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Species-specific differences in relative eye size are related to patterns of edge avoidance in an Amazonian rainforest bird community

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Keywords

Avian vision, ecology, habitat use, light environment, perception.

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Funding Information

Research was partially funded by a Fundación BBVA grant to DG. DG was funded by project grant CGL2011-26318 from the Ministerio de Economía y Competitividad (Spain). ESAS was funded by a project grant from the São Paulo Research Foundation (FAPESP): 2012/20468-4.

Received: 3 July 2014; Revised: 8 July 2014; Accepted: 15 July 2014

Ecology and Evolution 2014; 4(19): 3736– 3745

doi: 10.1002/ece3.1194

Introduction

Most vertebrates rely on light for foraging, communication, and predator avoidance, and numerous species adjust their daily routines as a function of available light (Thomas et al. 2002; Berg et al. 2006). But habitats vary widely in the amount of light that they are exposed to (Endler 1993). Several adaptations have been shown to allow organisms to survive in different ambient light conditions (McNab 2002), including an increase in relative eye size in habitats where light is scarce (Warrant 2004). This pattern has been found in diverse vertebrate orders, from tarsiers and humans to abyssal fish (War-

Abstract

Eye size shows a large degree of variation among species, even after correcting for body size. In birds, relatively larger eyes have been linked to predation risk, capture of mobile prey, and nocturnal habits. Relatively larger eyes enhance visual acuity and also allow birds to forage and communicate in low-light situations. Complex habitats such as tropical rain forests provide a mosaic of diverse lighting conditions, including differences among forest strata and at different distances from the forest edge. We examined in an Amazonian forest bird community whether microhabitat occupancy (defined by edge avoidance and forest stratum) was a predictor of relative eye size. We found that relative eye size increased with edge avoidance, but did not differ according to forest stratum. Nevertheless, the relationship between edge avoidance and relative eye size showed a nonsignificant positive trend for species that inhabit lower forest strata. Our analysis shows that birds that avoid forest edges have larger eyes than those living in lighter parts. We expect that this adaptation may allow birds to increase their active daily period in dim areas of the forest. The pattern that we found raises the question of what factors may limit the evolution of large eyes.

> rant 2004; Kirk 2006; Pearce and Dunbar 2012). Anatomical data show that larger eyes can accommodate larger pupillae and corneas, more photoreceptors that allow increased visual acuity, a larger visual field width, and thus the possibility of seeing in dim light conditions (Martin and Katzir 2000; Veilleux and Lewis 2011). In birds, species with relatively larger eyes have been shown to be more likely to feed on mobile prey and have nocturnal habits (Garamszegi et al. 2002), flee at a longer distance from predators (Møller and Erritzøe 2010, 2014) and sing earlier at dawn (Thomas et al. 2002; Berg et al. 2006). Additionally, a modification in eye shape caused by an increase in axial depth with respect

© 2014 The Authors. *Ecology and Evolution* published by John Wiley & Sons Ltd. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited. to the corneal diameter has been found in nocturnal birds, although this pattern has not been verified in a comparative analysis correcting for phylogeny (Hall and Ross 2007).

In structurally complex forests, there are large differences in light levels between strata and at different distances from the edge (Endler 1993), favoring the evolution of fine adaptations in communication strategies (Endler and Thery 1996). For instance, bird species that live in dark forest areas have highly conspicuous plumage patterns, which are expected to be advantageous in intraspecific communication (Marchetti 1993; Shultz and Burns 2013). However, we know of no specific test linking relative eye size with habitat darkness in such a structurally complex environment. We predicted that relative eye size should be dependent on within-forest microhabitat occupancy (Fig. 1). We tested our hypothesis in a species-rich rainforest bird community in the Amazonas Central Region (Cohn-Haft et al. 1997). In this habitat, strong differences among species in microhabitat usage allow a fine two-dimensional separation in distance to the edge and forest stratum (Stotz et al. 1996). We expected eye size to increase with increasing distance to the forest edge and also to be larger for understory than for canopy birds.

Material and Methods

Study area and field data collection

We conducted our study in the Adolpho Ducke Forest Reserve (25 km NW of Manaus, Brazil) in October 2009, which corresponds to the peak of the breeding season in this area (Stouffer et al. 2013). This is a large (10,000 ha) homogenous stretch of *terra firme* tropical forest with a continuous canopy around 37 m in height (Cohn-Haft et al. 1997). We selected an area of 900 by 300 m, run-



Figure 1. Forest edge near Manaus (Amazonas, Brazil). Forest avian species differ in the degree to which they avoid or favor forest edges and can thus be classified along a continuum of edge avoidance.

ning along the southern edge of the forest. In this area, we established three parallel paths at 100, 200, and 300 m from the forest edge. Each transect was further divided into 100 m stretches, creating a grid of 27 sound recording points. We recorded dawn chorus at these points (continuously between 05.00 and 09.00 AM; 48 kHz, 16 bits) using three automatic "Song-Meter 1" units (Wildlife Acoustics) during 9 days, all three transects being sampled each day at a different point. Recordings were divided in 5-min intervals and birds identified as present/ absent in each interval by a bird expert (Marconi Campos-Cerqueira, INPA, Brazil). All species could be identified with certainty, except Thraupis palmarum and T. episcopus, which have similar songs. Given their similar ecology and morphology, we arbitrarily assigned all recordings of this genus to T. palmarum.

A total of 136 bird species from 30 families were detected in the 108 h of recording time (see Appendix 1). We arbitrarily selected species that had been detected in more than half of the days (\geq 6 detection, N = 66 species) to avoid introducing noise from uncommon species into the analyses. We calculated an edge-avoidance index by dividing the number of days a species was detected in the innermost transect by the days the bird had been detected in all transects.

We tested the internal reliability of our edge-avoidance index by dividing the sample in two half-samples (the first 5 days against the last 4 days) and comparing the scores, which were found to be repeatable (Pearson's r = 0.44, N = 40, P < 0.01; sample is smaller because not all 66 species were detected in both half-samples). Although our method does not take into account imperfect detection (MacKenzie et al. 2004), we checked its reliability by testing the relationship between our edgeavoidance index and a published classification of edge species (Cohn-Haft et al. 1997). We found that birds that favor edges according to Cohn-Haft et al. (1997) had a lower edge-avoidance index than those who do not favor edges (PGLS: estimate (SE) = -0.14 (0.06), $F_{2.64} = 5.01$, P < 0.01), suggesting that our edge-avoidance index is a robust proxy of habitat preference in terms of edge versus. forest interior.

Data on preference for vegetation strata were obtained from a published source (Stotz et al. 1996) and was defined in three categories: understory (terrestrial + understory), middle height, and canopy. Body size was taken as the midpoint in a range of body lengths from a common data source (del Hoyo et al. 1992–2001).

Eye size measurements

For a subsample of species (N = 42), direct eye size measurements from dissected specimens conserved in ethanol

were available in Ritland's (1982) monograph, and we averaged values for all samples that were provided (mean number of samples = 1.5, SD = 1.04). We estimated eye volume assuming the shape of the eye to correspond to an oblate spheroid (Garamszegi et al. 2002), using the equation:

eye volume
$$(cm^3) = (4\pi/3) * a^2 * c$$
,

where *a* is the equatorial radius (TM1/2 in Ritland's) and *c* is the polar radius (TM2/2 in Ritland's), measured in cm.

For the remaining species (N = 24), we obtained eye size estimates by measuring exposed eye area in a sample of photographs obtained from different Internet sources (mean number of pictures per species = 2.86, SD = 0.34). Briefly, photographs were scaled on average bill measurements and the exposed eye area measured with the "polygon" tool in the software ImageJ (Wayne Rasband, NIH, USA). To this end, bill data were obtained by one of us (ESAS) from stuffed birds in the Museu de Zoologia da Universidade de São Paulo (mean number of specimens per species = 2.76, SD = 0.5). Eye area was averaged over two estimates obtained by photographs using beak length and beak height as scaling parameters, respectively.

Before pooling our measurements with those from Ritland (1982), we used a linear regression to correct for differences in measurement technique. To this end, a sample of 22 species available in Ritland's was also measured in photographs. The result of this linear regression suggests that exposed eye area measured in photographs is a close estimate of eye volume as measured in dissected specimens (area (mm²) = eye volume (cm³) * 0.034 – 0.105; $F_{(1,20)} = 94.25$, P < 0.001, $R^2 = 0.81$).

Although it would have been interesting to add to our study information on axial depth, and thus, eye shape (Hall and Ross 2007), we could only obtain these data in the subsample of species studied by Ritland (1982). Additionally, given that axial diameter is very strongly associated with eye volume as calculated from transverse radii (linear regression on logs: $F_{(1,41)} = 1517.9$, P < 0.001, $R^2 = 0.97$; β (SE) = 1.01 (0.34)), it would seems highly unlikely to find an allometric modification of shape in these species.

Statistical analysis

Data were analyzed with a phylogenetic linear model using packages *caper* and *ape* in R (Orme 2012; R Development Core Team 2013). We analyzed the relationship between relative eye size and edge avoidance and stratum with maximum likelihood estimates of Pagel's lambda values. We obtained a random sample of 1,000 phylogenetic trees from Jetz et al. (2012; birdtree.org), using the sampling tool available on the website. A majority-rule consensus tree is presented in Appendix 3 for illustration purposes. We repeated each model with each of the 1000 trees and report the mean slope of the phylogenetic regression and the mean two-tailed *P*-values. Model residuals did not depart from normality and homoscedasticity.

Results

Eve size evolution was better explained (lowest AIC) by a Brownian model (AIC = -32.10) than by an Ornstein–Uhlenbeck model (AIC = -14.15). When considering the relationship between eye size and body size, edge avoidance and forest stratum, the model with an absolute lower AIC (-51.2) included all terms and a nonsignificant interaction between edge avoidance and stratum (Table 1). However, a simpler model not including the interaction showed only a slightly higher AIC (-49.70), suggesting that both models are equally parsimonious. In summary, birds had increasing relative eye sizes with increasing edge avoidance (Fig. 2), and this pattern was similar for inhabitants of the three strata. Despite the nonsignificant interaction between these predictors, a comparison of slopes suggests a trend for a flatter slope in the case of canopy birds with respect to other strata (Fig. 2), which goes in the direction of our a priori expectation. The phylogenetic signal of eye size in the model was strong (mean ML estimation: $\lambda = 0.92$).

Discussion

We found that relative eye size was predicted by some microhabitat characteristics in a group of Amazonian forest birds. Birds that dwell in deeper, darker parts of the forest, furthest from the forest edge, had larger eyes for their size than birds that tend to occur in forest edges. Surprisingly, we did not find differences in eye size between birds favoring different forest strata, despite there being large differences in light conditions (Endler 1993).

Table 1. Parameter estimates (and SEs) for the best phylogenetic generalized linear model (PGLS) for eye volume, as determined from AIC comparison (see main text). Data show mean estimates for a sample of 1000 different trees. Statistics for the full model are as follows: $F_{5,61} = 41.26$, P < 0.001.

Terms	Estimate (SE)	t	Р
(Intercept)	-2.45 (0.26)	-9.42	<0.001
Body mass (log)	1.56 (0.13)	11.61	< 0.001
Forest stratum	0.07 (0.06)	1.27	0.21
Edge avoidance	0.60 (0.23)	2.59	0.01
Edge avoidance*Forest stratum	-0.17 (0.09)	-1.97	0.053



Figure 2. Plots showing the relationship between residual eye volume (corrected for body size) and our measure of edge avoidance for canopy (blue marks), middle stratum (green) and understory (red) birds. Data points are residuals from a regression of eye volume on body size and thus are not phylogenetically corrected. Regression lines for illustration only, slopes from the model are as follows: understory: 0.32 (0.12); medium stratum: 0.17 (0.08); and canopy: 0.12 (0.06). Slope comparisons, all *Z* < 1.4, *P* > 0.08.

The relationship between edge avoidance and eye size was similar for birds inhabiting the three different strata, although the interaction showed a nonsignificant trend for a weaker relationship in the case of canopy birds. The general pattern that we found is similar to a previous study in mammals, where similar differences in eye size were found between habitat types, but not in relation to forest strata (Veilleux and Lewis 2011).

Our results provide an additional layer of variation to previous research showing that relative large eye size in birds is an adaptation to capture of moving prey, nocturnal habits, and susceptibility to predation (Garamszegi et al. 2002). Physiological evidence shows that larger eyes provide higher visual acuity through a higher number of photoreceptors, and also an absolute increase in photostimulation which reduces the stimulation threshold (Martin 1993; Güntürkün 1999). Bird species with relatively larger eyes start singing earlier, probably being able to forage earlier than other species (Thomas et al. 2002, 2006; Berg et al. 2006). We would expect thus larger eyes to allow extended or earlier foraging time in dwellers of forest interiors, although no present study to our knowledge has examined this possibility in this group of species.

A previous study (Møller and Erritzøe 2010) did not find differences in relative eye size between birds living in open and close European habitats, suggesting that the differences that we found may be specific of extremely dark forests such as those found in the tropics. However, we do not know whether larger eyes fully compensate for differences in ambient light, or if this compensation is only partial.

If big eyes are important for early predator detection (Møller and Erritzøe 2010, 2014) and increase the range of light conditions under which birds can forage and communicate, why do some birds have relatively small eyes? The positive relationship between relative eye and brain size has been interpreted as a suggestion that neural costs may constraint the advantage of big eves (Garamszegi et al. 2002). However, an excess of light is detrimental for the retina cells, primarily by photo-chemical damages induced by ultraviolet and blue radiation (Marshall 1991). Indeed, some birds have evolved special anatomical structures (i.e., feathered evelids) to shade the eyes from an excess of light (Martin and Katzir 2000). Thus, the evolution of big eyes may also be constrained by costs due to photo-chemical injury in species which are exposed to high levels of sunlight.

Edge avoidance is a highly species-specific trait that organizes the distribution of species in many forested areas (Lindell et al. 2007). Under the current scenario of habitat destruction, differences in edge avoidance may result in heterogeneous responses to habitat fragmentation, leading to species-specific patterns of resilience (Laurance et al. 2004). We expect edge avoiders to be particularly vulnerable to habitat fragmentation. Our data provide evidence that behavioral differences and microhabitat occupancy are related to morphological differences among species possibly due to patterns of physiological adaptation.

Acknowledgments

Research was partially funded by a Fundación BBVA grant to DG. Marconi Campos-Cerqueira kindly analyzed the recordings and provided us with the species list. We are grateful to Dr. Luís Fábio Silveira for allowing access to naturalized specimens. Gonçalo Ferraz and Marina Anciães provided essential support during our work in Manaus. An anonymous reviewer provided us with useful and constructive feedback. Gavin Thomas generously helped us to improve the phylogenetic analyses. DG was funded by project grant CGL2011-26318 from the Ministerio de Economía y Competitividad (Spain). ESAS was funded by a project grant from the São Paulo Research Foundation (FAPESP): 2012/20468-4.

Data accessibility

Data are available as Appendices 1 and 2 at the end of this article. Recordings are deposited at the Fonoteca Zoologica (MNCN-CSIC).

Conflict of Interest

None declared.

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Appendix 1: Full list of avian species identified in the recordings, with number of detections and number of days in which each species was detected per transect. Total detections are the absolute number of 5-min intervals in which a species was detected during the duration of the study.

	Species	Total detections	Days detected in each transect		
Family			Inner	Medium	External
TINAMIDAE	Crypturellus soui	1	1	0	0
TINAMIDAE	Crypturellus variegatus	4	3	0	0
TINAMIDAE	Tinamus major	3	2	1	0
ACCIPITRIDAE	Leucopternis melanops	2	1	0	0
ACCIPITRIDAE	Buteo magnirostris	20	3	3	4
FALCONIDAE	Falco rufigularis	2	0	1	1
RALLIDAE	Laterallus viridis	2	1	0	0
COLUMBIDAE	Patagioenas plumbea	21	3	3	0
COLUMBIDAE	Patagioenas sp.	1	1	0	0
PSITTACIDAE	Amazona autumnalis	177	9	9	9
PSITTACIDAE	Amazona farinosa	3	2	0	0
PSITTACIDAE	Amazona sp.	1	0	1	0
PSITTACIDAE	Ara sp.	1	1	0	0
PSITTACIDAE	Brotogeris chrysoptera	9	3	3	0
PSITTACIDAE	Orthopsittaca manilata	1	1	0	0
PSITTACIDAE	Pionus menstruus	52	7	6	9
PSITTACIDAE	Pionus fuscus	41	, 6	2	0
PSITTACIDAE	Pionus sp	1	1	0	0
PSITTACIDAE	Pyrilia caica	38	5	2	1
CUCUUDAE	Dromococcyx payoninus	1	0	1	0
	Piava cavana	18	4	2	1
	Piava melanogaster	1	0	1	0
	Piava sp	4	2	2	0
	Lurocalis semitorquatus	3	2	0	0
NYCTIBIDAE	Nyctibius aethereus	1	1	0	0
	Phaethornis ruber	5	0	4	1
	Trogon melanurus	3	1	0	0
	Trogon sp	5	3	2	0
	Trogon viridis	35	6	1	1
GALBUILIDAE	Galbula albirostris	13	6	0	1
GALBUILIDAE	Galbula dea	15	6	2	1
GALBUILIDAE	lacamerops aureus	5	1	2	1
	Bucco tamatia	2	2	0	0
BUCCONIDAE	Chelidontera tenebrosa	1	1	0	0
BUCCONIDAE	Monasa atra	13	5	1	1
BUCCONIDAE	Notharchus macrorhynchos	1	1	0	0
	Canito niger	1	0	1	0
	Pteroglossus sp	2	2	0	0
RAMPHASTIDAE	Pteroglossus viridis	5	1	1	3
	Ramphastos tucanus	35	7	7	5
	Ramphastos vitallinus	5	7	1	0
	Ramphastos viteninas	1	2	1	0
RAMPHASTIDAE	Sclerurus caudacutus		5 1	0	0
RΔΜΡΗΔΥΤΙΩΛΕ	Selenidera ninerivora	22	5	2	0
		1	0	∠ 1	0
	Melanernes cruentatus	2	1	0	0
	Piculus chrysochloros	2	1	0	0
	Piculus flaviaula	12	1	2	0
IICIDAL	i iculus llavigula	12	4	2	U

Appendix 1 Continued.

Family	Species	Total detections	Days detected in each transect		
			Inner	Medium	External
PICIDAE	Veniliornis cassini	2	2	0	0
DENDROCOLAPTIDAE	Campylorhamphus procurvoides	1	1	0	0
DENDROCOLAPTIDAE	Deconvchura stictolaema	3	2	0	0
DENDROCOLAPTIDAE	Dendrexetastes rufiqula	5	2	0	0
DENDROCOLAPTIDAE	Dendrocincla fuliginosa	27	7	5	0
DENDROCOLAPTIDAE	Dendrocolaptes certhia	2	1	-	0
DENDROCOLAPTIDAE	Dendrocolaptes picumnus	7	4	0	0
DENDROCOLAPTIDAE	Glyphorynchus spirurus	7	2	3	0
DENDROCOLAPTIDAE	Lepidocolaptes albolineatus	2	- 1	0	0
	Sittasomus griseicapillus	13	2	1	0
	Xinhorhynchus pardalotus	36	7	3	0
	Cercomacra cinerascens	1	, 1	0	0
	Cymbilaimus lineatus	3	2	0	0
	Erederickena viridis	1	1	0	0
	Gympopithys rufigula	25	3	1	0
	Hypochemis cantator	6	1	1	0
	Myrmeciza ferruginea	9	2	2	1
	Myrmotherula hrachyura	9	2	1	0
	Myrmotherula gutturalis	1	2	0	0
	Myrmotherula avillaris	4	1	0	0
	Myrmotherula sp	1	0	1	0
	Porchostola rufifrons	65	0	1	2
	Perchostola Turinons	5	0	4	5
	Schistosishla lausostiama	24	2	1	1
	Thempomonos orderiosus	24	۲ ۲	۲ 1	1
		0	ו ר	1	0
		2	2	0	1
	Formisarius colma	40	0 6	2	1
	Formicanus conna	29 E	0	2	0
	Attila spadicous	כ 1 כ	2	0	0
	Allia spaulceus	2	2	0	1
	Campiosiona obsoletum	2	0	1	1
	Conopias parva	4	2	0	0
		2	2	0	0
	Hemitriccus zosterops	3	2	0	1
	Legalus leucophaius	1	0	0	1
		10	0	1	0
	Megarynchus pitangua	10	0	1	2
	Myiopagis gainardii	29	4	1	1
	iviyiornis ecaudatus	15	4	1	1
	Myiozetetes cayanensis	13	1	4	4
	Pitangus sulphuratus	5	1	1	1
	Platyrinchus coronatus	/	3	0	0
	Platyrinchus platyrhynchos	2	1	0	0
	Rhytipterna simplex	9	3	0	0
	Terenotriccus erythrurus	2	1	0	0
		4	2	1	1
	Todirostrum pictum	//	9	/	2
	i odirostrum sp.	1	U	U	1
	Ioimomya poliocephalus	1	1	U	0
	I olmomyias assimilis	21	4	1	1
IYKANNIDAÉ	Tolmomyias poliocephalus	52	6	5	3
IYKANNIDAÉ	Tyrannus melancholicus	5	2	0	0
TYRANNIDAE	Tyranopsis sulphurea	1	1	0	0
TYRANNIDAE	Zimmerius gracilipes	20	2	4	2

Appendix 1 Continued.

	Species	Total detections	Days detected in each transect		
Family			Inner	Medium	External
PIPRIDAE	Pipra erythrocephala	10	2	0	0
PIPRIDAE	Piprites chloris	1	1	0	0
PIPRIDAE	Tyranneutes virescens	1	1	0	0
COTINGIDAE	lodopleura fusca	1	1	0	0
COTINGIDAE	Lipaugus vociferans	11	5	0	0
TROGLODYTIDAE	Microcerculus bambla	6	1	1	1
TROGLODYTIDAE	Pheugopedius coraya	5	1	1	0
TROGLODYTIDAE	Troglodytes musculus	13	0	1	2
TURDIDAE	Turdus albicollis	5	2	0	0
TURDIDAE	Turdus ignobilis	1	1	0	0
TURDIDAE	Turdus leucomelas	4	3	0	0
TURDIDAE	Turdus sp.	2	1	1	0
POLIOPTILIDAE	Microbates collaris	3	2	0	0
EMBERIZIDAE	Arremon taciturnus	4	2	1	0
CARDINALIDAE	Caryothraustes canadensis	2	1	1	0
CARDINALIDAE	Saltator grossus	30	5	2	1
CARDINALIDAE	Saltator maximus	2	0	0	1
THRAUPIDAE	Chlorophanes spiza	2	1	1	0
THRAUPIDAE	Euphonia cayannensis	1	1	0	0
THRAUPIDAE	Euphonia chrysopasta	5	3	1	0
THRAUPIDAE	Lamprospiza melanoleuca	1	0	0	1
THRAUPIDAE	Tachyphonus cristatus	2	1	0	0
THRAUPIDAE	Tachyphonus surinamus	21	3	3	3
THRAUPIDAE	Tangara sp.	1	1	0	0
THRAUPIDAE	Tangara varia	8	3	3	0
THRAUPIDAE	Thraupis sp.	31	2	1	3
VIREONIDAE	Cyclarhis gujanensis	5	3	1	0
VIREONIDAE	Hylophilus muscicapinus	66	5	4	3
VIREONIDAE	Vireo olivaceus	1	0	0	1
VIREONIDAE	Vireolanius leucotis	27	6	3	2
ICTERIDAE	Cacicus cela	6	1	3	1
ICTERIDAE	Cacicus haemorrhous	246	9	9	8
ICTERIDAE	Celeus undatus	3	1	0	0
ICTERIDAE	Psarocolius viridis	1	1	0	0

Appendix 2: Database used in the main analysis of the study, including index of edge avoidance calculated from distribution of days detected, body size (log converted), forest stratum, and eye volume (log converted). Please see Methods for details.

Species	Edge avoidance	Body size (log)	Forest stratum	Eye volume (log)
Amazona autumnalis	0.333	1.525	3	0.352
Attila spadiceus	1.000	1.284	3	0.040
Brotogeris chrysoptera	0.500	1.204	3	-0.123
Buteo magnirostris	0.300	1.568	3	0.723
Cacicus cela	0.200	1.407	3	0.041
Cacicus haemorrhous	0.346	1.433	3	0.047
Conopophaga aurita	1.000	1.070	1	-0.230
Cyclarhis gujanensis	0.750	1.176	3	-0.219
Dendrexetastes rufigula	1.000	1.394	2	-0.150

Appendix 2 Continued.

Derderscher klighness 0.583 1.317 2 -0.197 Derderscoher production 1.000 1.435 2 -0.067 Euphonia chryspoesta 0.750 0.978 3 -0.674 Formiculus cohn 0.750 1.355 1 -0.0499 Gabula abrevitiv 0.667 1.475 2 -0.1137 Gabula abrevitiv 0.667 1.475 2 -0.0137 Gabula des explorative productive spinuts 0.400 1.061 3 -0.150 Cymonephilyr indigali 0.700 1.061 2 -0.519 Jacameraps aures 0.250 1.061 1 -0.227 Mepocremic Constrant 0.500 1.051 1 -0.227 Menasa ata 0.714 1.431 3 0.317 Menose ata ata 0.667 0.681 3 -0.642 Mytones couldras 0.667 0.813 3 -0.642 Mytones couldras 0.667 0.813 3 -0.522	Species	Edge avoidance	Body size (log)	Forest stratum	Eye volume (log)
Dendencepters plaumais 1.000 1.435 2 0.067 Explonic dryposota 0.750 0.278 3 -0.574 Explonic dryposota 0.750 1.255 1 -0.099 Galbula drom 0.667 1.473 3 -0.137 Galbula drom 0.667 1.473 3 -0.137 Gymongchutzs softwars 0.400 1.161 2 -0.619 Gymongchutzs softwars 1.000 1.061 3 -0.150 Hypochnemis contator 0.500 1.061 2 -0.619 Gymongchutzs softwars 1.000 1.415 3 0.026 Lipaugus voclicaris 0.000 1.357 3 0.024 Megorychus pirstragia 0.000 1.357 3 0.024 Moreatas 0.667 0.813 3 -0.252 Myoicatest colorentis 0.111 1.237 3 -0.252 Myoicatest colorentis 0.667 0.889 3 -0.252 Myoicate	Dendrocincla fuliginosa	0.583	1.317	2	-0.197
Euphonic chysopasta 0.750 0.978 3 -0.574 Comkanias chysopasta 0.750 1.255 1 -0.099 Galbula da 0.667 1.473 3 -0.137 Giphoponchia sparuas 0.400 1.161 2 -0.519 Giphoponchia sparuas 0.400 1.061 3 -0.368 Mipocamis custanua 0.100 1.061 2 -0.519 Jenance dos dos instanuas 0.500 1.061 2 -0.519 Jeanage varies 0.520 1.439 3 0.120 Jeanage varies 0.500 1.357 3 0.044 Mecoscerulus banha 0.333 1.061 1 -0.287 Monesa tria 0.667 0.813 3 -0.52 Miporis caudulas 0.667 0.813 3 -0.52 Miporis caudulas 0.667 0.813 3 -0.52 Miporis caudulas 0.667 1.814 1 -0.15 Miporis caudulas	Dendrocolaptes picumnus	1.000	1.435	2	0.067
Formeanis colma 0,750 1,255 1 -0.099 Gablua dabrosi 0,857 1,290 2 -0.158 Gablua dabrosi 0,667 1,473 3 -0.137 Gablua dabrosi 0,400 1,161 2 -0.619 Gymoprithys rufgule 0,750 1,079 1 -0.321 Herpitochuns dominaculatus 1,000 1,061 3 -0.368 Hyponemis cantator 0,500 1,061 2 -0.519 Licamerups aureas 0,250 1,439 3 0,120 Lipaugus vocterans 1,000 1,415 3 0,044 Microcerculus bamba 0,333 1,061 1 -0.287 Myoastata 0,667 0,888 3 -0.645 Myiorestes cayanenis 0,111 1,237 3 -0.457 Myiorestes cayanenis 0,567 0,889 3 -0.627 Mymecta ferroginea 0,667 0,889 3 -0.257 Mymoeta ferroginea </td <td>Euphonia chrysopasta</td> <td>0.750</td> <td>0.978</td> <td>3</td> <td>-0.574</td>	Euphonia chrysopasta	0.750	0.978	3	-0.574
Gabba dabroach 0.857 1.290 2 -0.158 Gabba dabroach 0.667 1.472 3 -0.137 Giphaporthus spinuux 0.400 1.161 2 -0.519 Gipmaporthys spinuux 0.400 1.061 3 -0.150 Herpsichnus dosinaculatus 0.500 1.061 2 -0.519 Jacamarogis aures 0.250 1.439 3 0.120 Jacamarogis aures 0.250 1.439 3 0.266 Megariprichs pitangua 0.000 1.357 3 0.044 Merceercuk sambla 0.333 1.061 1 -0.327 Merceercuk sambla 0.667 0.813 3 -0.522 Myicrais caudatus 0.667 0.813 3 -0.522 Myicrais caudatus 0.667 0.813 3 -0.527 Myicrais caudatus 0.667 0.813 3 -0.527 Myantheral barrhyan 0.500 1.511 -0.157 Myantheral barrhyan	Formicarius colma	0.750	1.255	1	-0.099
Gabba dea 0.667 1.473 3 -0.137 Gymborychus spiruus 0.400 1.161 2 -0.619 Gymborychus spiruus 0.400 1.061 3 -0.321 Herpalachmus dorimaculatus 1.000 1.061 3 -0.368 Hypocrentis cantator 0.500 1.061 2 -0.519 Jacamerops aureus 0.250 1.439 3 0.206 Megarynchus pitrayue 0.000 1.357 3 0.044 Merorecrulus bambla 0.333 1.061 1 -0.237 Myiconis ecaudotus 0.667 0.813 3 -0.646 Myiconis ecaudotus 0.667 0.889 3 -0.637 Mymecios ferruginea 0.400 1.161 1 -0.317 Mymecios ferruginea 0.400 1.531 3 -0.652 Mymecios ferruginea 0.462 1.154 1 -0.315 Preciso farcuginea 0.462 1.515 1 -0.457 P	Galbula albirostris	0.857	1.290	2	-0.158
Gyblopnychus spinurus 0.400 1.161 2 -0.619 Herpsilochnus dorsimaculatus 1.000 1.061 3 -0.150 Hylophilus muscicapinus 0.417 1.070 3 -0.363 Hylophilus muscicapinus 0.250 1.439 3 0.120 Jacamengs aureus 0.250 1.439 3 0.044 Microcenculus bambla 0.333 1.061 1 -0.287 Microcenculus bambla 0.333 1.061 1 -0.247 Monasa ara 0.714 1.431 3 -0.646 Myronetics candutus 0.667 0.889 3 -0.652 Myrosetics candutus 0.667 0.889 3 -0.652 Myrosetics candutus 0.667 0.889 3 -0.652 Perdonsia kurthons 0.462 1.541 1 -0.155 Perdonsia kurthons 0.462 1.541 1 -0.321 Myroseties candus 0.500 1.161 1 -0.329	Galbula dea	0.667	1.473	3	-0.137
Gymnoptikys urfigula 0.750 1.079 1 -0.321 Hypolchus orbinscultus 0.00 1.061 2 -0.58 Hypochnis cantator 0.500 1.061 2 -0.519 Jearnerops aurous 0.250 1.439 3 0.120 Upaugys workferans 1.000 1.415 3 0.044 Microscenulus bambla 0.333 1.061 1 -0.287 Microscenulus bambla 0.333 1.061 1 -0.287 Microscenulus bambla 0.667 0.818 3 -0.646 Myioritis ecaudatus 0.667 0.818 3 -0.652 Myimotherub bachyrar 0.667 0.889 3 -0.692 Patagionans plumbas 0.500 1.531 3 -0.237 Perconstola urithons 0.462 1.154 1 -0.115 Phyothonic sconcoraja 0.500 1.290 3 -0.292 Phyothonic sconcoraja 0.571 1.663 3 0.281	Glyphorynchus spirurus	0.400	1.161	2	-0.619
integrational construction 1060 1061 3 -0.150 Hyponicemics cantator 0.500 1.061 2 -0.519 Jacamerps aureus 0.250 1.439 3 0.120 Japangs vociferaris 1.000 1.4315 3 0.044 Mercecerulus bambla 0.333 1.061 1 -0.287 Mercecerulus bambla 0.333 1.061 1 -0.287 Monasa atra 0.714 1.431 3 -0.646 Myionaje squandti 0.667 0.813 3 -0.627 Myiozetes cargupenes 0.111 1.237 3 -0.339 Mymotherulus brachypra 0.667 0.889 3 -0.652 Mymotherulus brachypra 0.667 0.289 1 -1.149 Thrystopic cargup 0.500 1.511 1 -0.332 Physic cargan 0.571 1.290 3 -0.287 Paragloensa plumbea 0.500 1.511 1 -1.149 T	Gymnopithys rufigula	0.750	1.079	1	-0.321
hybpines 0.417 1.070 3 -0.589 Hyporemetic carlator 0.500 1.061 2 -0.519 Lipaugis vocifeans 0.250 1.439 3 0.0120 Lipaugis vocifeans 1.000 1.415 3 0.044 Microcerulus bamble 0.333 1.061 1 -0.287 Microcerulus bamble 0.333 1.061 1 -0.287 Microcerulus bamble 0.667 1.088 3 -0.646 Mycroserulus barachyara 0.667 0.889 3 -0.652 Mymerica ferruginea 0.400 1.161 1 -0.367 Mymerica ferruginea 0.462 1.154 1 -0.151 Preconstrola ruffors 0.462 1.154 1 -0.151 Preconstrola ruffors 0.462 1.163 3 -0.281 Prog cayana 0.571 1.663 3 -0.281 Prog cayana 0.571 1.407 3 0.318 Prog cayana	Herpsilochmus dorsimaculatus	1.000	1.061	3	-0.150
ippocnemis cantator 0.500 1.61 2 -0.519 Jacamerops aureus 0.250 1.439 3 0.120 Jupargus voc/ferans 1.000 1.415 3 0.026 Meganynchus pirangua 0.000 1.557 3 0.044 Microcercuits bamble 0.333 1.661 1 -0.287 Microcercuits bamble 0.333 1.661 1 -0.287 Myinozeits cayanarti 0.667 0.813 3 -0.539 Myinozeits cayanartis 0.111 1.377 3 -0.339 Mymetica feruginea 0.607 0.889 3 -0.652 Patajoenes piumbea 0.500 1.531 3 -0.257 Patajoenes piumbea 0.500 1.531 3 -0.251 Patajoenes piumbea 0.500 1.611 1 -0.392 Patajoenes piumbea 0.500 1.611 1 -0.392 Patajoenes piumbea 0.500 1.611 1 -0.451 <td< td=""><td>Hylophilus muscicapinus</td><td>0.417</td><td>1.070</td><td>3</td><td>-0.368</td></td<>	Hylophilus muscicapinus	0.417	1.070	3	-0.368
jacamerys aurwis 0.250 1.439 3 0.100 µapagus volchars 0.000 1.415 3 0.044 Microcerulus bamble 0.333 1.061 1 -0.287 Mycoagis gaimardi 0.667 1.088 3 -0.646 Mycoagis gaimardi 0.667 0.813 3 -0.522 Mycoadetus 0.667 0.889 3 -0.662 Mymecia ferruginea 0.400 1.161 1 -0.367 Mymecia ferruginea 0.667 0.889 3 -0.692 Partagioenas plumbea 0.500 1.531 3 -0.257 Percostola criffors 0.462 1.154 1 -0.115 Phycothorts crosya 0.500 1.161 1 -0.392 Piculus flavigula 0.667 1.290 3 -0.299 Pinor fuscus 0.511 1.663 3 -0.291 Pinor fuscus 0.500 1.407 3 0.313 Pinor fuscus 0.5	Hypocnemis cantator	0.500	1.061	2	-0.519
Lipaogu'socleans 1.000 1.415 3 0.206 Megarynchus pitangua 0.000 1.357 3 0.044 Morasa atra 0.714 1.431 3 0.317 Monasa atra 0.714 1.431 3 0.666 Myiopatis gainardii 0.667 0.813 3 -0.639 Myiopatis gainardii 0.667 0.813 3 -0.339 Mymotectas forruginea 0.400 1.161 1 -0.367 Mymothenula brachyura 0.667 0.899 3 -0.652 Patajoenes plumbea 0.500 1.531 3 -0.257 Patajoenes plumbea 0.500 1.161 1 -0.392 Pataforis Noter 0.000 0.929 1 -1.149 Phyotophans coraya 0.571 1.663 3 0.281 Pataforis Nacus 0.318 1.415 3 0.318 Ponus mestrus 0.333 1.342 2 -0.445 Petry o cayana <t< td=""><td>Jacamerops aureus</td><td>0.250</td><td>1.439</td><td>3</td><td>0.120</td></t<>	Jacamerops aureus	0.250	1.439	3	0.120
Meg_modulus planagua 0.000 1.357 3 0.044 Microcevorulus bambla 0.333 1.061 1 -0.287 Mycopagis gaimardi 0.667 1.088 3 -0.646 Myconse caudustus 0.667 0.813 3 -0.532 Mycoreters cayanensis 0.111 1.237 3 -0.399 Mymecize leruginea 0.400 1.161 1 -0.367 Mymotherula brachytura 0.667 0.889 3 -0.692 Patagioens plumbea 0.500 1.531 3 -0.257 Preconstola niffons 0.462 1.154 1 -0.115 Phaettomis ruber 0.500 1.611 1 -0.392 Piaya cayana 0.571 1.663 3 0.281 Ponus fuscus 0.750 1.407 3 0.318 Ponus fuscus 0.318 1.415 3 0.331 Pone rythrocephala 1.000 0.929 2 -0.448 Phangia sulphoratus	Lipaugus vociferans	1.000	1.415	3	0.206
Microcrevulus bambla 0.333 1.061 1 -0.287 Monasa ara 0.714 1.431 3 0.0317 Monasa ara 0.767 1.088 3 -0.664 Myiornis ecaudatus 0.667 0.813 3 -0.522 Myiccettes cayanesis 0.111 1.237 3 -0.339 Myrmeciza ferruginea 0.400 1.161 1 -0.367 Myrmotherula brachyura 0.667 0.889 3 -0.692 Patagioens plumbea 0.500 1.531 3 -0.227 Patagioens plumbea 0.500 1.161 1 -0.392 Phaethornis ruber 0.000 0.929 1 -1.149 Thopothorus coraya 0.500 1.161 1 -0.392 Pias degrame 0.571 1.663 3 0.281 Pians unstruus 0.318 1.417 3 0.318 Pionts instruus 0.318 1.417 -0.448 Pianus usulutuauuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu	Megarynchus pitangua	0.000	1.357	3	0.044
Monasa atra 0.714 1.431 3 0.317 Myiopagis gaimardii 0.667 0.813 3 0.646 Myiora lecaudatus 0.667 0.813 3 0.522 Myiora lecaudatus 0.667 0.813 3 0.522 Myiora lecaudatus 0.667 0.889 3 0.637 Mymecia forruginea 0.600 1.531 3 0.257 Paragioenas plurinbea 0.500 1.514 1 0.115 Phenostina futher 0.000 0.929 1 1.149 Phya divigula 0.667 1.290 3 -0.299 Plaus fuirgula 0.667 1.290 3 -0.299 Plaus fuirgula 0.667 1.290 3 -0.299 Plane strucus 0.318 1.415 3 0.318 Plane strucus 0.333 1.342 2 -0.049 Plane strucus 0.333 1.342 2 -0.045 Plane strucus 0.3667	Microcerculus bambla	0.333	1.061	1	-0.287
Mylopagis gaimardii 0.667 1.088 3 -0.646 Mylomik ecaudatus 0.667 0.813 3 -0.522 Mylocettes cargenesis 0.111 1.237 3 -0.339 Myrmeticeila brachyura 0.667 0.889 3 -0.692 Patagioenas plumbea 0.500 1.531 3 -0.257 Perconstola ruffrons 0.462 1.154 1 -0.115 Phaethomis ruber 0.000 0.929 1 -1.149 Thyothorus coraya 0.501 1.161 1 -0.392 Piaya cayana 0.571 1.663 3 0.281 Picous flavigula 0.667 1.290 3 -0.299 Pionus fuscus 0.318 1.415 3 0.318 Picous mentuus 0.318 1.415 3 0.318 Pionus mentuus 0.333 1.342 2 -0.448 Pitargus culturatus 0.300 1.079 1 -0.458 Phangusplantatus	Monasa atra	0.714	1.431	3	0.317
Myroms e-audatus 0.667 0.813 3 -0.522 Myroccie leruginea 0.400 1.161 1 -0.339 Myroccie leruginea 0.607 0.889 3 -0.692 Patagioenas plumbea 0.500 1.531 3 -0.692 Patagioenas plumbea 0.500 1.514 1 -0.115 Precnostia fulfrons 0.462 1.154 1 -0.392 Precnostia fulfrons 0.462 1.154 1 -0.392 Precnostia fulfrons 0.462 1.163 3 0.281 Phyrothorus coraya 0.500 1.161 1 -0.392 Piaya cayena 0.571 1.663 3 0.281 Pronus fuscus 0.750 1.407 3 0.331 Ponus fuscus 0.323 1.342 2 -0.488 Phangus sulphuratus 0.368 1.744 3 0.576 Ramphastos tucanus 0.667 1.708 3 -0.104 Schisto	Myiopagis gaimardii	0.667	1.088	3	-0.646
Minoresta 0.111 1.237 3 -0.339 Myrmetica ferruginea 0.400 1.161 1 -0.367 Myrmetica ferruginea 0.500 1.531 3 -0.592 Patagienas plumbea 0.500 1.531 3 -0.257 Pernostola ruffrons 0.462 1.154 1 -0.115 Phaethomis ruber 0.000 0.929 1 -1.149 Thnyothorus coraya 0.571 1.663 3 0.281 Piculs flavigula 0.667 1.290 3 -0.299 Pionus mistruus 0.318 1.415 3 0.318 Pionus mistruus 0.318 1.415 3 0.331 Piangu sulphuratus 0.333 1.342 2 -0.488 Pitry ablifons 0.500 1.079 1 -0.458 Peroglossus wirdis 0.200 1.538 3 0.518 Patyrinchus coronatus 1.0667 1.708 3 -0.556 Ramphastos tucarus	Myiornis ecaudatus	0.667	0.813	3	-0.522
Myrmeciza ferruginea 0.400 1.161 1 -0.367 Myrmeciza ferruginea 0.667 0.889 3 -0.092 Patagioenas plumbea 0.500 1.531 3 -0.257 Percnastola ruffrons 0.462 1.154 1 -0.115 Phaethomis ruber 0.000 0.929 1 -1.149 Thryothorus coraya 0.500 1.161 1 -0.392 Piaya cayana 0.571 1.663 3 0.281 Piculus flavigula 0.6667 1.290 3 -0.299 Pionus fuscus 0.318 1.415 3 0.318 Pione symmetrus 0.318 1.415 3 0.318 Pione symmetrus 0.333 1.342 2 -0.0498 Pita symbificus 0.000 0.942 2 -0.0458 Platyrinchus coronatus 1.000 1.079 1 -0.458 Platyrinchus coronatus 0.368 1.744 3 0.576 Ramphastos tucan	Myiozetetes cayanensis	0.111	1.237	3	-0.339
Myrmothenula brachyura 0.667 0.889 3 -0.692 Patagieenas plumbea 0.500 1.531 3 -0.257 Pernostola nuffrons 0.462 1.154 1 -0.115 Phaethornis ruber 0.000 0.929 1 -1.149 Thryothorus coraya 0.500 1.161 1 -0.392 Paya cayana 0.571 1.663 3 -0.219 Pionus flavigula 0.667 1.290 3 -0.219 Pionus mistruus 0.318 1.415 3 0.318 Pionus mistruus 0.333 1.342 2 -0.649 Pithys abliforins 0.500 1.079 1 -0.458 Pitarguss virolis 0.200 1.538 3 0.318 Prerolosus virolis 0.200 1.538 3 0.000 Ramphastos virolis 0.200 1.361 3 -0.104 Saltor cry sublis 0.667 1.708 3 -0.105 Saltor cry sublis	Myrmeciza ferruginea	0.400	1.161	1	-0.367
Pragioenas plumbea 0.500 1.531 3 -0.257 Percnostola ruffrons 0.462 1.154 1 -0.115 Phaethorins ruber 0.000 0.929 1 -1.149 Thryothorus coraya 0.500 1.161 1 -0.392 Piaya cayana 0.571 1.663 3 0.281 Piculus flavigula 0.667 1.290 3 -0.299 Pionus fuscus 0.318 1.415 3 0.318 Pionas fuscus 0.333 1.342 2 -0.049 Pitra subfrons 0.500 1.079 1 -0.458 Platagiuse subpluratus 0.333 1.342 2 -0.049 Pitra subfrons 0.500 1.079 1 -0.458 Platagineus coronatus 0.368 1.744 3 0.576 Ramphastos tucanus 0.667 1.708 3 0.523 Rhy futerna simplex 1.000 1.301 3 -0.155 Saltator grossus	Myrmotherula brachyura	0.667	0.889	3	-0.692
Perconstola rufifrons 0.462 1.154 1 -0.115 Phaethomis ruber 0.000 0.929 1 -1.149 Phystors coraya 0.500 1.161 1 -0.392 Play cayana 0.571 1.663 3 0.281 Piculs flavigula 0.667 1.290 3 -0.299 Pionus fuscus 0.750 1.407 3 0.318 Pionus fuscus 0.318 1.415 3 0.318 Pionus menstruus 0.333 1.342 2 -0.049 Pitrys abifrons 0.500 1.079 1 -0.458 Platyrinchus coronatus 1.000 0.942 2 -0.445 Precolosis wirális 0.200 1.538 3 0.518 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos vitelinus 0.667 1.708 3 -0.008 Saltator grossus 0.625 1.296 3 -0.104 Schistocicha leucostigrna	Patagioenas plumbea	0.500	1.531	3	-0.257
Phaethomis ruber 0.000 0.929 1 -1.149 Thrydthorus coraya 0.500 1.161 1 -0.392 Paya cayana 0.571 1.663 3 0.281 Piculus flavigula 0.667 1.290 3 -0.299 Pionts tracus 0.750 1.407 3 0.318 Piora enthrocephala 1.000 0.929 2 -0.488 Pitangus sulphuratus 0.333 1.342 2 -0.049 Pithy subifrons 0.500 1.079 1 -0.458 Platyrinckus coronatus 1.000 0.942 2 -0.445 Preroglossus viridis 0.200 1.538 3 0.318 Pyrila caica 0.625 1.362 3 0.000 Ramphastos vitellinus 0.667 1.708 3 -0.104 Schiator pierivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.558 Selenidera pieriv	Percnostola rufifrons	0.462	1.154	1	-0.115
Thyothorus coraya 0.500 1.161 1 -0.392 Piaya cayana 0.571 1.663 3 0.281 Piculus flavigula 0.667 1.290 3 -0.299 Pionus fuscus 0.750 1.407 3 0.318 Pionus menstruus 0.318 1.415 3 0.331 Pipa erythrocephala 1.000 0.929 2 -0.0488 Pitargus sulphuratus 0.333 1.342 2 -0.049 Pithys albifrons 0.500 1.079 1 -0.458 Pletargus sulphuratus 0.362 1.362 3 0.318 Pyrilia caica 0.625 1.362 3 0.000 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos tucanus 0.667 1.210 -0.008 53 Saltator grossus 0.625 1.296 3 -0.104 Schistocichal leucostigma 0.400 1.176 1 -0.155 Seleinidera piperivora	Phaethornis ruber	0.000	0.929	1	-1.149
Paya cayana 0.571 1.663 3 0.281 Piculs flavigula 0.667 1.290 3 -0.299 Pionus fuscus 0.750 1.407 3 0.318 Piona menstruus 0.318 1.415 3 0.331 Pira erythrocephal 1.000 0.929 2 -0.488 Pitargus sulphuratus 0.333 1.342 2 -0.049 Pithys sibifrons 0.500 1.079 1 -0.458 Pitarginchus coronatus 1.000 0.942 2 -0.445 Petroglossus viridis 0.200 1.538 3 0.010 Ramphastos tucanus 0.368 1.744 3 0.523 Rhytipterna simplex 1.000 1.301 3 -0.008 Saltator grossus 0.667 1.708 3 -0.155 Selenidera piperivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.558 Tachyphonus sur	Thrvothorus corava	0.500	1.161	1	-0.392
Piculus flavigula 0.667 1.290 3 -0.299 Piculus fluxcus 0.750 1.407 3 0.318 Pionus menstruus 0.318 1.415 3 0.331 Pionar yrthrocephala 1.000 0.929 2 -0.488 Pithys albifrons 0.500 1.079 1 -0.458 Platyrichus coronatus 1.000 0.942 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrila caica 0.625 1.362 3 0.000 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos vitellinus 0.667 1.708 3 -0.104 Schistocicha leucostigma 0.400 1.301 3 -0.104 Schistocicha leucostigma 0.667 1.211 2 -0.558 Selenidera piperivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.581 Tachyphonus surinamus 0.333 1.204 2 -0.315	Piava cavana	0.571	1.663	3	0.281
Pionus fuscus 0.750 1.407 3 0.318 Pionus menstruus 0.318 1.415 3 0.331 Pipra erythrocephala 1.000 0.929 2 -0.488 Pitangus sulphuratus 0.333 1.342 2 -0.445 Pitargus sulphuratus 0.500 1.079 1 -0.458 Patyrinchus coronatus 1.000 0.942 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrila caica 0.625 1.362 3 0.000 Ramphastos vitellinus 0.667 1.708 3 -0.576 Ramphastos vitellinus 0.667 1.708 3 -0.008 Saltator grossus 0.625 1.296 3 -0.104 Schistocichla leucostigma 0.400 1.176 1 -0.155 Selenidera piperivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.185	Piculus flavigula	0.667	1.290	3	-0.299
Pionus menstruus 0.318 1.415 3 0.331 Pipra erythrocephala 1.000 0.929 2 -0.488 Pitangus sulphuratus 0.333 1.342 2 -0.049 Pithys albifrons 0.500 1.079 1 -0.458 Platyrinchus coronatus 1.000 0.942 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrilia caica 0.667 1.768 3 0.523 Ramphastos tucanus 0.667 1.708 3 -0.008 Saltator grossus 0.667 1.210 -0.155 Saltator grossus 0.667 1.211 2 -0.558 Tachyphonus surinamus 0.333 1.204 2 -0.258 Tachyphonus surinamus 0.333 1.204 2 -0.261 Tharmophilus murinus 0.500 1.041 3 -0.357 Todirostrum pictum 0.500 0.982 3 -0.651 Tolmomyias spinilis	Pionus fuscus	0.750	1.407	3	0.318
Pipra erythrocephala 1.000 0.929 2 -0.488 Pitargus sulphuratus 0.333 1.342 2 -0.049 Pithy sulphuratus 0.500 1.079 1 -0.458 Pithyrichus coronatus 1.000 0.424 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrilia caica 0.625 1.362 3 0.000 Ramphastos vitellinus 0.667 1.708 3 -0.088 Saltar grossus 0.625 1.296 3 -0.104 Schistocichla leucostigma 0.400 1.176 1 -0.155 Schistocichla leucostigma 0.400 1.176 1 -0.155 Schistocichla leucostigma 0.400 1.176 1 -0.155 Statasomus griseicapillus 0.667 1.211 2 -0.558 Tachyphonus surinamus 0.333 1.204 2 -0.281 Tharmoranes ardesiacus 0.500 1.310 1 -0.102	Pionus menstruus	0.318	1.415	3	0.331
Priangus sulphuratus0.3331.3422-0.049Pithys albifrons0.5001.0791-0.458Platyrinchus coronatus1.0000.9422-0.445Pteroglossus viridis0.2001.53830.318Pyrilia caica0.6251.36230.000Ramphastos tucanus0.3681.74430.576Ramphastos vitellinus0.6671.7083-0.008Saltator grossus0.6251.2963-0.104Schizocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.588Tachyphonus surinamus0.3331.2042-0.185Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Todrostrum pictum0.5000.9823-0.651Todrostrum pictum0.5001.0793-0.473Togon viridis0.7501.42330.232Trogon viridis0.7501.4233-0.232Trogon viridis0.7551.4233-0.232Trogon viridis0.5451.1613-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.692Zirmerius gracilipes0.2501.0213 <td>Pipra ervthrocephala</td> <td>1.000</td> <td>0.929</td> <td>2</td> <td>-0.488</td>	Pipra ervthrocephala	1.000	0.929	2	-0.488
Pithys albifrons 0.500 1.079 1 -0.458 Platyrinchus coronatus 1.000 0.942 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrilia caica 0.625 1.362 3 0.000 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos vitellinus 0.667 1.708 3 -0.008 Saltator grossus 0.625 1.296 3 -0.104 Schistocicha leucostigma 0.400 1.176 1 -0.155 Selenidera piperivora 0.714 1.531 3 0.317 Sitasomus griseicapillus 0.667 1.211 2 -0.558 Tachyphonus surinamus 0.333 1.204 2 -0.185 Thannomanes ardesiacus 0.500 1.41 3 -0.102 Thampophilus murinus 0.727 1.130 1 -0.185 Todirostrum pictum 0.500 9.82 3 -0.651	Pitangus sulphuratus	0.333	1.342	2	-0.049
Payrinchus coronatus 1.000 0.942 2 -0.445 Pteroglossus viridis 0.200 1.538 3 0.318 Pyrilia caica 0.625 1.362 3 0.000 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos vitellinus 0.667 1.708 3 0.523 Rhytipterna simplex 1.000 1.301 3 -0.008 Saltator grossus 0.625 1.296 3 -0.104 Schistocichla leucostigma 0.400 1.176 1 -0.155 Selenidera piperivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.558 Tachyphonus surinamus 0.333 1.204 2 -0.185 Thamponanes ardesiacus 0.500 1.041 3 -0.357 Todirostrum pictum 0.500 0.982 3 -0.473 Tolmonyias soliocephalus 0.429 1.079 3 -0.473	Pithvs albifrons	0.500	1.079	1	-0.458
Pteroglossus viridis 0.200 1.538 3 0.318 Pyrilia caica 0.625 1.362 3 0.000 Ramphastos tucanus 0.368 1.744 3 0.576 Ramphastos vitellinus 0.667 1.708 3 0.523 Rhytipterna simplex 1.000 1.301 3 -0.008 Saltator grossus 0.625 1.296 3 -0.104 Schistocichla leucostigma 0.400 1.176 1 -0.155 Selenidera piperivora 0.714 1.531 3 0.317 Sittasomus griseicapillus 0.667 1.211 2 -0.558 Tachyphonus surinamus 0.333 1.204 2 -0.281 Tangara varia 0.500 1.130 1 -0.102 Thamnophilus murinus 0.727 1.130 2 -0.185 Todirostrum pictum 0.500 0.982 3 -0.473 Todirostrum pictum 0.500 0.982 3 -0.473	Platvrinchus coronatus	1.000	0.942	2	-0.445
Prilia caica0.6251.36230.000Ramphastos tucanus0.3681.74430.576Ramphastos vitellinus0.6671.70830.523Rhytipterna simplex1.0001.3013-0.008Saltator grossus0.6251.2963-0.104Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnomanes ardesiacus0.5009.823-0.651Tolirostrum pictum0.5000.9823-0.651Tolmonyias assimilis0.6671.1223-0.318Tolmonyias assimilis0.6671.1223-0.473Toglodytes aedon0.0001.0791-0.662Trogno viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrenous melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Zimmerius gracilipes0.2501.0213-0.540	Pteroalossus viridis	0.200	1.538	3	0.318
Ramphastos tucanus0.3681.74430.576Ramphastos vitellinus0.6671.70830.523Rhytipterna simplex1.0001.3013-0.008Saltator grossus0.6251.2963-0.104Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Todirostrum pictum0.5000.9823-0.651Todirostrum pictum0.6671.1223-0.318Tolmomyias asimilis0.6671.1223-0.473Troglodytes aedon0.0001.0791-0.662Turdus albicollis1.0001.36620.020Tyranus melancholicus1.0001.36620.020Tyranus melancholicus0.4551.1613-0.143Xiphorhynchus pardalotus0.5001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Pvrilia caica	0.625	1.362	3	0.000
Amphasos vitellinus0.6671.70830.523Rhytipterna simplex1.0001.3013-0.008Saltator grossus0.6251.2963-0.104Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Todirostrum pictum0.5000.9823-0.651Todirostrum pictum0.6671.1223-0.318Tolmomyias assimilis0.6671.1223-0.473Troglodytes aedon0.0001.0791-0.662Trogno viridis1.0001.36620.020Tyranus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Ziphorhynchus pardalotus0.5001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Ramphastos tucanus	0.368	1.744	3	0.576
Rhytipterna simplex1.0001.3013-0.008Saltator grossus0.6251.2963-0.104Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.588Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.473Troglodytes aedon0.0001.0791-0.662Torgon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyranus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Ramphastos vitellinus	0.667	1.708	3	0.523
Saltator grossus0.6251.2963-0.104Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.0413-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Toglodytes aedon0.0001.0791-0.662Torgon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyranus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Ziphorynchus paralalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Rhvtipterna simplex	1.000	1.301	3	-0.008
Schistocichla leucostigma0.4001.1761-0.155Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias policcephalus0.4291.0793-0.473Troglodytes aedon0.0001.36620.020Tyranus melancholicus1.0001.3663-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Saltator grossus	0.625	1.296	3	-0.104
Selenidera piperivora0.7141.53130.317Sittasomus griseicapillus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Turdus albicollis1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Schistocichla leucostigma	0.400	1.176	1	-0.155
Sittasonus Tachyphonus surinamus0.6671.2112-0.558Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Selenidera piperivora	0.714	1.531	3	0.317
Tachyphonus surinamus0.3331.2042-0.281Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Toglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Sittasomus griseicapillus	0.667	1.211	2	-0.558
Tangara varia0.5001.0413-0.730Thamnomanes ardesiacus0.5001.1301-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Tachyphonus surinamus	0.333	1.204	2	-0.281
Join-0.102Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Toglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Tangara varia	0.500	1.041	3	-0.730
Thamnophilus murinus0.7271.1302-0.185Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Thamnomanes ardesiacus	0.500	1.130	1	-0.102
Thraupis sp.0.3331.2173-0.357Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Thamnophilus murinus	0.727	1.130	2	-0.185
Todirostrum pictum0.5000.9823-0.651Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus1.0001.3263-0.143Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Thraupis sp.	0.333	1.217	3	-0.357
Tolmomyias assimilis0.6671.1223-0.318Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Todirostrum pictum	0.500	0.982	3	-0.651
Tolmomyias poliocephalus0.4291.0793-0.473Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	, Tolmomyias assimilis	0.667	1.122	3	-0.318
Troglodytes aedon0.0001.0791-0.662Trogon viridis0.7501.42330.232Turdus albicollis1.0001.36620.020Tyrannus melancholicus1.0001.3263-0.110Vireolanius leucotis0.5451.1613-0.143Xiphorhynchus pardalotus0.7001.3522-0.092Zimmerius gracilipes0.2501.0213-0.540	Tolmomvias poliocephalus	0.429	1.079	3	-0.473
Trogon viridis 0.750 1.423 3 0.232 Turdus albicollis 1.000 1.366 2 0.020 Tyrannus melancholicus 1.000 1.326 3 -0.110 Vireolanius leucotis 0.545 1.161 3 -0.143 Xiphorhynchus pardalotus 0.700 1.352 2 -0.092 Zimmerius gracilipes 0.250 1.021 3 -0.540	Troglodytes aedon	0.000	1.079	1	-0.662
Turdus albicollis 1.000 1.366 2 0.020 Tyrannus melancholicus 1.000 1.326 3 -0.110 Vireolanius leucotis 0.545 1.161 3 -0.143 Xiphorhynchus pardalotus 0.700 1.352 2 -0.092 Zimmerius gracilipes 0.250 1.021 3 -0.540	Trogon viridis	0.750	1.423	3	0.232
Tyrannus melancholicus 1.000 1.326 3 -0.110 Vireolanius leucotis 0.545 1.161 3 -0.143 Xiphorhynchus pardalotus 0.700 1.352 2 -0.092 Zimmerius gracilipes 0.250 1.021 3 -0.540	Turdus albicollis	1.000	1.366	2	0.020
Vireolanius leucotis 0.545 1.161 3 -0.143 Xiphorhynchus pardalotus 0.700 1.352 2 -0.092 Zimmerius gracilipes 0.250 1.021 3 -0.540	Tvrannus melancholicus	1.000	1.326	3	-0.110
Xiphorhynchus pardalotus 0.700 1.352 2 -0.092 Zimmerius gracilipes 0.250 1.021 3 -0.540	Vireolanius leucotis	0.545	1.161	3	-0.143
<i>Zimmerius gracilipes</i> 0.250 1.021 3 –0.540	Xiphorhynchus pardalotus	0.700	1.352	2	-0.092
	Zimmerius gracilipes	0.250	1.021	3	-0.540

3744

Appendix 3: Hypothetic phylogenetic reconstruction (consensus tree following majority rules) of the species used in the study, derived from birdtree.org. Note that in the analysis, 1000 random trees were used.

