocnemoides melanopogon</i>	1*, 2*, 3*, 6, 7*, 9*, 11*, 14*, 15*, 16*, 21-b*, 41	3	S,C	FF	c	Solta-asa-do-norte*
<i>Pernostola rufifrons</i>	1, 21-a*, 21-b*	3	S,C	F	r	Formigueiro-de-cabeça-preta*
<i>Myrmeciza ferruginea</i>	21-a*	3	S,C	F	c	Formigueiro-ferrugem*
<i>Myrmormis torquata</i>	21-a*		S,C	F	r	Formigueiro-ciscador*
<i>Gymnophyphus rufigula</i>	21-a*	3	S,C	F	c	Mãe-de-taoca-ferrugem*
<i>Phlegopsis erythroptera</i>	21-a*		S,C	F	r	Mãe-de-taoca-avermelhada*
<i>Conopophaga aurita</i>	21-b*	3	S,C	F	r	Chupa-dente-de-cinta*
Formicariidae						
<i>Formicarius colma</i>	21-b*		S,C	F	r	Pinto-da-mata-coroado
<i>Myrmothera campanisona</i>	21-a*		S,C	F	r	Torom-patinho*
Tyrannidae						
<i>Zimmerius gracilipes</i>	41		S,C	F	r	Poaieiro-de-pata-fina
<i>Campostoma obsoletum</i>	2, 5, 8, 21-b		S	F, I, SF	c	Risadinha
<i>Tyrannulus elatus</i>	11, 22		S,C	F, SF, I	c	Maria-te-viu
<i>Myiopagis gaimardii</i>	1, 7		S,C	F, FF	r	Maria-pechim
<i>Myiopagis flavivertex</i>	4, 5*	3	S,C	FF	r	Maria-de-coroa-amarela*
<i>Elaenia chiriquensis</i>	21-b		S,C	I, AA, SF	c	Chibum
<i>Elaenia flavogaster</i>	21-b		S,C	SF	r	Maria-é-dia
<i>Inezia subflava</i>	4		S,C	FF, I	r	Alegrinho-amarelo
<i>Mionectes macconnelli</i>	21-b*		S,C	F	c	Abre-asa-da-mata*
<i>Hemitriccus minor</i>	3*, 4, 32		S	FF	c	Maria-sebinha

<i>Todirostrum maculatum</i>	2, 5, 7, 8, 11, 12, 16, 21-b, 23, 27, 33, 35, 37, 39	2,4	S	FF, SF, I	c	Ferreirinho-estriado
<i>Corythopsis torquata</i>	21-a*	3	S	FF	r	Estalador-do-norte*
<i>Platyrynchus coronatus</i>	21-a*, 21-b*	3	S	F	c	Patinho-de-coroa-dourada*
<i>Tolmomyias sulphurescens</i>	15*	3	S	FF, F	c	Bico-chato-de-orelha-preta*
<i>Tolmomyias poliocephalus</i>	4	3	S	FF, F	c	Bico-chato-de-cabeça-cinza
<i>Rhynchoyclus olivaceus</i>	21-a*	3	S	F	r	Bico-chato-oliváceo*
<i>Oryzochorhynchus coronatus</i>	21-b*	3	S	F	r	Maria-lecre*
<i>Myiobius barbatus</i>	4, 11*, 16*	3	S	FF	r	Assanhadinho-peito-dourado*
<i>Terenotriccus erythrorus</i>	21-b*	4	S	F	r	Maria-rubiruiwa*
<i>Lathrotriccus euleri</i>	4		S	FF	r	Enferrujado
<i>Attila cinnamomeus</i>	1, 4		S	FF, F, I	r	Tinguaçu-ferrugem
<i>Myiarchus ferox</i>	1		S,C	SF, AA	c	Maria-cavaleira
<i>Myiarchus tyrannulus</i>	8, 10		S,C	AA	r	Maria-de-asa-ferrugem
<i>Pitangus sulphuratus</i>	1, 8, 10, 11, 12, 17, 21-b, 23, 34	2,4	S,C	FF, SF, AA	c	Bentevi-verdadeiro
<i>Pitangus lictor</i>	30	2,4	S	FF, I	c	Bentevi-do-brejo
<i>Megarynchus pitangua</i>	21-a, 21-b		S	F, SF	r	Neinei
<i>Myiozetetes luteiventris</i>	21-b		S	F	r	Bentevi-barulhento
<i>Myiozetetes cayenensis</i>	21-b, 22		S,C,G	F, SF, FF	c	Bentevi-assoviador
<i>Conopias parva</i>	21-b		S	F, SF, FF	r	Bentevi-da-copa
<i>Myiodynastes maculatus</i>	2, 3, 5, 8, 11, 21-b	4	S	F, SF, FF	r(s)	Bentevi-rajado
<i>Legatus leucophaeus</i>	2, 5, 22		S	SF, FF, I	c	Bentevi-pirata
<i>Empidononmus varius</i>	16*, 23	3	S	F, SF	c	Bentevi-peitica*
<i>Tyrannopsis sulphurea</i>	5, 21-b		S	F	r	Suiriri-da-garganta-rajada
<i>Tyrannus savana</i>	21-b		S,C,G	SF	c(s)	Tesourinha-do-campo
<i>Tyrannus melancholicus</i>	2, 3, 5, 8,10,11,12, 21-b, 23, 27, 29, 31	2,4	S,C	SF, FF, AA	c	Suiriri-tropical
<i>Pachyrhamphus rufus</i>	1, 2*, 9*		S, C	SF	r	Caneleiro-cinzeno*
<i>Pachyrhamphus marginatus</i>	4		S	FF	r	Caneleiro-bordado
<i>Tityra cayana</i>	23		S,C	FF, SF	r	Araponguinha-de-rabo-preto
Pipridae						
<i>Schiffornis major</i>	4, 7*	3	S	FF	r	Flautim-ruivo*
<i>Corapipo gutturalis</i>	1*	3	S	F	r	Dançarino-de-garganta-branca*

Table 1. (Continued)

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<i>Pipra erythrocephala</i>	24*	3	S	F, FF	r	Dançador-de-cabeça-dourada*
<i>Pipra pipra</i>	21-a*, 21-b*	3	S	F, FF	c	Dançador-de-coroa-branca*
<i>Pipra filicauda</i>	2*, 3*, 4, 14*		S	F, FF, I	c	Dançador-de-cauda-fina*
Cotingidae						
<i>Cotinga cayana</i>	9		S	F	r	Cotinga-pintado
<i>Lipaugus vociferans</i>	21-b, 30	2,4	S,G	F	c	Criciú-seringueiro
<i>Cephalopterus ornatus</i>	29, 32	4	S,G	F, FI	r	Anambé-preto
Hirundinidae						
<i>Phaeoprogne tapera</i>	1, 3, 8, 10, 11, 13, 14, 16, 17, 22, 34, 40	2,4	C,G	AR	c	Andorinha-do-campo
<i>Progne chalybea</i>	3, 6, 9, 10, 12, 13, 14, 17, 29, 35, 37, 40	2,4	C,G	AR	c	Andorinha-grande
<i>Progne subis</i>	3, 6, 12, 13, 22, 35	2,4	G	AR	c(s)	Andorinha-azul
<i>Tachycineta albiventer</i>	1, 4, 5, 9, 10, 11, 12, 13, 22, 27, 30, 31, 35, 40	2,4	C,G	AR	c(s)	Andorinha-do-rio
<i>Stelgidopteryx ruficollis</i>	8, 11, 21-b, 23		C,G	AR	c	Andorinha-serradora-do-sul
<i>Hirundo rustica</i>	22		S	AR	r	Andorinha-dá-chaminé
Troglodytidae						
<i>Thryothorus coraya</i>	21-b		C	FI, FS	c	Garrincha-coraya
<i>Thryothorus leucotis</i>	1*, 2, 3, 5, 6*, 7,10, 11*, 12, 16, 17, 22	2,3,4	C	FI, FS,AA	c	Garrincha-trovão*
<i>Troglodytes aedon</i>	21-b		S,C	AA	c	Corruira-dê-casa
<i>Cyphorhinus arada</i>	21-a*	3	S,C	F	c	Músico-da-mata*
<i>Microcerallus bamba</i>	21-b		S,C	F	c	Flautista-dê-asa-branca
Sylviidae						
<i>Polioptila plumbea</i>	1, 7		S	FS, FI	r	Balança-rabo-de-chapéu-preto
Turdidae						
<i>Turdus fumigatus</i>	1*, 2*, 3*, 5*, 6*, 7*, 16*, 41	3	S	FI, F	r	Sabiá-vermelho
<i>Turdus albicollis</i>	21-a*, 21-b*	3	S	F	r	Sabiá-coleira*

Vireonidae						
<i>Cyclarhis gujanensis</i>	21-b, 22			SF, AA	c	Pitiguari
<i>Hylophilus semicinctus</i>	2, 3, 5, 12, 15*, 21-b, 23, 37		2,3,4	FF, SF	r	Vite-vite-de-cabeça-verde*
Parulidae						
<i>Setophaga ruticilla</i>	4			FF	r	Mariquita-de-rabo-vermelho
Thraupidae						
<i>Hemithraupis guira</i>	4, 7, 41			FF	r	Saira-de-papo-preto
<i>Eucometis penicillata</i>	3*, 7, 14*, 41			FF	r	Pipira-da-taoca*
<i>Tachyphonus surinamus</i>	21-b*			F, SF	r	Pipira-da-guiana*
<i>Tachyphonus luctuosus</i>	4, 7			S,C SF	r	Pipira-de-encontro-branco
<i>Ramphocelus carbo</i>	2, 21-b, 22, 23, 29		4	S,C,G SF, AA	c	Pipira-vermelha
<i>Thraupis episcopus</i>	8, 11, 12, 21-b, 23		2,4	S,C SF, AA	c	Sanhaço-azul
<i>Thraupis palmarum</i>	21-b			S,C SF, AA	c	Sanhaço-do-coqueiro
<i>Euphonia plumbea</i>	41			S,G F, FF	r	Gaturamo-anão
<i>Euphonia chloritica</i>	21-b, 41			S,C FF	c	Gaturamo-ffi
<i>Euphonia chrysopasta</i>	41			S FF	r	Gaturamo-de-barriga-amarela
<i>Euphonia minuta</i>	8			FF	r	Gaturamo-azul
Tangara mexicana	21-b, 41			S,C FF	r	Saira-de-bando
<i>Dacnis cayana</i>	8			S,C FF	r	Sai-azul
<i>Dacnis flaviventer</i>	3, 5			FF	r	Sai-amarelo
<i>Coereba flaveola</i>	1, 31			S FF, AA	c	Cambacica
Icteridae						
<i>Psarocolius decunianus</i>	1, 3, 6, 12, 29, 39		2,4	S,C,G FF, I, SF	c	Japó-preto
<i>Psarocolius viridis</i>	5, 11, 29			S,C,G FF, I, SF	c	Japó-verde
<i>Cacicus cela</i>	5, 9, 10, 11, 12, 21-b, 22, 27, 28, 29, 35, 37, 39		2,4	S, C,G FF, I, SF	c	Japim-xexêu
<i>Scaphidura oryzivora</i>	1, 16			S,C,G B, FF	c	Gratuna
Fringillidae						
<i>Ammodramus aurifrons</i>	21-b			S,C AA	c	Tico-tico-do-campo
<i>Sporophila lineola</i>	21-b			S,C FF	c(s)	Bigodinho
<i>Oryzoborus angolensis</i>	1			S FF	r	Currió



Table 1. (Continued)

Scientific name (species)	Location (numbers as in map)	Analysis (Figure n°)	Soc.	Habitat	Abd.	Local name
<i>Paroaria gularis</i>	1,4, 8, 11, 37	2,4	S,C,G	FF, I, SF	c	Galo-de-campina
<i>Caryothraustes canadensis</i>	21-b		S,C,G	F, FF	r	Furriel-canário
<i>Cyanocopsa cyanoides</i>	2*, 14*, 23,14		S,C	FF, SF	r	Azulão-da-mata*

Location: 21-a, 21-b (mainland); 22-28 (mainland river margins) and the remaining numbers represent the island sites; Codes: Soc. – Sociality; S – solitary; C – couple; G – in groups or small flocks; Habitat: F – Terra firme forest; FF – Flooded forest; SF – Secondary Forest; I – igapo; B – beach; AA – deforested areas; AR – aerial. Abd. – Abundance in Anavilhanas: c – common; r – rare; (s) – seasonal. \*Species caught in mist nets and the respective areas in which they occurred.

abundance in relation to sites (islands). The matrix was constructed with all bird species observed on the eight islands in which we ran eight 10 km transects. The MDS analysis was used to generate a single ordination of bird species within sites. To reduce the multidimensionality of the raw data matrix, the ordinations were based on the Bray–Curtis coefficient from PATN program (see Belbin 1982) that generates the Bray–Curtis association (similarity) distance matrix among all sites. The Bray–Curtis coefficient has been recently recommended and used in ecological studies (Minchin 1987; McNally 1994). It has also been used in some studies conducted near our study area with plants (Costa 2000; Magnusson et al. 1999), insects (Lima et al. 2000), and birds (Cintra 1997; Guilherme and Cintra 2001). It is calculated according to the following formula:

$$D = \Sigma |{}^D_{ik} - {}^D_{jk}| / \Sigma \{ {}^D_{ik} - {}^D_{jk} \}$$

where  ${}^D_{ik}$  = the data value for the  $i^{\text{th}}$  row and  $k^{\text{th}}$  column of the data matrix;  ${}^D_{jk}$  = the data value for the  $j^{\text{th}}$  row and  $k^{\text{th}}$  column of the data matrix.

We also used HMDS analysis to compare the bird community among the same eight areas, the islands mentioned above, and between the islands and the two upland “terra firme” forest areas on the left bank of the Rio Negro (areas 21a and 21b). In this case the qualitative (presence/absence) and quantitative (species/abundance) data came only from bird captures using 10 ornithological nets opened in each area.

## Results

We recorded 232 bird species for the Anavilhanas Ecological Station including the data from visual surveys of many 10 km transects by boat, netting transects on islands and the mainland, and the results of sporadic surveys conducted in 1998. In the entire Anavilhanas Station area the families Tyrannidae and Thamnophilidae showed the highest richness with 38 (16.4%) and 21 (9.0%) of the species respectively.

Our boat and mist-net surveys were more concentrated on the islands. A total of 162 bird species (69.8%) was recorded for 33 islands and 135 bird species (58.2%) for the 9 mainland sites (Terra Firme) surveyed (Table 1). For some islands only one bird species was recorded (sites 18, and 19) and a maximum of 49 bird species was recorded for a given island (site 1). A minimum of one bird species was recorded at mainland sites (site 25) and a maximum of 88 bird species (site 21-b). There were 97 bird species recorded exclusively for the islands (41.8% of the total for EEA) and 70 bird species recorded exclusively for the mainland (30.2% of the total for EEA).

In our data, only two bird families (Tinamidae, 2 species) and Formicariidae (2 species) were restricted to uplands, the terra firme sites. Four bird families – Ciconiidae (1), Rallidae (2 species), Rynchopidae (1 species) and Parulidae (1 species) were restricted to the islands. For the upland sites the families

Tyrannidae (14 species), Thamnophilidae (10 species), and Dendrocolaptidae (5 species) were the most representative in species richness. For the island sites the families Tyrannidae (16 species), Thamnophilidae (9 species) and Thraupidae (9 species) were the most representative in species richness (See also Table 1).

The majority of bird species are permanent residents and less than 5% are neotropical and austral migrants, some of them coming from the northern hemisphere (such as Osprey – *Pandion haliaetus*, and the Purple Martin – *Progne subis*) and others from the Central and Western regions of Brazil (such as Lined Seedeater – *Sporophila lineola*, Fork-tailed Flycatcher – *Tyrannus savana*, and Streaked Flycatcher – *Myiodynastes maculatus*).

The results of the Multiple Dimensional Scaling Ordination analysis HMDS (data from boat transects) performed on the quantitative matrix with bird species abundance (using Bray–Curtis coefficient) indicate that the bird community composition among islands was very similar, irrespective of island size and position in the archipelago (Figure 2).

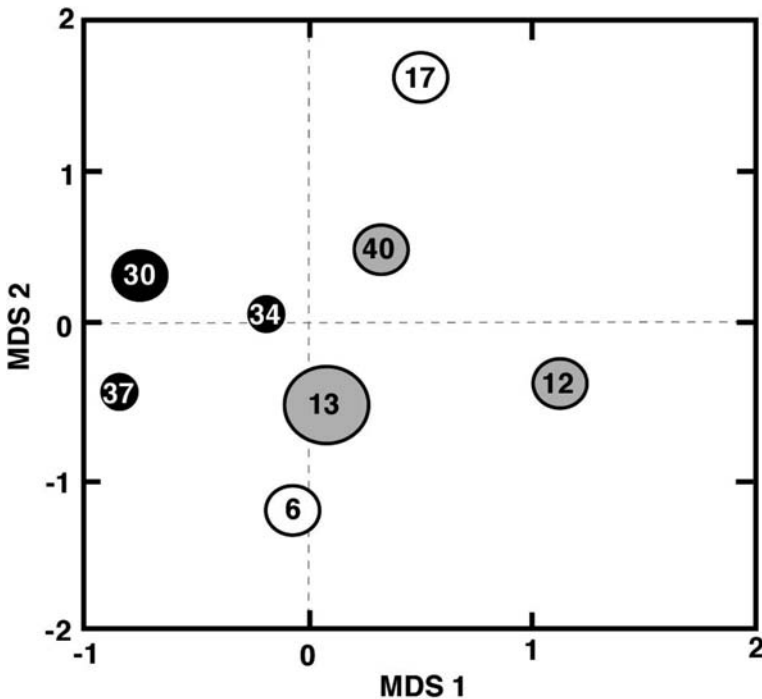


Figure 2. Multidimensional Scaling ordination (MDS) of islands in the Anavilhanas Archipelago, based on 10 km visual transects (see Figure 1). Numbers inside symbols refer to islands on which the bird species were sampled. Symbol size corresponds to island size: small (5–10 km long), medium (10–15 km), large (>15 km). Symbol color denotes position in archipelago: black (northern third), gray (central third), white (southern third). The closer points are to one another in the graph, the more similar are their bird species composition.

The results of the HMDS analysis (data from bird captures using ornithological nets) performed as above also suggests the same pattern found for the results using data from boat transects. The islands showed similar bird community composition among themselves, but very different from that of the “terra firme” forest areas (Figure 3). Although species composition based on boat transect surveys did not differ between mainland (areas 23–27) and islands (areas 6, 12, 13, 17, 29, 30, 34, 37, 40) as strongly as that sampled by mist nets, probably because boat-based transects alongside the mainland confounded adjacent flooded and terra firme habitats, the two types of sites nevertheless can be distinguished (Figure 4).

### Discussion

Some bird species not well known or with a limited distribution in the Amazon region are relatively frequently encountered in Anavilhanas, among these are

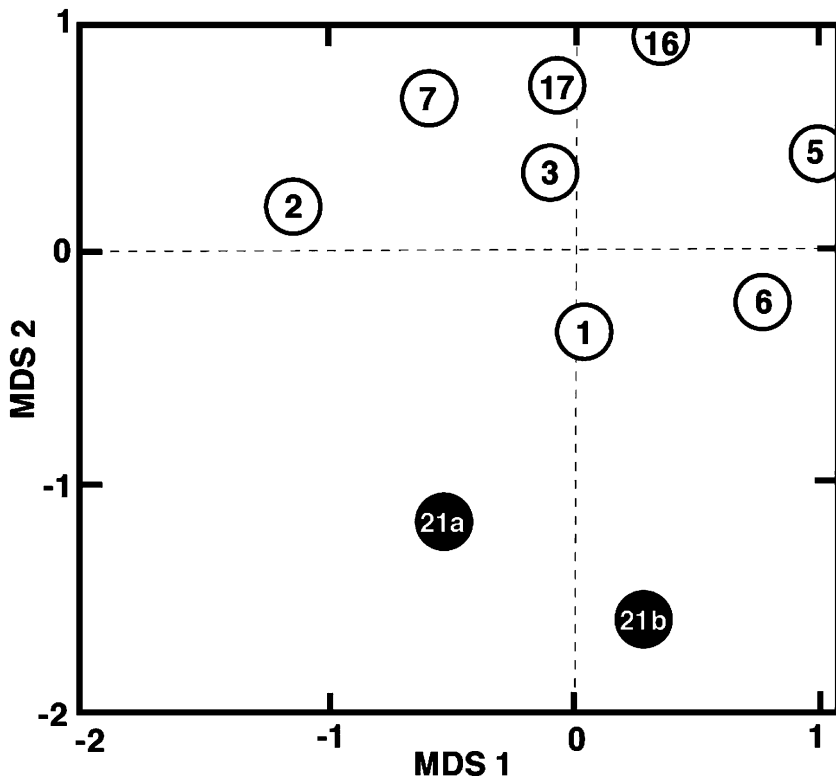


Figure 3. Ordination (MDS) of islands (open circles) and mainland sites (black circles), based on mist net captures (see Figure 1 for area locations). Bird community composition was similar among islands but different from that of the “terra firme” forest areas on the mainland.

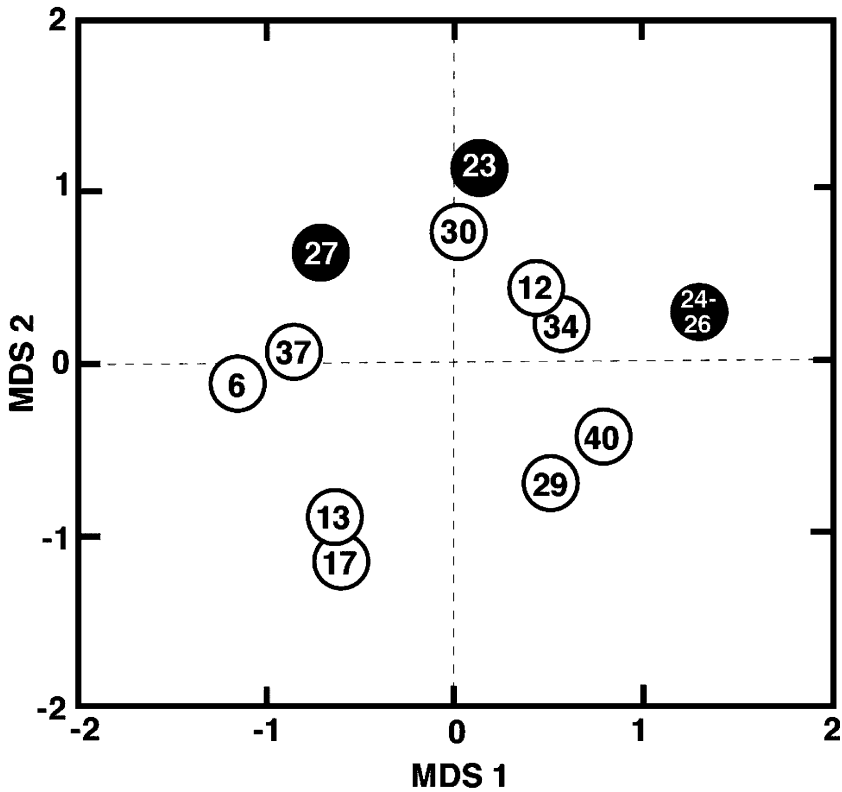


Figure 4. Ordination (MDS) of island (open circles) and mainland river margins (black circles; sites 24–26 overlapped in the analysis and are shown together), based on 10 km transect (see methods). Bird community composition was not especially similar among mainland sites, but these differed from all island sites.

*Spizastur melanoleucus*, *Mitu tomentosa*, *Phaethornis rufurumii*, *Xiphorhynchus kienerii*, *Thamnophilus nigrocinereus*, *Myrmotherula klagesi*, *Myrmoborus lugubris*, *Pipra filicauda*, and *Cephalopterus ornatus*. Situations like this where some island bird species exhibit geographical restriction also occur in some other rivers in the Amazon.

Rosenberg (1990) studied the bird community of two islands in a natural environment of white water river islands, one from the Amazon river and another from the Napo river in the Peruvian Amazon. He found a similar pattern of distribution for island birds in northeastern Peru and he suggested that the majority of most habitat specialized species were obligate island species. Rosenberg (1990) also presents a list of 231 bird species occurring in river islands in eastern Peru and southern Colombia. From those only 3% were also recorded in “terra firme” forest, 40% occurred in aquatic environments including rivers, lakes, stream margins, beaches and swamps, 25% occurred in

“varzea” forests, and 14% were migrant transients and birds that use secondary habitats created by the action of rivers.

In the Brazilian Amazon, a similar study was conducted at the Marchantaria island in the Solimões river. Of the 204 bird species recorded, 57 (28%) bred in the area and one third were species suggested by Remsen and Parker (1983) as having originated from habitats created by rivers (Petermann 1997).

In the communities of 12 (7-year-old) forested land-bridge islands created by the construction of the Guri Dam in Venezuela, Terborgh et al. (1997) found that 58 species of forest-nesting birds on eleven small and medium islands supported respectively only 9 and 12 resident species after islands isolation. They found the bird species composition on islands to be highly variable and no species was found in all islands. Populations on the majority of 1-ha islands had just one pair of bird per species which they think was the result of colonization to replenish individuals that had dispersed or died. Terborgh et al. (1997) concluded that changes in bird community composition seems to be governed by biological (predation on nests) and stochastic processes (high turnover).

The Anavilhanas Islands are dynamically affected by the river, and this creates a mosaic of habitats such as forests, lakes, floating grass, inundated areas, successional forests, swamps with dead trees, etc. Although the forest structure on the islands seems complex, they do have a lower number of tree species than the terra firme forest (Parolin et al. 2003). Also many resources, such as higher types of microhabitats, an abundance of leaf litter, the presence of army ants, abundance of epiphytic plants, may contribute to foraging specialization among bird species in mainland terra firme and not on the islands because those resources are absent on the islands.

The islands are also used by migrant birds (e.g. sandpipers – *Tringa melanoleuca.*, *Calidris fuscicollis*; ducks – *Dendrocygna*; terns – *Phaethusa*, *Sterna*; skimmers – *Rynchops*; egrets – *Ardea*, *Egretta*, *Bubulcus*; – hawks – *Pandion*, *Ictinea*; nighthawks – *Podager nacunda*; tyrant-flycatchers – *Tyrannus* spp., *Myiodynastes*, *Myiarchus*, *Syristes*; swallows – *Progne* spp. *Tachycineta*; blackbirds – *Leistes*; and finches – *Sporophila* spp.); and by some species from mainland terra firme forest to forage and roost (e.g. macaws – *Ara* spp., parrots – *Amazona* spp., oropendulas – *Psarocolius*; caciques – *Cacicus*) (see also Stotz et al. 1992).

The difference in avifaunas between mainland and islands provides an additional possible causal factor for the celebrated species endemism found on opposite banks of large Amazonian tributaries (Haffer 1974, 1992; Cracraft 1985). Not only are the rivers themselves formidable barriers to the dispersal of small forest birds, but also competition with species adapted to the flooded forest habitat along the river courses may make that habitat more difficult to colonize even after successful dispersal from the mainland. Thus, the islands, rather than serving as stepping stones between opposite banks, could be as inhospitable to terra firme species as the open water itself. The biogeographic

implications of this differentiated species composition will be explored in more detail in a separate paper.

The archipelago is relatively rich in species and seems to have a bird community composition (richness and abundance) as high as other river archipelagos located 500 km from Manaus up the Negro river (Barcelos) and 900 km up the same river (São Gabriel da Cachoeira, RC Pers. Obs).

The same can be said in relation to the bird community composition from the terra firme forest, with a high number of species and many typical species from areas in the Central Amazon surrounding Anavilhanas (Cohn-Haft et al. 1997). However, the Anavilhanas archipelago is unique in the Amazon, and has its own avifauna, which is distinct from the neighboring forests and also distinct from other island systems studied in the region. Because of this it should be protected and preserved to guarantee the pristine habitats that maintain high diversity of bird species and those endemic of the Amazon region.

### Acknowledgments

We thank the boat drivers and station staff João Batista de Sá Rodrigues, José Palheta, Sr. Olegário, Raimundo Maracanã, and Sra. Marlí for their help during field work and logistics in 1988 and 1989. Rita Mesquita and Summer Wilson were excellent field companions during the bird surveys in 1988 and 1989, as was Sérgio H. Borges in 1997. IBAMA gave permission to work in Anavilhanas Station and their facilities. Marina Antongiovanni provided the satellite image for the map. This study was supported by INPA and IBAMA.

### References

- Belbin L. 1982. PATN: Pattern Analysis Package. CSIRO, Canberra, Australia.
- Bierregaard R.O. 1990. Species composition and trophic organization of the understory bird community in a central Amazonian terra firme forest. In: Gentry A.H. (ed.), *Four Neotropical Rainforests*. Yale University Press, New Haven, USA, pp. 217–236.
- Borges S.H. and Carvalhaes A. 2000. Bird species of black water inundations forests in the Jaú National Park (Amazonas state, Brazil): their contribution to regional species richness. *Biodiv. Conserv.* 9: 209–214.
- Borges S.H., Cohn-Haft M., Carvalhaes A.M.P., Henriques L.M., Pacheco J.F. and Whittaker A. 2001. Birds of Jau National Park, Brazilian Amazon: species checklist, biogeography and conservation. *Ornithologia Neotrop.* 12: 109–140.
- Cintra R. and Yamashita C. 1990. Habitats, Abundância e ocorrência de aves no Pantanal de Poconé. Mato Grosso. *Papeis Avulsos de Zoologia (S. Paulo)* 37: 1–21.
- Cintra R. 1997. Spatial distribution and foraging tactics of Tyrant Flycatchers in two habitats in the Brazilian Amazon. *Stud. Neotrop. Environ.* 32: 17–27.
- Cohn-Haft M., Whittaker A. and Stouffer P.C. 1997. A new look at the “species-poor” Central Amazon: the avifauna north of Manaus, Brazil. In: Remsen J.V.Jr. (ed.), *Ornithological Monographs* 48. AOU, Washington, DC, pp. 205–236.

- Costa F. 2000. Effects of selective logging and girdling of commercially non-valuable trees on the understory plant communities in a central Amazonian forest. PhD Thesis. INPA/University of Amazonas, Manaus, Am.
- Cracraft J. 1985. Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemism. In: Buckley P.A., Foster M.S., Morton E.S., Ridgely R.S. and Buckley F.G. (eds), *Neotropical Ornithology*. Ornithol. Monogr. 36, pp. 49–84.
- Guilherme E. and Cintra R. 2001. Effects of intensity and age of selective logging and tree girdling on an understory bird community composition in Central Amazonia, Brazil. *Ecotropica* 7: 77–92.
- Haffer J. 1974. Avian speciation in tropical South America. Publications of the Nuttall Ornithological Club, No. 14.
- Haffer J. 1992. On the “river effect” in some forest birds of southern Amazonia. *Bol. Mus. Para. Emílio Goeldi (série Zoologia)* 8: 217–245.
- Junk W.J. and Furch K. 1985. The physical and chemical properties of Amazonian waters and their relationships with the biota. In: G.T. Prance and Lovejoy T.E. (eds), *Amazonia*, Pergamon Press, Oxford, pp. 3–17.
- Lima A.P., Cordeiro-Duarte A.C., Luizão F.J. and Higushi N. 2000. Effects of selective logging intensity on two termite species of genus *Synthermes* in Central Amazonia. *Forest Ecol. Manage.* 137: 151–154.
- Magnusson W.E., Lima O.P., Reis F.Q., Higushi N. and Ramos J.F. 1999. Logging activity and tree regeneration in an Amazonian forest. *Forest Ecol. Manage.* 113: 67–74.
- MacNally R.C. 1994. On charactering foraging versatility, illustrated by using birds. *Oikos* 69: 95–106.
- MacArthur R.H. and Wilson E.O. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton, N.J.
- Meyer de’ Schauensee R. and Phelps W.H.Jr. 1978. *A Guide to the Birds of Venezuela*. Princeton University Press, Princeton, NJ.
- Minchin P.R. 1987. An evaluation of the relative robustness of techniques for ecological ordination. *Vegetatio* 69: 89–107.
- Parolin P., Adis J. da Silva M.F., do Amaral I.L., Schmidt L. and Piedade M.T.F. 2003. Floristic composition of a floodplain forest in the Anavilhanas archipelago, Brazilian Amazonia. *Amazoniana* 17: 399–411.
- Petermann P. 1997. The Birds. In: Wolfgang J. Junk (eds), *The Central Amazon Floodplain, Ecology of a Pulsing System*. Springer-Verlag, Berlin, pp. 419–451.
- Pires J. M. and Prance G. T. 1985. The vegetation types of the Brazilian Amazon. In: Prance G.T. and Lovejoy T.E. (eds), *Amazonia*. Pergamon Press, Oxford, pp. 109–145.
- Remsen J. V.Jr and Parker T. A.III 1983. Contribution of river-created habitats to bird species richness in Amazonia. *Biotropica* 15: 223–231.
- Rosenberg G. H. 1990. Habitat specialization and foraging behavior by birds of Amazonian river islands in northeastern Peru. *Condor* 92: 427–443.
- Sanaiotti T. and Cintra R. 2001. Breeding and migrating birds in an Amazonian Savanna. *Stud. Neotrop. Environ.* 36: 23–32.
- Sioli H. 1984. *The Amazon: Limnology and Landscape Ecology of a Mighty Tropical River and its Basin*. Dr. W. Junk Publishers, Dordrecht.
- Stotz D. F., Bierregaard R. O., Cohn-Haft M., Petermann P., Smith J., Whittaker A. and Wilson S. V. 1992. The status of North American migrants in central Amazonian Brazil. *Condor* 94: 608–621.
- Terborgh J. 1985. Habitat selection in Amazonian Birds. In: Cody M. L. (eds), *Habitat Selection in Birds*. Academic Press, New York, pp. 311–338.
- Terborgh J., Fitzpatrick J. and Emmons L. 1984. Annotated checklist of bird and mammal species of Cocha Cashu Biological Station, Manu National Park, Peru *Fieldiana-Zoology*. Pub. Field Museum Nat. History, 21(New Series): 1–29.



- Terborgh J., Robinson S. K., Parker T. A.III, Munn C. A. and Pierpont N. 1990. Structure and organization of an Amazonian forest bird community. *Ecol. Monogr.* 60: 213–238.
- Terborgh J., Lopez L. and Tello S. J. 1997. Bird communities in transitions: the Lago Guri islands. *Ecology* 78: 1494–1501.
- Willis E. O. 1977. Lista preliminar das aves da parte noroeste e áreas vizinhas da Reserva Ducke, Amazonas, Brasil. *Revista Brasileira de Biologia.* 37: 585–601.