UNIVERSIDADE DE BRASÍLIA
INSTITUTO DE CIÊNCIAS BIOLÓGICAS
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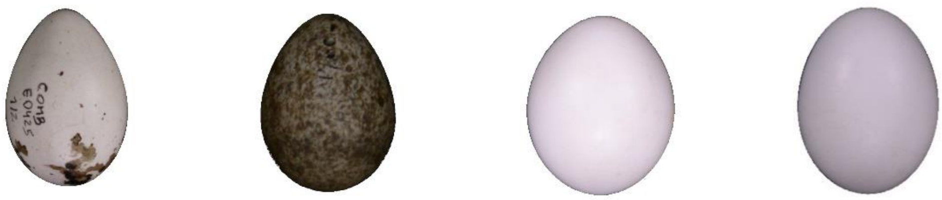
PADRÕES DE VARIAÇÃO DO FORMATO DOS OVOS DE PASSERIFORMES NEOTROPICAIS EM RELAÇÃO AO CLIMA, ECOLOGIA E BIOLOGIA REPRODUTIVA



TATIANE LIMA DA SILVA

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Tese apresentada ao programa de Pós-Graduação em Ecologia, Instituto de Ciências Biológicas da Universidade de Brasília como requisito parcial para obtenção do título de Doutor em Ecologia.

Orientador: Dr. Miguel Ângelo Marini

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Universidade de Brasília
Instituto de Ciências Biológicas
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Tese de doutorado

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Tatiane Lima da Silva

Banca examinadora:

Prof. Dr. Miguel Ângelo Marini
Orientador/Presidente
Universidade de Brasília (UnB)

Prof. Dr. Fabricio Villalobos
Membro externo
Instituto de Ecología (INECOL)

Prof. Dr. Mauro Pichorim
Membro externo
Universidade Federal do Rio Grande do Norte (UFRN)

Prof. Dra. Rosana Tidon
Membro interno
Universidade de Brasília (UnB)

Prof. Dr. André Mendonça
Membro interno suplente
Universidade de Brasília (UnB)

Brasília, 30 de julho de 2024

"É preciso derreter o ego. Derretê-lo com amor profundo, para que ele desapareça e a pessoa se torne parte do oceano".

"Somos responsáveis por nós mesmos. Ninguém é responsável por mim, é minha responsabilidade total e absoluta. O que quer que eu seja, sou a minha própria criação".

Osho. **O Livro do Ego**. Liberte-se da ilusão.

"Onde quer que você esteja, esteja por inteiro".

"Muitas pessoas estão tão aprisionadas em suas mentes que a beleza da natureza não existe para elas".

"Ao menos que você esteja presente no Agora, a mente vai continuar governado você".

Eckhart Tolle. **O poder do Agora**. Um guia para a iluminação espiritual.

Dedico essa tese àquelas pessoas que mesmo em seus momentos mais difíceis, onde a escuridão tomava o controle do corpo e da mente, conseguiram encontrar forças em si mesmos para seguir em frente.

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A grande força interior que me move a sempre seguir em frente.

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SUMÁRIO

RESUMO

Os ovos apresentam a mesma função geral de proteção e manutenção do embrião em desenvolvimento em todas as aves. Entretanto, exibem ampla variação quanto ao formato, partindo de formatos esféricos a extremamente alongados. O maior componente de variação ocorre em larga escala taxonômica e correlaciona-se majoritariamente a limitações alométricas e filogenéticas ligadas ao tamanho corporal, formato da pelve a estilo de vida das fêmeas. O menor componente de variação ocorreria em espécies mais próximas filogeneticamente e poderia representar a seleção por formatos que forneçam vantagens ao desenvolvimento dos embriões. Aqui, investigamos como o clima, e as características reprodutivas e ecológicas das espécies correlacionam-se com o formato dos ovos em espécies de Passeriformes da região Neotropical. O formato foi analisado a partir dos índices de alongamento (comprimento/largura) e assimetria (quanto um polo é mais pontiagudo). Os ovos foram medidos a partir de fotografias digitais obtidas durante a visita a 36 coleções oológicas em museus na Europa, EUA e América do Sul. O formato dos ovos foi avaliado em três capítulos a partir de modelos filogenéticos. No capítulo 1, avaliamos a influência das características reprodutivas (tamanho da ninhada, volume dos ovos e tipo de ninho) e ecológicas (habitat, dieta e comportamento migratório) no formato espécie-específico de 468 espécies. No capítulo 2, avaliamos o papel do macroclima (Köppen-Geiger e WorldClim) e das condições climáticas do mês da postura dos ovos em 4.095 ninhadas de 428 espécies. No capítulo 3, analisamos a influência de condições ambientais restringentes, dieta e características reprodutivas na variação intra-ninhada do formato dos ovos em 3.822 ninhadas de 420 espécies. Nossos resultados indicam que a filogenia, limitação aerodinâmica para voo, exposição ambiental dos ovos, tamanho e número de ovos por ninhada, precipitação, limitação de cálcio na dieta e movimentos migratórios podem atuar como fatores relevantes para explicar a variação do formato dos ovos em Passeriformes Neotropicais.

Palavras-chave: Aves, clima, coleções oológicas, modelos filogenéticos, reprodução

ABSTRACT

Birds' eggs exhibit the same general functions of protection and maintenance during embryo development. However, eggs show a wide variation in shape, ranging from spherical to highly elongated. Broad taxonomic scales are responsible for the most extensive variation in egg shape, which correlates with allometric and phylogenetic constraints related to female body size, pelvis shape, and lifestyle. Lower variation in egg shape would occur in closely related species and may represent selection for shapes that optimize embryonic development. Here, we investigate how climate and reproductive and ecological traits correlate with the egg shape of passerine species in the Neotropical region. Egg shapes were calculated through the elongation (length/breath) and asymmetry (pointedness) indexes. Eggs were measured from digital photographs taken during visits to 36 museum egg collections from Europe, the USA, and South America. Using phylogenetic-controlled models, we evaluated egg shape variation in three chapters. In Chapter 1, we explored the effects of reproductive (clutch size, egg volume, and nest type) and ecological (habitat, diet, and migration behavior) traits in the species-specific egg shape of 468 species. Chapter 2 evaluates the long-term (Köppen-Geiger and WorldClim) and short-term (month of egg laying) effects of climate conditions on the egg shape of 4,095 clutches from 428 species. In Chapter 3, we analyzed the influence of potentially stringent conditions, diet, and breeding traits in the within-clutch egg shape variation in 3,822 clutches from 420 species. Our results indicated that phylogeny, streamlined body adapted to powered flight, environmental exposure of eggs, clutch and egg size, precipitation, calcium-limited diets, and migratory behavior are relevant factors that help explain egg-shape variation in Neotropical passerines.

Keywords: Birds, climate, oological collections, phylogenetic models, reproduction

INTRODUÇÃO GERAL

Os ovos rígidos e calcificados da Classe Aves consistem em um complexo aparato de reprodução (Birkhead 2016). A parte externa apresenta uma casca calcárea que simultaneamente fornece proteção física e permite trocas de gases metabólicos por meio de poros, além de fornecer cálcio para a formação óssea do embrião (Rahn et al. 1987). A parte interna fornece a nutrição necessária para o embrião em desenvolvimento, composta principalmente pelo vitelo na região central, rico em lipídeos e circundado pelo albúmen, rico em água e proteínas (Sotherland and Rahn 1987; Hincke et al. 2012). Apesar de desempenharem as mesmas funções de proteção e manutenção, os ovos exibem ampla variação quanto a textura da superfície da casca (Igic et al. 2015), coloração de fundo (Wisocki et al. 2020), maculação (i.e., padrão de manchas) (Gosler et al. 2005), espessura da casca (Birchard and Deeming 2009), tamanho (Krist 2011), qualidade nutricional (Deeming 2007) e formato (Stoddard et al. 2017). O entendimento dos padrões de variação de tais características oológicas permite uma melhor compreensão da história de vida e biologia reprodutiva das aves.

Os ovos fornecem importantes informações acerca das estratégias reprodutivas das aves (Deeming and Reynolds 2015). O tamanho e o número de ovos por ninhada são as variáveis reprodutivas mais comumente estudadas e estão relacionadas ao investimento reprodutivo na qualidade a quantidade de filhotes por tentativa reprodutiva, respectivamente (Smith and Fretwell 1974). Entretanto, a funcionalidade do formato dos ovos na reprodução das aves ainda permanece incerta, apesar do prévio reconhecimento de sua variação (Lack 1968; Preston 1968). Lack (1968) sugeriu que a variação do formato dos ovos seria resultante de processos adaptativos, porém as causas responsáveis por tal variação seriam desconhecidas. Entretanto, a partir da última década, a variação no formato dos ovos passou a ser explorada, resultando no aparecimento de padrões associados ao clima (Duursma et al. 2018), reprodução (Deeming 2018; Birkhead et al. 2019) e morfologia (Stoddard et al. 2017; Montgomerie et al. 2021) das aves.

A limitada literatura acerca da variação do formato dos ovos pode ser atribuída, em grande parte, ás dificuldades metodológicas de quantificação do formato (Biggins et al. 2018). Isso porque, apesar de consistirem em objetos biológicos relativamente simples, o formato de um ovo é difícil de descrever ou quantificar numericamente (Ávila 2014). Fórmulas matemáticas descritoras do formato dos ovos são conhecidas há várias décadas (e.g., Preston 1953; Carter 1968; Baker 2002), entretanto sua empregabilidade estava limitada à escassez de métodos de fácil acesso ao público com pouco conhecimento técnico matemático. Tal limitação não existe atualmente, a partir do desenvolvimento de metodologias para a obtenção do formato dos ovos a partir de fotografias digitais (e.g., Troscianko 2014; Biggins et al. 2018).

Os fatores que afetam o formato dos ovos variam de acordo com a escala taxonômica avaliada (Montgomerie et al. 2021). Estudos em larga escala taxonômica mostram que o formato é ordem-específico, como por exemplo, ovos arredondados são prevalentes em espécies com pelve larga e de hábitos arbóreos (e.g. Columbiformes, Falconiformes, Accipitriformes e Strigiformes) e ovos alongados são comuns em aves de pelve estreita e hábito aquático (e.g. Anseriformes e Suliformes) (Stoddard et al. 2017; Shatkovska et al. 2018) e maior tamanho corporal e desenvolvimento precocial (i.e., filhotes que nascem emplumados e independentes dos adultos para alimentação e termorregulação) (e.g. Gaviiformes, Podicipediformes e alguns Gruiformes) (Mytiai et al. 2017). Entretanto, variações em menor escala dentro do formato característico dentro de determinada ordem são raramente exploradas. Duursma et al. (2018) relata que o formato dos ovos em espécies de Passeriformes na Austrália, com clima predominantemente árido, estaria relacionado a variação climática, mas não é conhecido se tal padrão seria seguido por espécies que evoluíram em climas diferentes, como polar, temperado ou tropical.

Apesar do aumento de estudos na última década, o entendimento acerca dos padrões de variação do formato dos ovos ainda está nos seus primeiros passos. Em vista disso, essa tese tem como objetivo geral avaliar e descrever os padrões de variação do formato dos ovos em espécies de Passeriformes da região Neotropical. Especificamente, procuramos entender se existe variação dentro do padrão elíptico típico da ordem entre as famílias e se tal variação poderia estar relacionada a diferenças climáticas, ecológicas e reprodutivas das espécies. Os Passeriformes consistem em um apropriado grupo de estudo por exibirem considerável variação no formato dos ovos (Mytiai et al. 2017), por todas as espécies apresentam desenvolvimento altricial, i.e., os filhotes nascem sem penas e dependentes dos adultos para alimentação e termorregulação (Dyke and Kaiser 2010) e por representam a ordem mais diversa entre as aves, com cerca de 6.000 espécies mundialmente e 2.200 espécies distribuídas em 45 famílias na região Neotropical (Ricklefs 2012)

A tese é formada por três capítulos, cada um explorando uma vertente dos possíveis fatores associados a variação no formato dos ovos de espécies de Passeriformes Neotropicais. No capítulo 1 avaliamos a influência das características ecológicas e reprodutivas das espécies na variação do formato dos ovos a nível espécie-específico. No capítulo 2 exploramos o papel das condições climáticas de longo e curto prazo na variação do formato dos ovos em comunidades de espécies. No capítulo 3 avaliamos o papel de condições ambientais potencialmente restringentes, dieta e características reprodutivas na variação intra-ninhada do formato dos ovos em comunidades de espécies. Tal divisão de capítulos foi realizada pois a exploração dos preditores avaliados requer diferentes filtros na base de dados dos ovos. O clima foi o principal filtro entre os capítulos. O capítulo 1 não apresenta preditores climáticos, sendo aquele com o maior número amostral por incluir ninhadas anteriores a 1901. Dados climáticos são disponíveis a partir de 1901, portanto apenas as ninhadas a partir desse ano e com dados do mês e ano de postura foram incluídas nos capítulos 2 e 3. Como o capítulo 3 explora o variação intra-ninhada do formato dos ovos a partir do coeficiente de variação, apenas as ninhadas com mais de um ovo medido foram incluídas, sendo excluídas as ninhadas contento ovos quebrados e apenas um ovo intacto. Tal seleção diminuiu o tamanho amostral do capítulo 3 em relação ao capítulo 2.

CAPÍTULO 1

Species-specific egg shape is affected by breeding and ecological traits across Neotropical passerines

Abstract

The species-specific variation in bird egg shape may result from allometry, phylogenetic relatedness, and environmental adaptation. In taxonomic closely related species, egg shape variation may be more related to environmental adaptation, such as climatic conditions, breeding, and ecological traits. However, few studies have explored egg shape variation on a large spatial scale among closely related species. Using phylogenetic-controlled models, we tested the influence of breeding (clutch size, egg volume, and nest type) and ecological (habitat, diet, and migration behavior) traits on the species-specific egg shape of 468 Neotropical passerines. We gathered data from 36 museum egg collections to calculate two egg shape indexes: egg elongation (length divided by breath) and asymmetry (pointedness). We found that egg elongation increases with egg volume, more shaded habitats, and calcium-limited diets. Egg asymmetry increases with clutch size, more shaded habitats, calcium-limited diets, and migratory behavior. Our results suggested that egg elongation is more constrained by oviduct width, in which an increase in egg size accompanies an increase in egg elongation, and egg asymmetry is more affected by species traits, such as clutch size and migration behavior.

Keywords: clutch size, diet, egg shape, egg size, egg collections, bird migration

1. Introduction

The species-specific variation in bird egg shape may result from allometry, phylogenetic relatedness, and environmental adaptation (Montgomerie et al. 2021). Allometry and phylogeny effects are related to constraints on female body size and lifestyle and help explain most egg shape variation across high taxonomic levels, such as among avian orders (Deeming 2018; Shatkovska et al. 2018; Mytiai et al. 2021). On the other hand, egg shape variation in closely related species or with similar life histories may be more related to environmental adaptation, such as climatic conditions (Duursma et al. 2018), breeding (e.g., egg size, clutch size, nest type) and ecological (e.g., diet, habitat, and migration behavior) traits (Stoddard et al. 2017; Birkhead et al. 2019).

The shape of eggs is mainly described by elongation and asymmetry indexes. Egg elongation is the ratio between egg length and width, and egg asymmetry depicts how one egg end is more pointed than the other (Preston 1969). Previous studies found positive correlations between egg elongation and asymmetry, ranging from 0.36 to 0.54 (Preston 1969; Stoddard et al. 2017; Biggins et al. 2018). However, as these indexes describe different components of egg shape variation, they correlate with different aspects of bird ecology (Montgomerie et al. 2021).

Egg shape may reflect limitations of egg size and incubation efficiency. The shape of eggs is formed during egg development in the oviduct, where oviduct width constraints increase in egg size (Smart 1991). Therefore, increased egg size is commonly associated with increased egg elongation (Montgomerie et al. 2021; Mytiai et al. 2021). Clutch size may result from selecting egg shapes that promote a compact fit under the brood patch of incubating adults (Andersson 1978). Heat transfer occurs through the brood patch, a featherless hyper-vascularized skin area in the abdomen formed during reproduction (Redfern 2010). In most species, adults incubate eggs to maintain an optimal temperature for embryonic development (Deeming 2016). As the heat transfer between the brood patch and eggs is size-limited, egg shapes that maximize the fitting under the brood patch may be expected, such as more elongated and asymmetrical eggs in larger clutches (Barta and Székely 1997). However, previous studies reported decreased elongation in larger clutches (Gosler et al. 2005; Górski et al. 2015) or no effect (Janiga 1996; Encabo et al. 2001; Bańbura et al. 2018).

Most birds lay eggs in nests placed in a variety of habitats. Habitats with more vegetation cover, such as forests and woodlands, can increase shade availability, preventing overheating in unattended eggs (Sidis et al. 1994; Lusk et al. 2003). Bird nests range from ground scrapes to complex domed structures (Chia et al. 2023). Eggs laid in open nests (i.e., without a roof cover) may be more exposed to climatic conditions than domed nests (i.e., with a roof cover) or nests placed in cavities (Perez et al. 2020). Nests can buffer external environmental conditions through an internal microclimate of higher humidity and more temperature stability to allow egg and nestling development (Rahn and Paganelli 1990; Deeming 2011b). Therefore, egg shapes that decrease water loss through evaporation and heat transfer from thermal radiation could be more common when eggs face high exposure to environmental conditions, such as in open nests and less-shaded habitats (Duursma et al. 2018).

Calcium is an essential and limited resource for bird reproduction (Reynolds and Perrins 2010). Females must consume calcium-rich food items during the pre-laying period to allow eggshell formation (Perrins 1996). Calcium-poor diets, such as frugivores and nectarivores, may face more limitations in calcium acquisition than carnivore species (Birkhead 2016). Decreased eggshell thickness can increase breakage risk (Narushin and Romanov 2002). Therefore, investing in egg shapes with a lower surface-to-volume ratio may offset calcium limitation in calcium-poor diets. Previous studies on single passerine species reported more elongated eggs in environments with higher calcium availability (Gosler et al. 2005; Bańbura et al. 2018). However, in a broad-scale taxonomic study, eggs were more elongated in diets with low calcium intake (Stoddard et al. 2017).

Migratory species must allocate limited resources to migrate, reproduce, and molt annually (Hedenström 2007). As these events exhibit low overlapping, migratory species tend to invest less time in egg incubation and parental care (Minias and Włodarczyk 2020) and more in clutch size (Sousa et al. 2024) than resident species. Reduction in incubation periods may occur with an increased speed in gas exchange between the embryo and external environment through a higher eggshell porosity and superficial area (Rahn and Ar 1974; Whittow 1980). As more elongated eggs tend to have higher eggshell porosity (Zimmermann and Hipfner 2007), one could expect increased egg elongation in migratory species.

Here, we aim to evaluate the role of reproductive and ecological traits in the variation of the species-specific egg shape in passerines from the Neotropical region. We predict that egg elongation and egg asymmetry are positively correlated and increase in (i) larger clutches (best fit under adult brood patch), (ii) larger egg size (egg size constrained by oviduct width), (iii) open nests (higher egg exposure to weather), (iv) less-shaded habitats (higher egg exposure to weather), (v) calcium-poor diets (calcium limitation), and (vi) migratory species (decreased duration of incubation period).

2. Methods

(a) Egg shape database

We searched for passerines reproduction data in the Neotropical region from egg sets deposited in 36 museum egg collections in South and Central America, the USA, and Europe (Supplementary Material, Table S1) visited between 2014 and 2023. We also inspected online egg collections from the Field Museum of Natural History (FMNH, Chicago, USA) at https://collections-zoology.fieldmuseum.org/ and the Museum of Vertebrate Zoology (MVZ, California, USA) at http://arctos.database.museum/mvz_egg/ for photos of egg sets with black background and scale. During museum visits, we used a standardized procedure of camera distance and angle, black background contrast, lighting, and ruler position to photograph egg sets. We collected information about the date, location, clutch size (number of eggs in the clutch), and taxonomic classification from egg set labels/cards. To standardize and update taxonomy, we checked for synonyms starting from the oldest species name provided in museum labels and followed the chronological order of museum catalogs published from 1877 to 1979 (Supplementary Material, Table S2). Lastly, we updated the species' taxonomic names according to Jetz et al. (2012).

We filtered egg sets to exclude potentially biased clutches. First, we confirmed clutch size by checking the clutch size range for each species according to Billerman et al. (2020). Then, we used only egg sets with reliable clutch size, i.e., clutches not altered by incomplete clutch collecting (mostly with only one egg), within the clutch size range for each species, and not altered by collectors (Green and Scharlemann 2003). Lastly, we excluded clutches parasitized by *Molothrus* spp. or *Tapera naevia*, as the host eggs may be ejected from the nest (Soler 2018).

We measured eggs with the Egg Tools plugin (Troscianko 2014), using the digital photographs of egg sets obtained during museum visits and online egg collections (FMNH and MVZ) in ImageJ software (Rasband 1997). Egg measurements included length (mm), maximal width (mm), volume (mm^3), and ellipse deviation (dimensionless) of eggs. We obtained two egg-shape indexes, elongation (length divided by maximal width) and asymmetry (pointedness), through the ellipse deviation. Here, asymmetry values indicated a deviation from a symmetric elliptical egg, with high values indicating more pointed eggs (Troscianko 2014). All reliable egg sets found for each species were used to calculate the species-specific mean of elongation and asymmetry.

(b) Ecological and breeding data

Here, we consider the Neotropical region from the USA border with Mexico and the West Indies to Argentina and the Falkland Islands (Stotz 1996). We obtained the species-specific clutch size (number of eggs per egg set) and egg size (as egg volume) through the mean and mode (only for clutch size) of all reliable egg sets. We excluded clutches with one egg for species-specific clutch size, as they may represent incomplete clutches. However, one-egg clutches were included in the mean volume calculation. We classified nests as open when eggs had no roof protection and closed when eggs were concealed in domed structures or cavities (Billerman et al. 2020). Habitat and diet classification was modified from Tobias et al. (2022). We considered open habitats as areas with low vegetation cover (i.e., less-shaded habitats), such as grasslands, shrublands, and rocky substrates with very little vegetation; closed habitats as areas with high vegetation cover, such as forests and woodlands; and water-associated habitats as coastal, riverine and wetlands areas. We classified invertivores, aquatic predators, and vertivores as carnivores; frugivores, granivores, herbivore terrestrials, and nectarivores as herbivores; and omnivores (when consumed both plant and animal items in a roughly equal proportion). Migration behavior follows the classification proposed by Tobias et al. (2022). We considered species in which most populations migrate as migratory, species with a minority of migratory populations as partially migratory, and species that did not migrate as sedentary.

(c) Data analyses

We used the Phylogenetic Generalized Least Squares (PGLS) approach to account for the dependence between species due to shared ancestry (Martins and Hansen 1997). We ran PGLS models in the R package “nlme” (Pinheiro and Bates 2023). We computed the phylogenetic consensus tree from 1,000 random trees containing the species of interest gathered at https://birdtree.org/ (Ericson et al. 2006; Jetz et al. 2012). We calculated the phylogenetic signal of Pagel’s lambda (λ) between bird phylogeny and the egg’s traits elongation and asymmetry. Pagel’s lambda varies from 0 to 1; if $\lambda = 0$, traits had no phylogenetic signal and $\lambda=1$, traits evolved under the Brownian motion model with closely related species sharing higher trait similarity (Pagel 1999). The phylogenetic tree and the phylogenetic signal were obtained in the R packages “ape” (Paradis and Schliep 2019) and “phytools” (Revell 2024), respectively.

We transformed all numerical variables before modeling to improve normality using the R package “bestNormalize” (Peterson and Cavanaugh 2020; Peterson 2021), which chooses the best transformation to normalize data. Accordingly, we used the Yeo-Johnson transformation (Riani et al. 2023) for egg elongation, square root for egg asymmetry, and box-cox transformation for clutch size and volume (Sakia 1992). We evaluated multicollinearity in numerical predictors through Pearson correlation (threshold $r < 0.7$) and numerical and categorical predictors through variance inflation factor (VIF < 3) (Zuur et al. 2010). We calculated VIF in the R package “*car”* (Fox and Weisberg 2019).

We ran separate models for egg elongation and asymmetry as response variables. Predictor variables for multiple regression models included mean clutch, mean volume, nest type (open and closed), habitat (open, closed, and water-associated), diet (carnivore, herbivore, and omnivore), and migratory behavior (migratory, partially migratory, and sedentary). We confirmed the normality and homogeneity of model residuals using graphical inspections.

3. Results

We gathered 15,143 eggs from 5,873 clutches of 468 species belonging to 32 Neotropical passerine families. We used these breeding records to calculate each species-specific egg shape. Table S3 from the Supplementary Material provides the number of clutches available per species evaluated. Phylogenetic signals were significant for egg elongation ($\lambda = 0.85$, LR $= 186.99$, $p < 0.001$) and asymmetry ($\lambda = 0.79$, LR $= 100.41$, $p < 0.001$). These results indicate that egg shapes are similar among closely related species (Fig. 1).

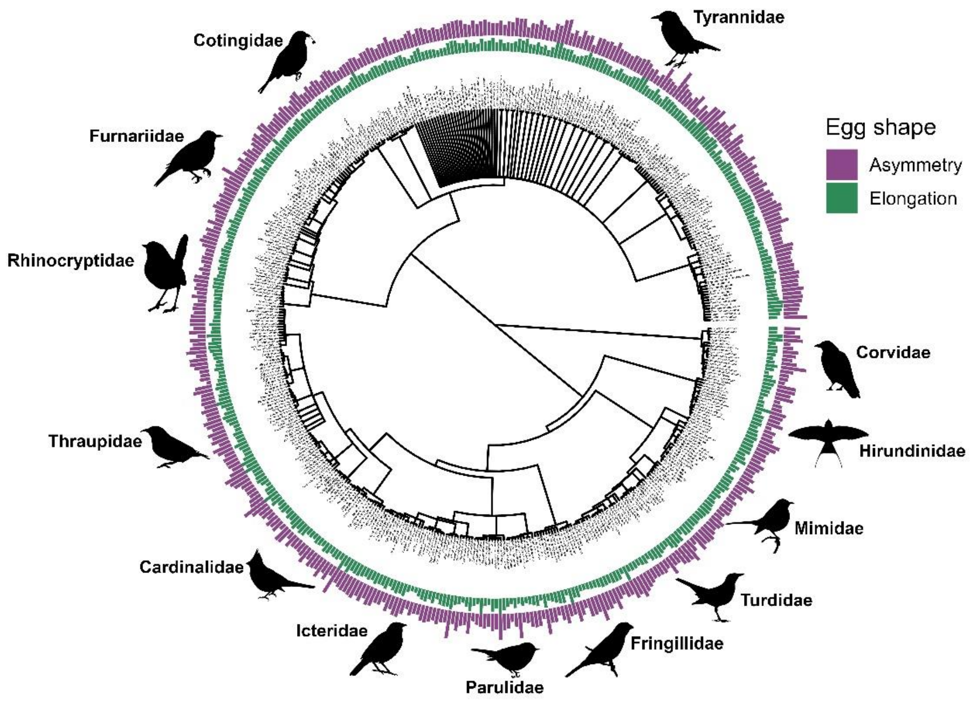

Fig. 1 Egg elongation and asymmetry distribution across the avian phylogeny based on Jetz et al. (2012). Asymmetry values were multiplied by 1,000 to improve plot visibility. Bird silhouettes gathered from https://www.phylopic.org/.

The correlation between egg elongation and asymmetry was low but significant (Pearson's $r = 0.35$, $t = 8.15$, $p < 0.001$), so passerine eggs tend to show a correlated increase in egg elongation and asymmetry (Fig. 2). Families with higher egg elongation were Ptiliogonatidae (1.47), Cinclidae (1.44), and Icteridae (1.43). Families with higher egg asymmetry included Ptiliogonatidae (0.00045), Laniidae (0.00038), and Vireonidae (0.00037).

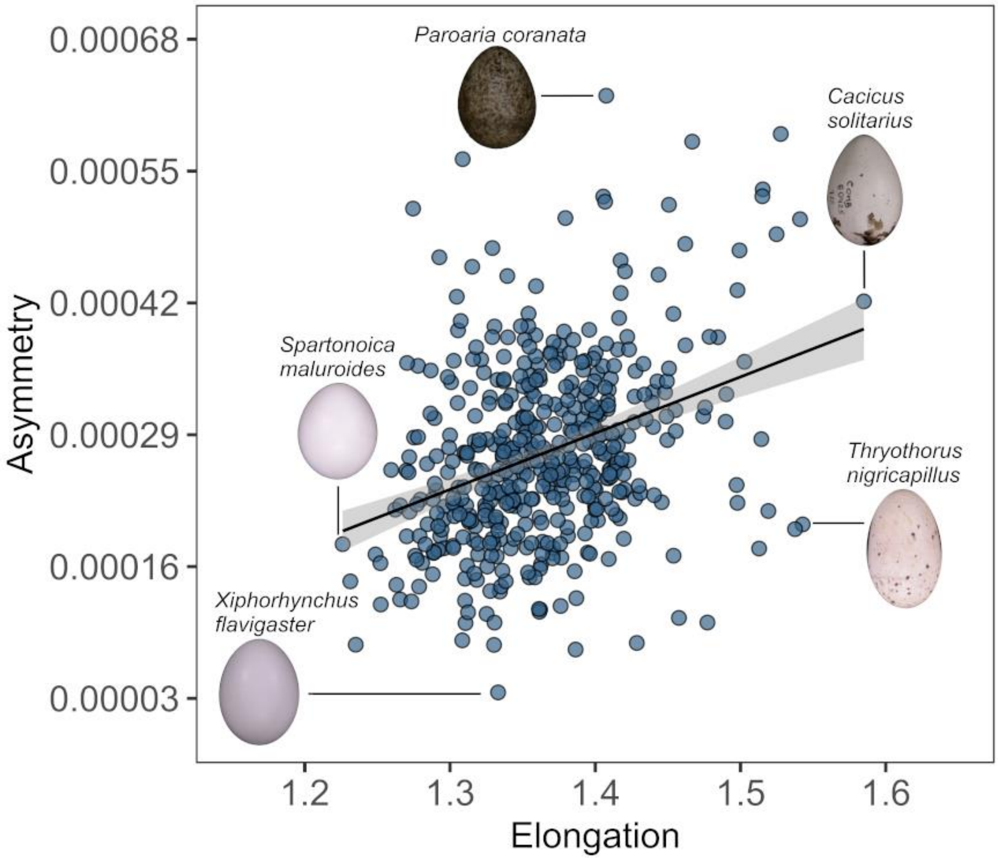

Fig. 2 Egg elongation and asymmetry in 468 Neotropical passerines. Egg photographs depict maximum and minimum egg shape indexes. Grey shaded area represents the 95% confidence interval.

PGLS models show that egg elongation is higher in larger egg sizes, closed habitats, and herbivore and omnivore diets (Table 1, Fig. 3). Egg asymmetry is higher in larger clutch sizes, closed habitats, omnivore diets, and migratory species (Table 1, Fig. 4).

Table 1. Parameter estimates (Estim.), standard errors (SE), and tests for Phylogenetic Generalized Least Squares (PGLS) models with clutch size, egg volume, nest type (open and closed), habitat (open, closed, and water-associated), diet (carnivore, herbivore, and omnivore), and migration behavior (migratory, partially migratory = Part, and sedentary = Seden) as predictors and egg elongation and asymmetry as response variables. Bold lines show significant effects.

	Elongation				Asymmetry			
	Estim.	SE	t	P	Estim.	SE	t	P
(Intercept)	0.11	0.18	0.62	0.54	0.017	0.0006	26.14	<0.01
Clutch size	-0.05	0.05	-1.17	0.24	**0.0004**	**0.0001**	**2.98**	**<0.01**
Egg volume	**0.27**	**0.05**	**5.90**	**<0.01**	0.0001	0.0001	0.66	0.51
Nest type: open	-0.19	0.10	-1.96	0.05	0.0005	0.0003	1.84	0.07
Habitat: open	**-0.31**	**0.10**	**-3.25**	**<0.01**	-0.0005	0.0003	-1.90	0.06
Habitat: water	-0.21	0.18	-1.17	0.24	**-0.0012**	**0.0005**	**-2.31**	**0.02**
Diet: herbivore	**0.40**	**0.11**	**3.55**	**<0.01**	0.0000	0.0003	0.04	0.97
Diet: omnivore	**0.78**	**0.12**	**6.27**	**<0.01**	**0.0009**	**0.0004**	**2.33**	**0.02**
Migration: Part	-0.09	0.16	-0.54	0.59	**-0.0011**	**0.0005**	**-2.25**	**0.03**
Migration: Seden	-0.13	0.14	-0.98	0.33	**-0.0012**	**0.0004**	**-3.08**	**<0.01**

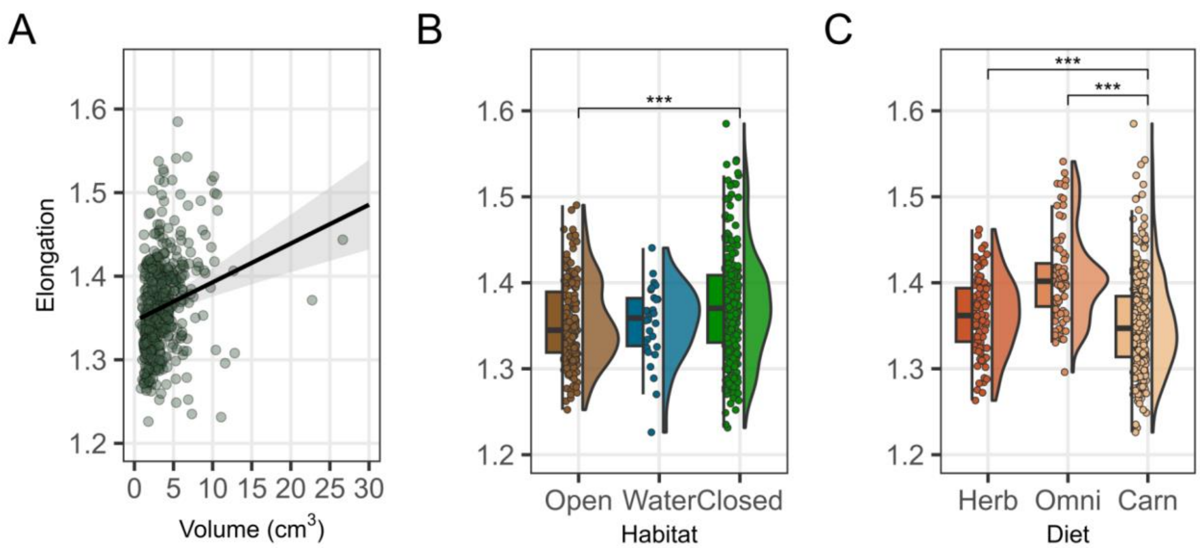

Fig. 3 Phylogenetic Generalized Least Squares (PGLS) model effects on species-specific egg elongation in Neotropical passerines. A– Effect of egg volume. B– Effect of habitat type (close, open, and water-associated habitats). C– Effect of diet (Carn = carnivore, Herb = herbivore, Omni = omnivore). Grey shaded area represents the 95% confidence interval, and asterisks represent significant contrasts.

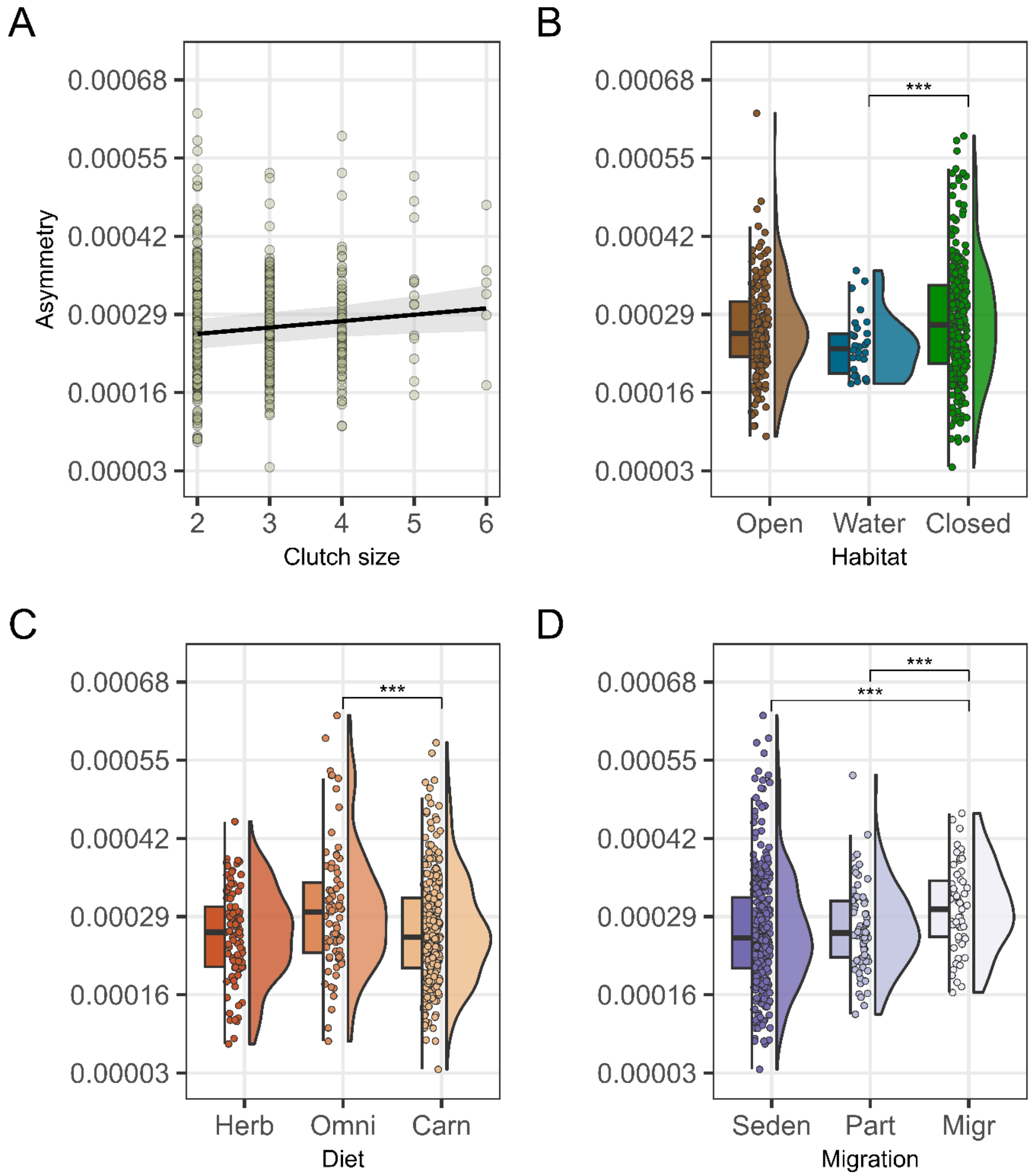

Fig. 4 Phylogenetic Generalized Least Squares (PGLS) model effects on species-specific egg asymmetry in Neotropical passerines. A– Effect of clutch size. B– Effect of habitat type (close, open, and water-associated habitats). C– Effect of diet (Carn = carnivore, Herb = herbivore, Omni = omnivore). D– Effect of migration behavior (Migr = migratory, Part = partially migratory, Seden = sedentary). Grey shaded area represents the 95% confidence interval and asterisks represent significant contrasts.

4. Discussion

Here, we investigated how breeding and ecological traits correlate with species-specific egg shape in 468 Neotropical passerines. We found support for most hypotheses tested, except for opposite responses in nest type and habitat. Egg elongation and asymmetry showed a weak positive correlation (r = 0.35), which helps explain their different responses to the predictors evaluated. Accordingly, only egg elongation was influenced by egg size, indicating that elongation is the more constrained component of egg shape variation.

Egg asymmetry but not egg elongation increased with clutch size. Increased egg asymmetry in larger clutches may optimize incubation efficiency through a compact fit under the adult brood patch (Andersson 1978; Barta and Székely 1997). However, previous studies reported contrasting effects, with increased egg asymmetry (Montgomerie et al. 2021), egg elongation (Kouidri et al. 2015), or no effect on egg shape (Briskie and Sealy 1990; Stoddard et al. 2017; Bańbura et al. 2018) in larger clutches. Besides the increased contact area between the eggs and the adult brood patch, more asymmetric eggs could also decrease the cooling rate in unattended eggs. As the pointed end of eggs cools faster than the blunt end due to a relatively larger surface area to volume ratio, a clutch arrangement with the pointed ends oriented towards the nest center can slow clutch heat loss (Šálek and Zárybnická 2015).

Our data supported the prediction of increased elongation but not asymmetry in larger eggs. Reduction in body mass to allow powered flight imposed a reduced abdominal cavity (Jenni-Eiermann and Srygley 2017) and, consequently, a smaller space for egg development (Inverson and Ewert 1991). As egg size is mainly constrained by oviduct width (Mytiai et al. 2021), increased egg length, and therefore egg elongation, is a way to allocate a larger egg in a size-limited body cavity (Inverson and Ewert 1991). On the other hand, egg asymmetry may be constrained by an interaction between oviduct width and egg mass relative to female body mass. More asymmetric eggs can be produced when relatively large eggs enter a narrow part of the oviduct, forcing its contents (yolk and albumen) backward (Deeming 2022).

Contrary to our predictions, egg elongation increased in closed nests and more shaded habitats. Although marginal (p = 0.05), egg elongation was higher in closed nests. Previous studies reported increased egg elongation in closed nests (Duursma et al. 2018; Montgomerie et al. 2021), shaded habitats (Duursma et al. 2018), and no nest effects (Stoddard et al. 2017). Eggs laid in nests with a roof cover or cavities are exposed to a microclimate of higher humidity and lower temperature than the surrounding weather (Rahn and Paganelli 1990; Deeming 2011b). As the surface-to-volume ratio decreases in more elongated eggs (Tatiane Silva and Miguel Marini unpublished data, Chapter 2), we expected that less elongated (more rounded) eggs would be more common in open nests and less shaded habitats to decrease water loss and heat transfer. Thus, other factors may also be associated with increased egg elongation. For example, oviduct width may constrain albumen (water-rich) deposition around the central yolk (lipid-rich), resulting in more water content in elongated eggs (Astheimer and Grau 1985; Deeming 2018). Thus, water-limited habitats could restrain water investment in eggs.

Species with calcium-limited diets had more elongated and asymmetric eggs, confirming our predictions. Although poorly explored, previous studies reported an increase (Stoddard et al. 2017) and a decrease (Gosler et al. 2005) in egg elongation in diets low in calcium. Carnivore species eat more calcium-rich food than other diets, thus being able to spend more calcium on eggshell formation (Graveland and van Gijzen 1994; Reynolds and Perrins 2010). The lower surface-to-volume ratio in more elongated and asymmetric eggs (Tatiane Silva and Miguel Marini unpublished data, Chapter 2) allows less calcium investment, being more advantageous in calcium-limited diets. However, some species may compensate for eggshell thinning through increased pigmentation (Gosler et al. 2005).

Migratory species have more asymmetric eggs, as expected. Previous studies reported increased egg elongation and asymmetry in migratory species (Stoddard et al. 2017; Gómez-Bahamón et al. 2023). A streamlined body adapted to powered flight and dispersal may contribute to higher egg asymmetry and elongation in migratory species (Stoddard et al. 2017). Migratory species tend to invest less time in egg incubation than resident species due to not overlapping reproduction and migration activities over the annual cycle (Minias and Włodarczyk 2020). The larger pointed end in more asymmetric eggs can decrease the incubation period's duration through more concentration of pores in the blunt end, optimizing gas exchange (Smart 1991). Moreover, species that migrate farther distances tend to invest more in clutch size than egg size (Sousa et al. 2024). As our data showed that egg asymmetry is also positively related to clutch size, increased egg asymmetry in migratory species can be related to an interplay between body shape constraints and optimization of gas exchange.

In conclusion, our study showed that phylogenetic relatedness and reproductive and ecological traits influence egg-shape variation in Neotropical passerines. Egg elongation and asymmetry were weakly correlated and distinctly affected by clutch size, egg size, nest type, and migratory behavior. In contrast, habitat and diet similarly affected both egg shape indexes. Therefore, distinct selective pressures may be acting on egg elongation and asymmetry.

CAPÍTULO 2

Climate, nest type and surface-to-volume ratio drive egg shape variation in Neotropical passerines

Abstract

Climatic conditions where bird species reproduce can exert selective pressures to optimize their embryonic development. Variation in egg morphology, such as egg shape, may face selective pressures at large and small climatic scales to prevent excessive water loss and maintain the exchange of metabolic gases. Here, we evaluated if the long-term climate and the weather of egg-laying months correlate with egg-shape variation in Neotropical passerines. We studied 4,095 clutches (10,994 eggs) of 428 Neotropical passerine species from egg sets deposited in 36 collections in South and Central America, the USA, and Europe. We used egg shape indexes of elongation (length divided by width) and asymmetry ("pointedness"). Eggs with higher elongation and asymmetry indexes showed a lower surface-to-volume ratio (SA:V). With a phylogenetic comparative approach, we showed that open-nesting species breeding in drier conditions had more elongated eggs than those in humid climates. Lower SA:V in elongated eggs may prevent embryo dehydration through decreased water loss in drier environments. Our findings suggest that egg shape has co-evolved with climatic conditions in nests with higher environmental exposure.

Keywords: bird reproduction, egg elongation, egg asymmetry, egg collections, Neotropics, precipitation.

1. Introduction

Egg shape varies from most spherical to pear-shaped in birds (Stoddard et al. 2017). From initial mathematical descriptions (Mallock 1925; Preston 1953, 1968; Todd and Smart 1984) and allometric relationships (Hoyt 1976; Rahn and Paganelli 1988), egg shape variation seemed to have no adaptative significance (Hoyt 1976). Instead, bird's egg shape had wrongly assigned functions, such as the pear-shaped eggs of Common Guillemot's *Uria aalge,* as an adaptation to prevent them from rolling off cliff edges (Birkhead et al. 2017b). However, recent studies have shown that egg shape is related to flight ability (Stoddard et al. 2017), breeding traits (Birkhead et al. 2019; Nagy et al. 2019), development mode (Mytiai et al. 2017), egg composition (Deeming 2018), allometry (Mytiai et al. 2021), morphological constraints (Montgomerie et al. 2021), and climate variation (Duursma et al. 2018).

Egg shape variation is phylogenetically constrained. Egg shape has a consistent phylogenetic effect, with an avian order-specific general shape associated with constraints in female pelvic morphology and habitat type (Shatkovska et al. 2018). For example, near-spherical eggs correlate with the wide pelvis of raptorial birds (Falconiformes, Accipitriformes, Strigiformes) and pigeons (Columbiformes), and elongated eggs with the narrow pelvis of some waterbirds (Anseriformes, Gaviiformes, Podicipediformes, Suliformes) (Preston 1969; Shatkovska et al. 2018). Egg measurements associated with egg elongation may explain up to 67% of the variation among bird orders, in which increased egg size is associated with increased egg elongation (Mytiai et al. 2021). However, egg-shape variation among and within families from an avian order may result from selection pressures that can enhance embryonic development across different nesting environments and levels of egg exposure (Duursma et al. 2018).

Egg shape may optimize gas exchange along climatic gradients. Embryonic development is a diffusion-limited process of gas exchange of O_2, CO_2, and water vapor between the environment and eggshell pores (Ar et al. 1974). Eggs laid in arid and hot environments may risk embryo dehydration due to increased water loss and exposure to solar radiation (Walsberg and Schmidt 1992). Egg shapes with a lower surface-to-volume ratio (SA:V) could decrease water diffusion and heat conduction of the eggshell (Kooijman 1986; Van Der Meer 2006; Rubin 2023). Therefore, one could expect that egg shapes with lower SA:V may be prevalent in arid and hot conditions. Previous studies reported the prevalence of asymmetric egg shapes in cold and humid environments (Stoddard et al. 2017) and elongated egg shapes in hot and dry climates (Duursma et al. 2018) in passerine species. However, those studies did not report the egg's SA:V. Therefore, the relation between egg shape and SA:V is poorly understood.

Nest structure can influence the microclimate around the eggs. Birds exhibit a great variety of nest types, including the absence of nests (eggs buried on the ground), nests with minimal substrate scratching or basic lining, constructed platforms, cups, domed structures, and primary or secondary use of cavities (Collias 1964; Chia et al. 2023). Such variety reflects the level of egg exposure to environmental conditions. Nests with enclosed structures, i.e., walls and roofs, provide better insulation for eggs from extreme environmental conditions (Martin et al. 2017; Perez et al. 2020). Nest walls can retain heat and humidity, optimizing the nest microclimate for embryo development (Deeming 2016). Therefore, according to the species' nest design, eggs may experience different exposure levels to climate conditions. A previous study reported less elongated eggs in open-nesting species from hot and arid regions in Australia (Duursma et al. 2018). The authors suggested that less elongated (more rounded) eggs had lower SA:V than more elongated eggs, reducing thermal stress from thermal radiation in hotter areas. However, no measurements of SA:V were conducted to confirm this assumption.

Passerines (Passeriformes) comprise the most speciose bird order, with more than 6,000 species worldwide and 2,200 species from 45 families in the Neotropical region (Ricklefs 2012; Billerman et al. 2020). All members have altricial development, characterized by helpless hatchlings and smaller egg sizes compared to precocial species, with more independent hatchlings and larger eggs (Dyke and Kaiser 2010). Passerines also display considerable variation from their general ovoid egg shape (Mytiai et al. 2017), bred from arid to polar habitats, and build nests with higher and lower egg exposure to abiotic conditions (Billerman et al. 2020). Therefore, they represent a well-suited taxonomic group for evaluating intra-order egg shape variation in relation to climatic conditions.

Several studies focused on egg-shape variation among avian orders (e.g., Stoddard et al. 2017; Deeming 2018; Montgomerie et al. 2021) and at species levels (e.g., Adamou et al. 2018; Bańbura et al. 2018; Dolenec 2019). However, few studies have evaluated egg-shape variation among passerines (but see Duursma et al. 2018). Here, we explored how the shape of Neotropical passerine eggs varies according to long-term climate and weather during egg-laying months. As lower SA:V decreases the water diffusion and heat conduction (Rubin 2023), we predicted that if more elongated and asymmetrical eggs had a lower SA:V, they would be prevalent in drier and hotter conditions. This prediction would be expected for open-nesting species because their eggs had more precipitation and solar radiation exposure than those of closed-nesting species. We tested these predictions in three steps. First, (i) we calculated the SA:V for different egg shapes. Second, (ii) we tested whether the egg shape similarity between closely related species is due to their shared ancestry. Third, (iii) after accounting for phylogenetic relatedness, we tested whether nesting in different climatic conditions can predict egg shape variation in Neotropical passerines species with higher (open nests) and lower (closed nests) levels of egg exposure.

2. Methods

(a) Egg shape database

We searched for data regarding reproduction of Neotropical passerines in 36 egg collections in South and Central America, the USA, and Europe (Supplementary Material, Table S1) visited between 2014 and 2023. We also checked the online egg collections of the Field Museum of Natural History (FMNH, Chicago, USA) at https://collections-zoology.fieldmuseum.org/ and the Museum of Vertebrate Zoology (MVZ, California, USA) at http://arctos.database.museum/mvz_egg/ for photos of Neotropical passerine's egg sets with black background and ruler scale. We photographed egg sets using a standardized camera distance and angle procedure, background black contrast and lighting, and ruler position. We also collected information regarding egg-laying date (day/month/year), location (Country, State/Province, and Municipality/County), clutch size (number of eggs in the clutch), collector, and first taxonomic classification. As data from some museum egg collections had outdated taxonomy, we checked for synonyms starting from the oldest species name described in the museum labels/cards, followed by the chronological order in museum catalogs published from 1877 to 1979 (Supplementary Material, Table S2). Lastly, we updated the species' taxonomic names to Jetz et al. (2012).

Before egg measurement, we excluded clutches that could be biased or increased variance noise in the data analysis, i.e., egg sets parasitized by *Molothrus* spp. or *Tapera* *naevia*, as they may eject host eggs from the nest (Soler 2018) and egg sets with uncertain clutch sizes due to loss, incomplete clutch collecting (with only one egg), and altered clutches by collectors (Green and Scharlemann 2003). We only included egg sets with clutch sizes within each species range gathered from Billerman et al. (2020). We measured all eggs from all digital photographs of egg sets found for each species through the plugin Egg Tools (Troscianko 2014) in the ImageJ software (Rasband 1997). Egg measurements included length (mm), maximal width (mm), surface area (mm^2), volume (mm^3), and ellipse deviation (dimensionless). Egg shape indexes were elongation, i.e., length divided by maximal width and asymmetry ("pointedness") through the ellipse deviation, which measured the deviation from a symmetric elliptical egg with high values indicating more pointed eggs (Troscianko 2014). After measuring all eggs from all clutches, we calculated the mean elongation and asymmetry for each clutch found for each species.

(b) Climate data

We consider the Neotropical region from the West Indies and the USA border with Mexico to the southernmost part of Argentina, including the Falkland Islands (Stotz 1996). Our dataset consists of longitudinal data, with multiple clutches (egg sets) for each species evaluated, displaying temporal (1901–2021) and spatial (latitude: -54° to 32°, longitude: -118° to -34°) variation. We used the coordinates (latitude and longitude) provided by museum labels/cards to classify the climate of each clutch found for each species. When not available, we obtained the centroid coordinates of the Municipality/County with a maximum error of ± 25 km through the geocode function in the R package "ggmap" (Kahle and Wickham 2013). We evaluated the correlation between climate and egg shape through long-term and short-term climate models.

In long-term climate models, we classify the local climate where the clutches were collected through a categorical and numerical approach. We used the Köppen-Geiger Main Climate classification (MKG) to categorize the climate of the Neotropical region. Köppen-Geiger classification is based on five vegetation groups, air temperature, and precipitation: Tropical, temperature ≥ 18°C in the coldest month; Temperate, temperature of 10°C in the warmest month and 0 to 18°C in the coldest month; Arid, mean annual precipitation < 10 mm/year times a dryness threshold, which depends on the annual mean temperature and cycle of precipitation; Polar, temperature ≤ 10°C in the warmest month; and Cold, temperature >

10°C in the warmest month and ≤ 0°C in the coldest month (Beck et al. 2018). The Köppen-Geiger data is available at https://www.gloh2o.org/koppen/. We extracted the MKG for each locality through the R package "raster" (Hijmans 2023). For the numerical approach, we used the local long-term mean, i.e., the average of the climate variables between 1970 and 2000 obtained at 2.5 minutes spatial resolution from the WorldClim Bioclimatic database (Fick and Hijmans 2017) available at https://www.worldclim.org/. We extracted the annual total precipitation, mean, maximum, and minimal temperatures for the long-term climate models through the R package "raster" (Hijmans 2023).

In short-term climate models, we used the weather of the egg-laying month of each clutch gathered for each species. In this approach, we obtained the weather when (month/year) and where (latitude/longitude) each egg set was collected. We gathered the weather data from the Climatic Research Unit gridded Time Series (CRU TS), available on the Centre for Environmental Data Analyses (CEDA) at https://archive.ceda.ac.uk/. The CRU TS dataset represents worldwide land-based monthly variation in weather from 1901 to 2022 at 0.5° resolution (Harris et al. 2020). We extracted monthly values of total precipitation, mean, maximum, and minimal temperatures, and potential evapotranspiration (PET) through the R package "ncdf4" (Pierce 2019). Then, we calculated the aridity index through the division of precipitation by PET, in which higher aridity index values indicated more humid conditions and lower values indicated drier conditions (Cherlet et al. 2018; Marcelino et al. 2020). We extracted all climate data with R (R Core Team 2024).

For islands with unavailable climate data, we used nearby islands with similar latitudes and MKG as a proxy for their climates. For the Galapagos islands, we inferred the climate of Isla Floreana, Isla de San Cristóbal, Isla Seymour Norte, and Isla Pinta based on Isla Santa Cruz. For Mexican islands, we used the climate of Isla Tiburón for Isla San Pedro Martin (PET) and Isla San Lorenzo (precipitation) and the climate (PET) of Isla de Cedros for Isla Natividad and Islas de San Benito. We inferred the climate of Isla de Patos in Venezuela from Isla Cachachare in Trinidad and Tobago.

(c) Data analyses

We performed linear models between egg shape elongation and asymmetry (as predictors) and SA:V in mm^{-1} (surface area divided by volume) for each egg of all clutches. We fitted separated models for species (all, open-nesting, and closed-nesting) and families.

To account for allometric relationships, we calculated the relative egg shape (model residuals) through linear models of each shape index (elongation and asymmetry) in relation to the mean species' body mass (log-transformed) obtained from (Tobias et al. 2022). We used Phylogenetic Generalized Linear Mixed Models (PGLMMs) to address the non-independence between species due to their shared ancestry (Ives and Helmus 2011). We ran separate PGLMMs for egg elongation and egg asymmetry as response variables, with species as a random effect to account for multiple observations from the same species through the R package "phyr" (Li et al. 2020). We obtained the phylogenetic consensus tree from a sample of 1,000 trees from Jetz et al. (2012) at https://birdtree.org/. We calculated the phylogenetic signal of Pagel's lambda (λ) between bird phylogeny and the egg's traits elongation and asymmetry. Pagel's lambda (λ) values of 0 represent unrelated traits, and 1 represents traits that evolved following the Brownian motion model of evolution, with similar trait values among closely related species (Pagel 1999). The phylogenetic tree and phylogenetic signal were estimated using the R packages "ape" (Paradis and Schliep 2019) and "phytools" (Revell 2024), respectively.

We transformed all variables to improve normality using the R package "bestNormalize" (Peterson and Cavanaugh 2020; Peterson 2021), which selected the best transformation for each variable, being Yeo-Johnson transformation (Riani et al. 2023) for elongation and Ordered Quantile normalization (Peterson and Cavanaugh 2020) for egg volume and climate predictors. We checked collinearity in numerical predictors through Pearson correlation (threshold $r < 0.7$) and in numerical and categorical predictors through variance inflation factor (VIF < 3) (Zuur et al. 2010). We calculated VIF in the R package "*car*" (Fox and Weisberg 2019). Temperature variables were highly correlated ($r > 0.8$), so we only included the mean temperature in the models.

The MKG, annual precipitation, and annual mean temperature were predictors in the long-term climate models. The month aridity index and month mean temperature were predictors in models for the weather of egg-laying months. We ran separate models for open- and closed-nesting species. We classified nests as open when eggs are mostly exposed to the environment without roof protection and closed when eggs are protected in domed structures or cavities (Billerman et al. 2020). We avoid pseudoreplication by including unique breeding records for a month/year per species. As other variables may also influence egg measurements (Covas 2011; Stoddard et al. 2017), we also included the covariates island (as a dummy variable, yes or no), clutch size (number of eggs in each egg set), and egg volume to control for their effects. Egg volume was included as a fixed variable to control the effect of egg size on egg shape. We rerun all models in a subset of species with ≥ 10 records to evaluate if species with smaller sample sizes (< 10 records) could affect model outputs. We also performed models for each passerine family with ≥ 20 records to evaluate differential family trends. We checked the normality and homogeneity of model residuals through graphical inspections and spatial autocorrelation with Moran's I test through the R package "moranfast" (Cooper 2020).

3. Results

We gathered 4,095 clutches (10,994 eggs) of 428 passerine species belonging to 30 families (Supplementary Material, Table S4) from the Neotropical region. Most breeding records were from the MKG Tropical region (47.2%, n = 1,932), followed by the MKG Temperate region (36%, n = 1,473), MKG Arid region (15.6%, n = 642), and the MKG Polar region (1.2%, n = 48) (Fig. 1). We did not find breeding records from the MKG Cold region.

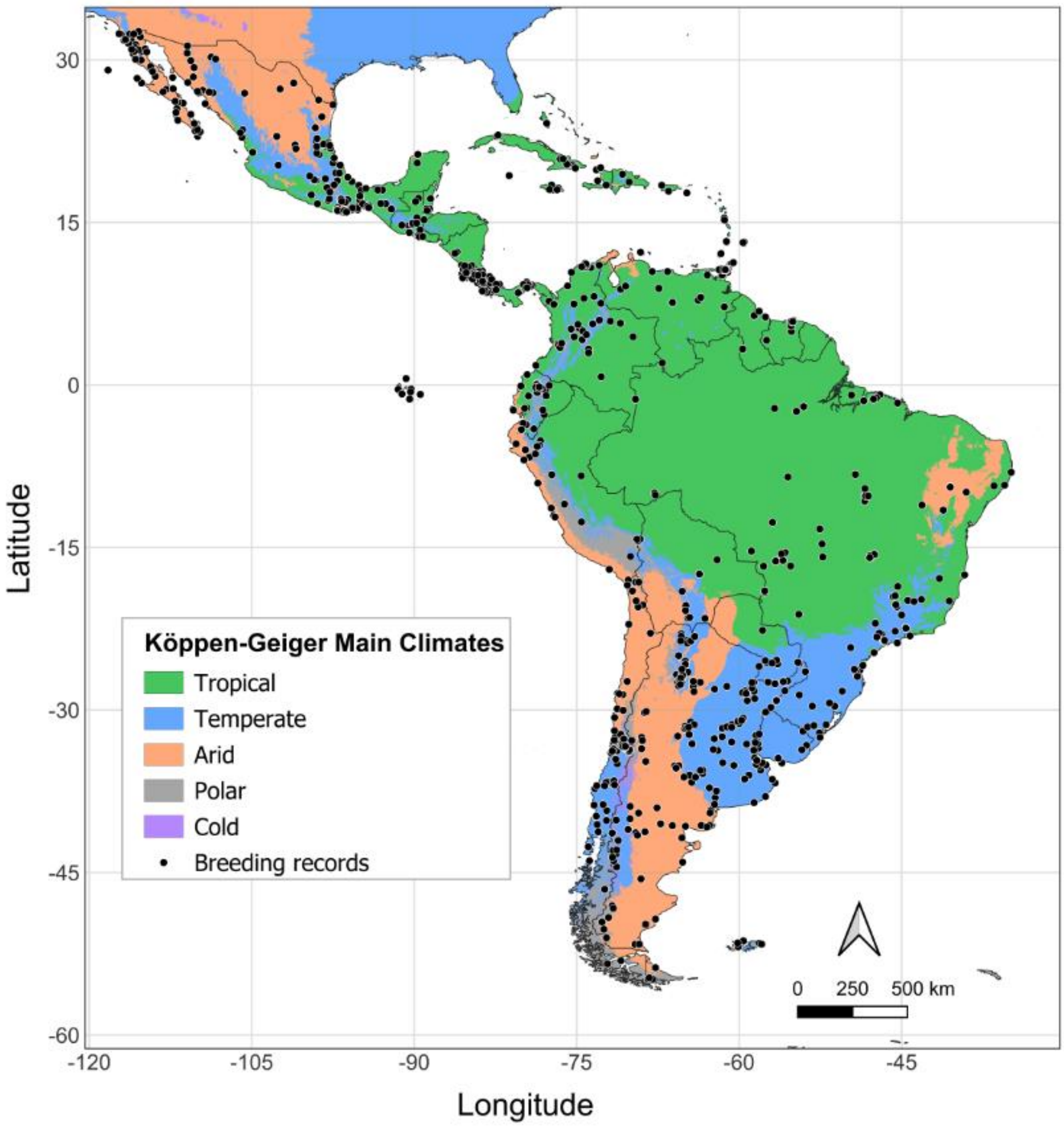

Fig. 1 Distribution of passerine breeding records from museum egg collections and Köppen-Geiger Main Climates (MKG) in the Neotropical region

More elongated eggs showed a lower SA:V in all-species models ($\beta = -0.30 \pm 0.01$, $p < 0.001$) (Fig. 2A), as well as in open ($\beta = -0.41 \pm 0.01$, $p < 0.001$) and closed ($\beta = -0.2 \pm 0.02$, $p < 0.001$) nesting species. More asymmetric eggs also showed a lower SA:V in all-species models ($\beta = -0.00008 \pm 0.00002$, $p < 0.001$) (Fig. 2B) and in open ($\beta = -0.00009 \pm 0.00003$, $p = 0.008$) and closed ($\beta = -0.00008 \pm 0.00004$, $p < 0.03$) nesting species. Most families followed this overall trend for egg elongation (Corvidae, Furnariidae, Hirundinidae, Passerellidae, Pipridae, Thraupidae, Troglodytidae, Turdidae, Tyrannidae), except Fringillidae. However, more asymmetric eggs had a lower SA:V in Corvidae, Hirundinidae, Pipridae, Thraupidae, and Tyrannidae and a higher SA:V in Cardinalidae, Furnariidae, Icteridae, Thamnophilidae, Tityridae, and Troglodytidae.

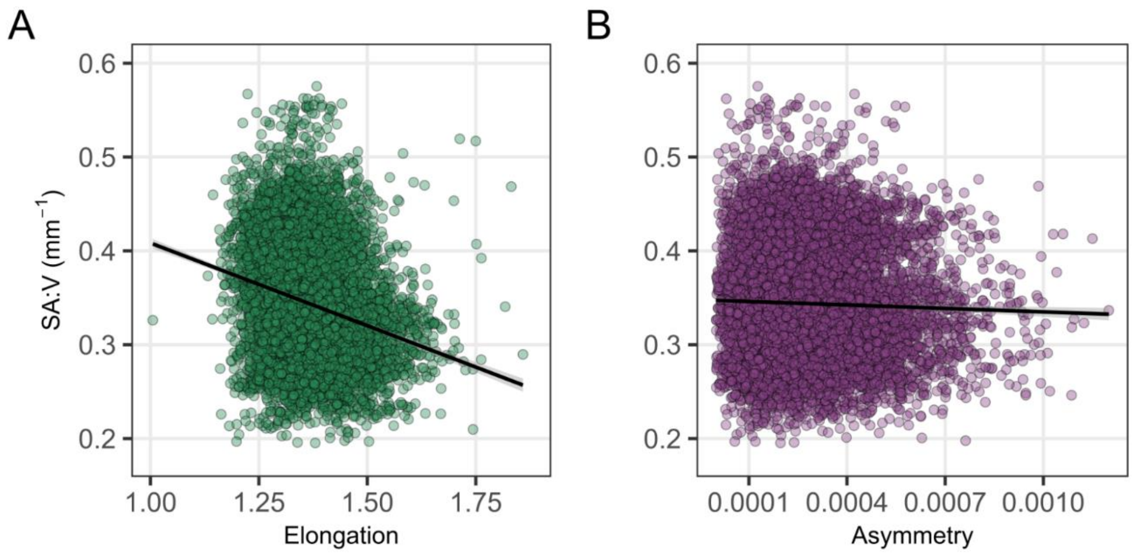

Fig. 2 Linear regressions between egg shape and SA:V (surface-to-volume ratio) in Neotropical passerines species. A–Egg elongation (length/maximum width). B–Egg asymmetry ("pointedness"). Grey shaded area represents the 95% confidence interval.

Relative egg elongation ($\lambda = 0.79$, LR = 151.63, $p < 0.001$) and asymmetry ($\lambda = 0.79$, LR = 75.41, $p < 0.001$) showed significant phylogenetic signals, indicating that closely related species have more similar egg shape.

Climate conditions only affected the egg shape of open-nesting species. PGLMMs for long-term climate showed that relative egg elongation decreased in more humid areas (Fig. 3A) and relative egg asymmetry was higher in eggs laid in the MKG Temperate compared to the MKG Arid climates (Table 1). Subset models (species ≥ 10 records) only supported the effect on elongation as the effect on asymmetry was weak ($p = 0.04$). PGLMMs for weather of egg-laying months showed that relative egg elongation decreased with higher aridity indexes (more humid months) (Fig. 3B) (Table 2). Subset models (species ≥ 10 records) supported those results. There was no spatial autocorrelation in elongation (Moran's I test; open nest: $p = 0.23$, closed nest: $p = 0.83$) and asymmetry (Moran's I test; open nest: $p = 0.93$, closed nest = 0.99) model residuals.

Table 1. Parameter estimates, standard errors (SE), and tests for Phylogenetic Generalized Linear Mixed Models (PGLMMs) with long-term climate variables as predictors (An. prec. = annual precipitation, An. mean temp. = annual mean temperature), relative egg elongation and relative egg asymmetry as response variables, and species as a random variable. Bold lines show significant effects.

	Open nest				Closed nest			
	Estimate	SE	Z	P	Estimate	SE	Z	P
Relative Elongation								
Intercept	-0.13	0.84	-0.15	0.88	0.15	0.92	0.17	0.87
An. prec.	**-0.12**	**0.03**	**-4.01**	**<0.01**	-0.02	0.04	-0.64	0.52
An. mean temp.	0.01	0.03	0.44	0.66	0.01	0.04	0.22	0.83
MKG-Polar	0.25	0.19	1.32	0.19	0.09	0.21	0.41	0.68
MKG-Temperate	0.05	0.07	0.72	0.47	-0.04	0.08	-0.48	0.63
MKG- Tropical	0.13	0.09	1.46	0.14	-0.04	0.11	-0.41	0.68
Relative Asymmetry								
Intercept	-0.24	0.89	-0.27	0.79	-0.22	0.91	-0.24	0.81
An. prec.	-0.04	0.03	-1.29	0.2	0	0.04	0.13	0.89
An. mean temp.	0.03	0.03	0.82	0.41	0.02	0.04	0.44	0.66
MKG-Polar	0.23	0.19	1.24	0.22	0.11	0.22	0.5	0.62
MKG-Temperate	**0.13**	**0.07**	**2.01**	**0.04**	0.01	0.09	0.09	0.93
MKG-Tropical	0.05	0.09	0.59	0.55	0.05	0.11	0.44	0.66

Table 2. Parameter estimates, standard errors (SE), and tests for Phylogenetic Generalized Linear Mixed Models (PGLMMs) with weather of egg-laying month as predictors, relative egg elongation and relative egg asymmetry as response variables, and species as a random variable. Bold lines show significant effects.

	Open nest				Closed nest			
	Estimate	SE	Z	P	Estimate	SE	Z	P
Relative Elongation								
Intercept	-0.04	0.84	-0.05	0.96	0.13	0.92	0.14	0.89
Monthly Aridity index	**-0.09**	**0.02**	**-4.16**	**<0.01**	-0.04	0.03	-1.65	0.1
Monthly mean temperature	-0.01	0.02	-0.32	0.75	0.003	0.03	0.11	0.92
Relative Asymmetry								
Intercept	-0.15	0.89	-0.17	0.86	-0.17	0.9	-0.19	0.85
Monthly Aridity index	-0.02	0.02	-0.92	0.36	-0.01	0.03	-0.46	0.64
Monthly mean temperature	-0.02	0.02	-0.77	0.44	0.02	0.03	0.82	0.41

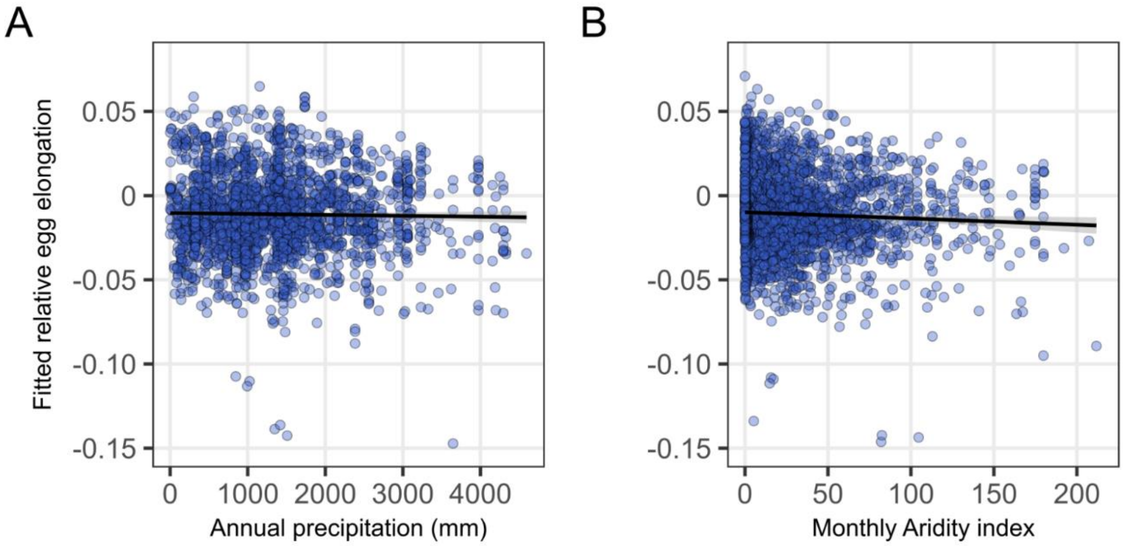

Fig. 3 Phylogenetically controlled linear regression depicting the humidity effects in relative egg elongation of Neotropical passerine species with open nests. A–Effect of annual precipitation. B– Effect of aridity index in egg-laying months (higher values indicate humid conditions). Grey shaded area represents the 95% confidence interval.

As climate only affected the egg shape of open-nesting species, we evaluated climate effects for 14 passerine families with open nests. Climatic conditions affected egg shape in 64% of the families. Egg elongation mainly decreased as humidity and cold increased (Fig. 4). Egg asymmetry decreased in humid areas in Pipridae and showed positive and negative temperature effects among families (Fig. 5).

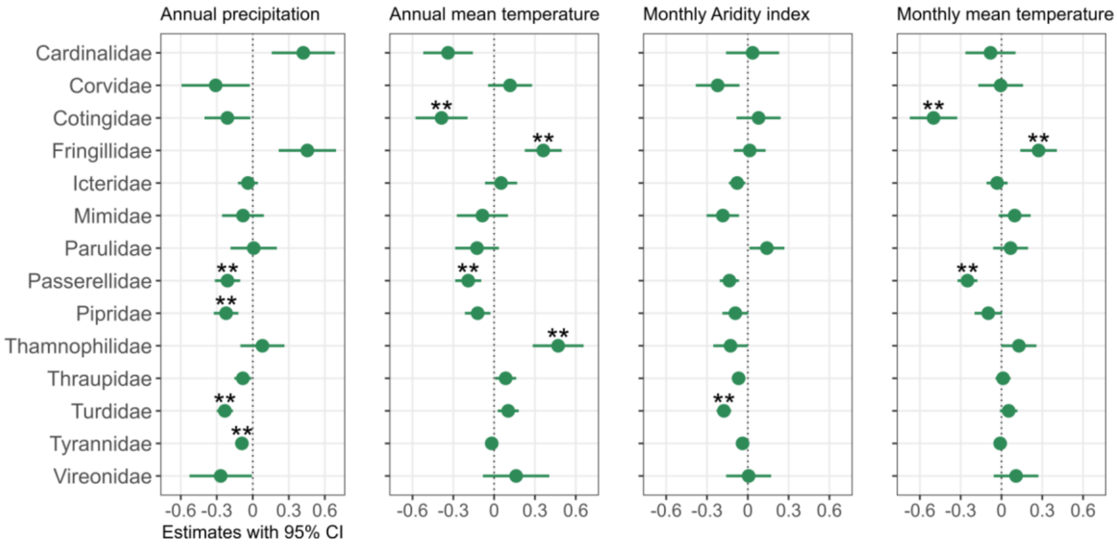

Fig. 4 Estimates with a 95% confidence interval for Phylogenetic Generalized Linear Mixed Models (PGLMMs) of long-term climate (annual precipitation and annual mean temperature) and weather of egg-laying month (monthly aridity index and monthly mean temperature) with relative egg elongation as the response variable for Neotropical passerine families with open-nesting species. Estimates were z-transformed. Asterisks indicate significant estimates.

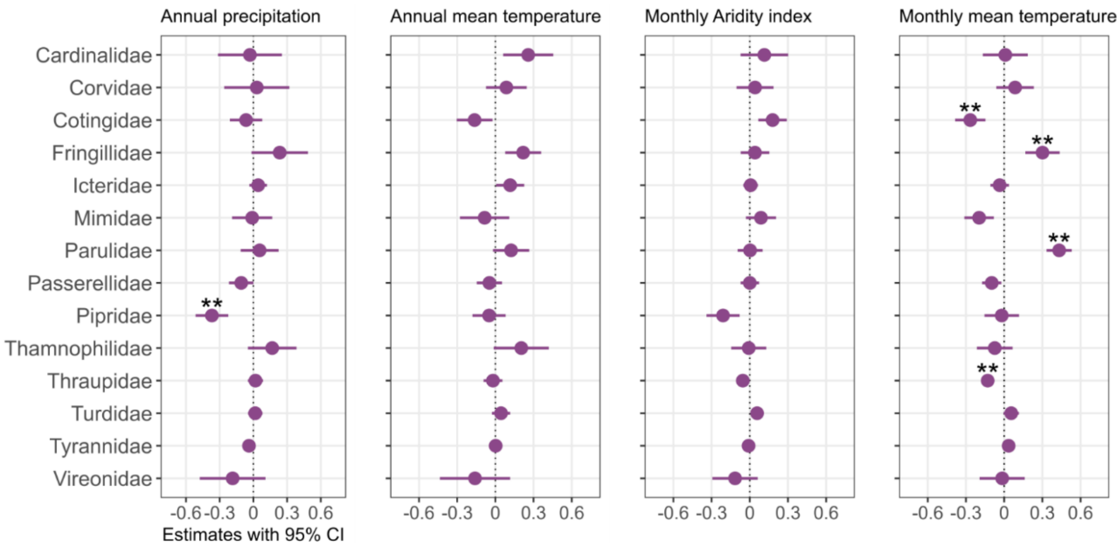

Fig. 5 Estimates with a 95% confidence interval for Phylogenetic Generalized Linear Mixed Models (PGLMMs) of long-term climate (annual precipitation and annual mean temperature) and weather of egg-laying month (monthly aridity index and monthly mean temperature) with relative asymmetry as the response variable for Neotropical passerine families with open-nesting species. Estimates were z-transformed. Asterisks indicate significant estimates.

4. Discussion

We evaluated how long-term and short-term (weather of the egg-laying month) climates affect the egg shape of Neotropical passerines. Our predictions were supported by the data, except for temperature effects. We showed that (i) SA:V decreased in more elongated and asymmetric eggs, (ii) closely related passerine species have more similar egg shapes due to shared ancestry, and (iii) climate conditions affected the egg shape of open-nesting species. Egg shape showed a consistent pattern in relation to precipitation, in which eggs tend to be more elongated and more asymmetric (only Pipridae) in drier conditions. However, the egg shape did not show a clear average temperature pattern, as family-level models revealed negative and positive temperature effects, resulting in no general temperature effect.

Passerine species with more elongated and asymmetric eggs tend to have smaller SA:V. If one compares eggs with the same volume, elongated eggs have higher SA:V than spherical eggs (Paganelli et al. 1974). However, increased egg elongation and asymmetry are usually related to increased egg size. This correlation between egg shape and egg size occurs because the pelvis width of female birds constrains egg development (Smart 1991; Deeming 2022). Indeed, double-yolked eggs usually have similar widths but are more elongated (Preston 1969; Deeming 2011a) and asymmetric (pointed) (Birkhead et al. 2017a) than single-yolked eggs. Thus, the decrease in SA:V in more elongated and asymmetric eggs reflected their larger size against more rounder and symmetric eggs.

Phylogenetic relatedness helped explain egg-shape similarity among closely related passerines. Previous studies have demonstrated high egg shape conservation in avian orders related to similar pelvis morphology, habitat, and breeding traits (Andersson 1978; Shatkovska et al. 2018; Montgomerie et al. 2021). We showed that egg shape is also conservative among and within passerine families. Therefore, studies addressing egg shape at higher and lower taxonomic scales should always account for phylogenetic relatedness.

More elongated eggs in open nests had a smaller SA:V and were prevalent in drier climatic conditions. Eggs from open nests are under higher environmental exposure than those from closed nests, and when in drier and hotter climates, they may have reduced egg hatchability through embryo dehydration (Walsberg and Schmidt 1992; Perez et al. 2020). Therefore, large and elongated eggs with lower SA:V may be more advantageous in arid and hot climates as they can decrease water vapor diffusion and heat conduction. Moreover, large and elongated eggs can have more water content in the albumen (Astheimer and Grau 1985), providing water supply in water-limited environments. However, contrary to our results, egg elongation decreased in hot and arid climates in passerines from Australia (Duursma et al. 2018). As most passerines from Australia belong to different families from those in the Neotropical region, phylogenetic characteristics may help explain such differences in passerine egg shape in different climates. Besides egg shape, several traits related to embryonic gas exchange, such as eggshell thickness (Peterson et al. 2020), coloration (Gómez et al. 2018), and parental behavior (Portugal et al. 2014), can optimize embryo development. Thus, further studies should explore if the interplay among morphological, physiological, and behavioral traits related to embryo development is responsible for egg-shape variation among related taxa in distinct geographical regions.

Temperature effects on egg shape showed opposite effects at family-level models. We expected that egg elongation and asymmetry associated with lower SA:V would increase in hotter climates, but Passerellidae, Cotingidae, and Thraupidae increased in colder climates. Sparrows presented lower SA:V in more elongated eggs, cotingas had no effect, and tanagers had lower SA:V in more elongated and asymmetric eggs. Sparrows and tanagers live in several habitat types, such as grasslands, deserts, and forests, and consume a wide variety of food types, including invertebrates, fruits, and seeds (Winkler et al. 2020a, b). On the other hand, cotingas are primarily herbivores (fruits and leaves) and live mostly in humid tropical forests (Winkler et al. 2020c). As egg shape had no effect in SA:V in cotinga eggs, increased egg elongation and asymmetry in colder climates could be related to other limiting factors. Birds require high consumption of calcium-rich food items during pre-laying periods to allow optimal eggshell formation (Reynolds 2001; McClelland et al. 2021). Calcium-poor diets, such as herbivores, may face more limitations in acquiring calcium-rich food items in hotter temperatures. Besides, many cotingas have clutch sizes of just one egg (Belmonte-Lopes et al. 2011; Winkler et al. 2020c), so more egg investment through egg size is expected. As increased egg sizes are constrained by oviduct width (Deeming 2018; Montgomerie et al. 2021), large eggs are commonly more elongated and asymmetric. Thus, distinct patterns in egg-shape responses to climate conditions among passerine families may be related to contrasting ecological and life-history traits.

In conclusion, our results showed that egg-shape variation in Neotropical passerines is associated with climate conditions both at spatial (large-scale climate) and temporal (weather during egg-laying months) scales. Egg shape is affected by an interplay between the level of environmental exposure of nests and SA:V. More elongated and asymmetric eggs with lower SA:V from open-nesting species are prevalent in drier climates, probably to prevent embryo dehydration.

CAPÍTULO 3

Within-clutch variation of egg shape in Neotropical passerines is affected by climate, clutch size and diet

Abstract

Egg shape exhibits wide variation among bird species due to phylogenetic-related morphological constraints and ecological and life-history traits. However, factors related to within-clutch variation are poorly understood. Here, we tested the influence of long-term and short-term precipitation and temperature anomalies, diet (carnivore, herbivore, and omnivore), egg volume, clutch size, and nest type (open and closed) on within-clutch egg shape variation in Neotropical passerines. Within-clutch variation was measured by the coefficient of variation (%) of two egg shape indexes, elongation (length divided by width) and asymmetry (pointedness). We gathered 3,822 egg sets (10,720 eggs) of 420 passerine species. We found higher within-clutch variation in egg asymmetry (CV = 31.63%) than in egg elongation (CV = 2.18%). Using phylogenetic-controlled models, we found that within-clutch variation of egg elongation increased in larger clutch sizes, egg volumes, and omnivore diets. Within-clutch variation of egg asymmetry increased with long-term precipitation anomalies on the year's driest month before egg-laying, larger clutch sizes, and herbivore diets. Our results suggest that besides variation among species, within-clutch egg shape variation can also respond to climate and life-history characteristics.

Keywords: breeding, climatic anomalies, coefficient of variation, egg shape, egg collections, Passeriformes.

1. Introduction

Egg shape exhibits wide variation among bird species. Large-scale differences occur mainly among orders due to phylogeny constraints and general morphological and ecological traits, such as flight efficiency (Stoddard et al. 2017), pelvic morphology and habitat type (Shatkovska et al. 2018), embryonic development mode (Mytiai et al. 2017), and breeding traits (Andersson 1978; Birkhead et al. 2019). Small-scale egg shape variations also occur in lower taxonomic levels. For example, egg shape correlates with nest type and climatic conditions in passerines (Passeriformes) (Duursma et al. 2018). Intraspecific egg shape variation reflects parental condition, such as age and body mass (Coulson 1963; Hõrak et al. 1995), clutch size (Johnson et al. 2001), breeding season (Adamou et al. 2018), and distinct populations (Bańbura et al. 2018). Egg shape within clutches would represent the lower portion of variation but is poorly investigated (but see Schmitz Ornés et al. 2023).

Breeding investment is widely limited by food availability (Martin 1987). Egg formation demands resource allocation to produce three main components: yolk, albumen, and shell. The yolk provides the energetic supply for embryonic development with 20 to 40% lipid content, whereas the albumen represents the water reserve with 85 to 90% water content (Ricklefs 1977). Eggshell production demands high calcium intake from feeding in periods close to egg-laying, increasing the energy cost of searching for high-level calcium food items, especially in species with calcium-poor diets (Reynolds and Perrins 2010). Resource acquisition for egg production can come from energy reserves stored long before the breeding season (capital breeders) or food consumed close to egg-laying (income breeders) (Drent and Daan 1980; Jönsson 1997).

Environmental stringent conditions may impact the clutch's energetic investment. Precipitation and temperature conditions influence food availability, such as insects and fruits (Houston 2013; Winkler et al. 2013; Arbeiter et al. 2016). A relatively constant food supply during mild climatic conditions ensures more energy input for adults to invest in egg production (Martin 1987). However, stringent conditions, such as heat waves, droughts, and high precipitation, may reflect in adults with poor body conditions or immunosuppressed due to decreased food availability and search efficiency (Machado-Filho et al. 2010; Renner and Zohner 2018; Marcelino et al. 2020). Consequently, limited resource acquisition can prevent optimal egg investment (i.e., large eggs), resulting in increased within-clutch variation in egg size (Martin 1987). Indeed, colder and wetter breeding seasons were correlated with decreased insect activity and female body mass in passerines, which laid smaller eggs in the laying sequence and increased within-clutch variation in egg size (Järvinen and Ylimaunu 1986; Golawski and Mitrus 2018).

Passerines are income breeders, gathering their energetic supply to produce eggs on a daily basis close to laying (Perrins 1996). Therefore, one would expect that only short-term extreme weather conditions during the breeding season impact their food acquisition. However, the carry-over effects of extreme weather during winter periods can also impact young survival and breeding investment through poor parental body condition (Guillemain et al. 2008; Duriez et al. 2012). Thus, both short- and long-term climatic conditions can affect egg production.

Egg shape can be associated with differential investment in egg yolk and albumen. Egg production begins with lipoprotein deposition in ovarian follicles to form the yolk, which moves through the oviduct where the albumen is secreted around it (Nager 2006). Yolk is inversely proportional to albumen (Sotherland and Rahn 1987). Increased yolk volume in the egg's central position forces albumen deposition in its extremities due to oviduct width constraint, which results in more elongated and asymmetric eggs (Cucco et al. 2012; Deeming 2018). Larger eggs are associated with increased lipid-rich yolk in precocial species and increased protein- and water-rich albumen in altricial species (Williams 1994). Because passerines exhibit altricial development, within-clutch variation in egg shape may result from differential albumen investment.

Egg shape variation within clutches may also be affected by life-history traits. Breeding investment occurs through clutch size and egg volume. Depending on clutch size, females may allocate energetic reserves differently among eggs within clutches (Stearns 1989; Roff 1992). A larger clutch size may constrain optimal egg investment if food is limited (Martin 1987). As egg shape may be related to differences in egg composition investment (Deeming 2018), increased clutch size may also be associated with increased variation in within-clutch egg shape.

Here, we aim to evaluate the effects of stringent conditions (calculated as climate anomalies) and life-history traits in within-clutch egg-shape variation in Neotropical passerines. We predict that within-clutch egg-shape variation would increase in (i) stringent conditions of precipitation and temperature in long- and short-term windows from the egg-laying as limitations in egg investment may be constrained by the positioning of yolk and albumen contents, (ii) calcium-poor diets due to increased limitation of calcium supply, and (iii) egg size and (iv) clutch size due to limitation in egg composition investment.

2. Methods

(a) Egg shape database

We gathered reproductive data of Neotropical passerines from egg sets deposited in 33 museum egg collections in South and Central America, the USA, and Europe (Supplementary Material, Table S5) visited between 2014 and 2023. We also checked oological collections available online from the Field Museum of Natural History (FMNH, Chicago, USA) at https://collections-zoology.fieldmuseum.org/ and the Museum of Vertebrate Zoology (MVZ, California, USA) at http://arctos.database.museum/mvz_egg/ for digital photographs of egg sets with black background contrast and ruler scale. We used a standardized procedure of camera distance and angle, black background contrast, lighting, and ruler position to photograph egg sets. We collected information on date, location, clutch size (number of eggs in the clutch), and taxonomic classification from labels of egg sets. To standardize and update taxonomy, we checked for synonyms starting from the oldest species name provided in museum labels and followed the chronological order of museum catalogs published from 1877 to 1979 (Supplementary Material, Table S2). Lastly, we updated the species' taxonomic names according to Jetz et al. (2012).

We filtered available egg sets to exclude potential biases. First, we confirmed clutch size by checking the clutch size range for each species according to Billerman et al. (2020). Then, we used only egg sets with reliable clutch size, i.e., clutches not altered by incomplete clutch collecting (with only one egg), too large for the species, or altered by collectors (Green and Scharlemann 2003). Lastly, we excluded clutches parasitized by *Molothrus* spp. or *Tapera naevia*, as the host eggs may be ejected from the nest (Soler 2018).

We measured all eggs from all egg sets gathered for each species. The digital photographs of egg sets with a ruler scale were measured in ImageJ software (Rasband 1997) through the Egg Tools plugin (Troscianko 2014). Egg measurements included length (mm), maximal width (mm), surface area (mm^2), volume (mm^3), and ellipse deviation (dimensionless) of eggs. We obtained two egg-shape indexes, elongation (length divided by maximal width) and asymmetry (pointedness), through the ellipse deviation. Asymmetry values indicated a deviation from a symmetric elliptical egg, with high values indicating more pointed eggs (Troscianko 2014). Lastly, we calculated the within-clutch variation of elongation and asymmetry for each clutch by the coefficient of variation (CV = standard deviation / mean x 100).

(b) Climate data

Here, we consider the Neotropical region from the USA border with Mexico and the West Indies to Argentina and the Falkland Islands (Stotz 1996). Our dataset consists of longitudinal data, with multiple clutches (egg sets) for each species evaluated, displaying temporal (1901–2019) and spatial (latitude: -54° to 32°, longitude: -118° to -34°) variation. We obtained the climate for each clutch based on the coordinates (latitude and longitude) provided by museum labels. If coordinates were unavailable, we obtained the municipality/county centroid coordinates with a maximum error of ± 25 km through the geocode function in the R package "ggmap" (Kahle and Wickham 2013).

We obtained long-term and short-term climate anomalies. Climate anomalies are variations in climate conditions during a particular period in relation to a baseline climate (i.e., an average from several decades) from the same particular period (American Meteorological Society 2000). For the long-term approach, we gathered the climate of the year before the egg-laying month of each clutch, including precipitation of the driest month, precipitation of the wettest month, minimum temperature of the coldest month, and maximum temperature of the warmest month. For the short-term approach, we obtained precipitation and minimum and maximum temperatures from the month before the egg-laying month of each clutch. We calculated climatic anomalies as the difference between the weather data (long-term and short-term) and the historical climate data for each egg set. We gathered the weather data from the Climatic Research Unit gridded Time Series (CRU TS), available on the Centre for Environmental Data Analyses (CEDA) at https://archive.ceda.ac.uk/. The CRU TS dataset represents worldwide land-based monthly variation in weather from 1901 to 2022 at 0.5° resolution (Harris et al. 2020). We extracted the weather of egg sets through the R package "ncdf4" (Pierce 2019). The historical climate data were the climatic average between 1970 and 2000 at a 2.5-minute resolution obtained from the WorldClim Bioclimatic database

(Fick and Hijmans 2017), available at https://www.worldclim.org/. We extracted historical climate data of egg sets through the R package “raster” (Hijmans 2023). We extracted all climate data with R (R Core Team 2024).

For islands with unavailable climate data, we used nearby islands with similar latitudes and MKG as a proxy for their climates. For the Galapagos islands, we inferred the climate of Isla Floreana, Isla de San Cristóbal, Isla Seymour Norte, and Isla Pinta based on Isla Santa Cruz. For Mexican islands, we used the climate of Isla Tiburón for Isla San Pedro Martin and the climate of Isla de Cedros for Isla Natividad and Islas de San Benito. We inferred the climate of Isla de Patos in Venezuela from Isla Cachachare in Trinidad and Tobago.

(c) Data analyses

We used Phylogenetic Generalized Linear Mixed Models (PGLMMs) to account for the dependence between species due to shared ancestry (Ives and Helmus 2011). We ran separate PGLMMs for within-clutch variation in egg elongation and egg asymmetry as response variables, with species as a random effect to address several records from the same species through the R package “phyr” (Li et al. 2020). We computed the phylogenetic consensus tree from 1,000 random trees containing the species of interest gathered at https://birdtree.org/ (Ericson et al. 2006; Jetz et al. 2012). We calculated the phylogenetic signal of Pagel’s lambda (λ) between bird phylogeny and the egg’s traits within-clutch variation of elongation and asymmetry. Pagel’s lambda varies from 0 to 1; if $\lambda = 0$, traits had no phylogenetic signal and $\lambda = 1$, traits evolved under the Brownian motion model with closely related species sharing higher trait similarity (Pagel 1999). The phylogenetic tree and the phylogenetic signal were obtained in the R packages “ape” (Paradis and Schliep 2019) and “phytools” (Revell 2024), respectively.

We transformed all continuous variables before modelling to improve normality using the R package “bestNormalize” (Peterson and Cavanaugh 2020; Peterson 2021), which chooses the best transformation to normalize numeric variables. Accordingly, we used the box-cox transformation for within-clutch variation in egg elongation and asymmetry (Sakia 1992) and the ordered quantile normalization for egg volume and climate variables (Peterson and Cavanaugh 2020). We evaluated multicollinearity in numerical predictors through Pearson correlation (threshold $r < 0.7$) and in numerical and categorical predictors through variance inflation factor (VIF < 3) (Zuur et al. 2010). We calculated VIF in the R package "*car*" (Fox and Weisberg 2019).

We ran separate models for long-term and short-term anomalies as long-term minimum and maximum temperatures were highly correlated ($r > 0.8$) with short-term minimum and maximum temperatures. Long-term predictors for multiple regression models included precipitation of the driest month, precipitation of the wettest month, minimum temperature of the coldest month, and maximum temperature of the warmest month from the year before egg-laying months. Short-term predictors for multiple regression models were precipitation and minimum and maximum temperatures from the month before egg-laying months. We included in all models the covariates egg volume (average volume in each clutch), clutch size (number of eggs in each clutch), diet (carnivore, herbivore, and omnivore), and nest type (open and closed). Egg volume was included as a fixed variable to control the effect of egg size on egg shape. Diet classification was modified from Tobias et al. (2022). We classified invertivores, aquatic predators, and vertivores as carnivores; frugivores, granivores, herbivore terrestrials, and nectarivores as herbivores; omnivores remain omnivores. Because we had reproductive records from the mainland and islands, we also included the covariate island (as a dummy variable, yes or no) to account for possible island effects (Covas 2011). We classified nests as open when eggs had no roof protection and closed when eggs were concealed in domed structures or cavities (Billerman et al. 2020). We confirmed the normality and homogeneity of model residuals using graphical inspections and spatial autocorrelation with Moran's I test through the R package "moranfast" (Cooper 2020), respectively.

3. Results

We gathered 3,822 egg sets (10,720 eggs) of 420 passerine species from 30 families in the Neotropical region (Supplementary Material, Table S6). Phylogenetic signals were low for within-clutch variation in egg elongation ($\lambda = 0.09$, LR = 14.81, $p < 0.001$) and asymmetry ($\lambda = 0.16$, LR = 11.69, $p < 0.001$). However, they significantly differed from zero, indicating that closely related species have more similar within-clutch egg shape variation than expected by chance. There was no spatial autocorrelation in elongation (Moran's I test; long-term: p =

0.60, short-term: $p = 0.59$) and asymmetry (Moran's I test; long-term: $p = 0.61$, short-term = 0.72) model residuals.

The species analyzed showed higher within-clutch variation in egg asymmetry (CV = 31.63%) than in egg elongation (CV = 2.18%) (Fig. 1). Among families, Grallariidae had the highest within-clutch variation in egg asymmetry (CV = 55.12%) and Laniidae had the lowest (CV = 25.81%). Cotingidae had the highest within-clutch variation in egg elongation (CV = 2.81%) and Donacobiidae had the lowest (CV = 1.32%).

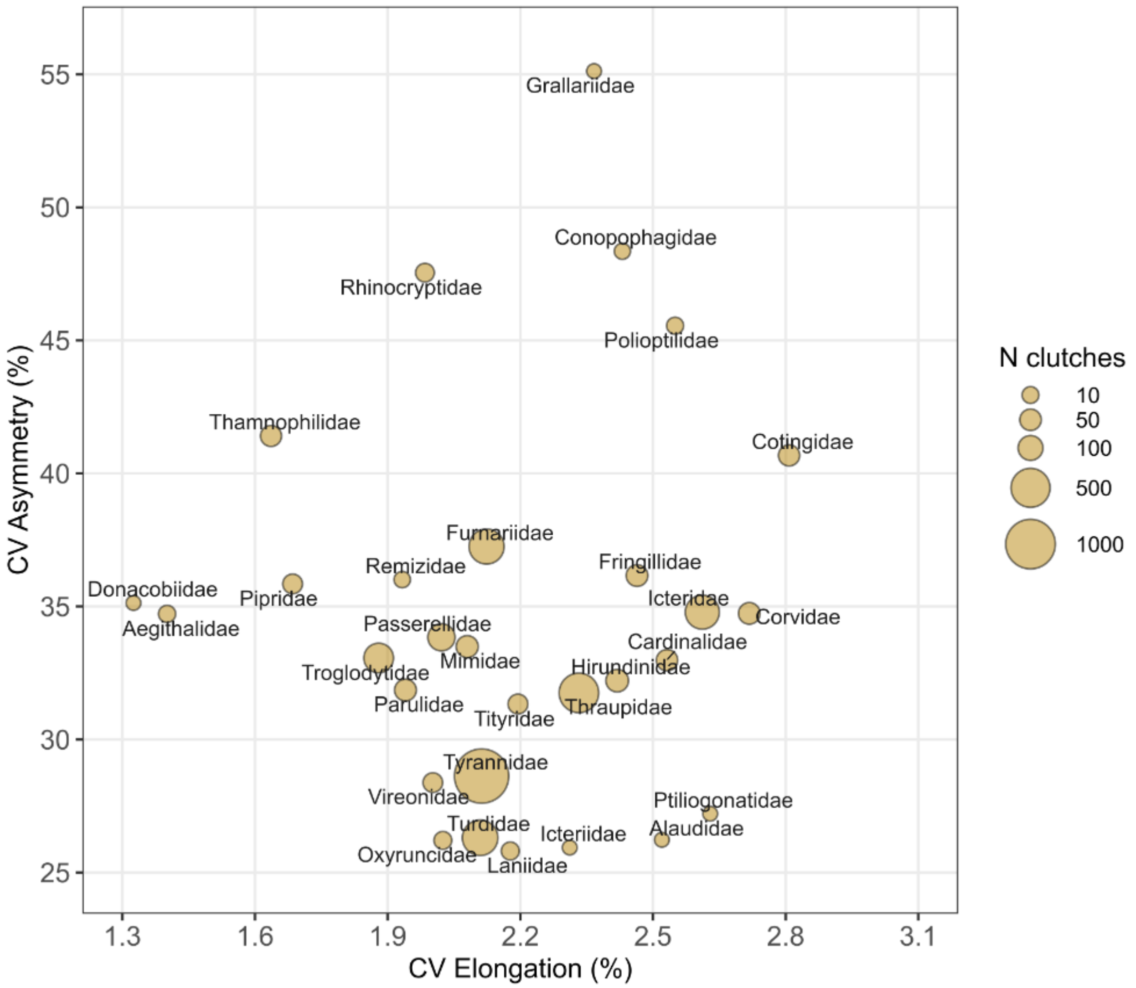

Fig. 1 Within-clutch variation of egg elongation and asymmetry measured by the coefficient of variation (%) in Neotropical passerine families evaluated. Point size represents the number of clutches measured.

PGLMM models showed that within-clutch variation of egg elongation increased in larger clutch sizes, egg volumes, herbivore (marginal effect) and omnivore diets (Table 1 and 2, Fig. 2).

Table 1. Parameter estimates (z-transformed), standard errors (SE), and tests for Phylogenetic Generalized Linear Mixed Models (PGLMMs) with long-term (one year before the egg-laying month) climate anomalies (Prec. dri. m. - precipitation of the driest month, Prec. wet. m. - precipitation of the wettest month, Min. temp. col. m. - minimum temperature of the coldest month, and Max. temp. war. m. - maximum temperature of the warmest month), egg volume, diet (carnivore, herbivore, and omnivore), clutch size, and nest type (closed and open) as predictors. Within-clutch variation (coefficient of variation) of egg elongation and egg asymmetry are response variables, and species are the random variable. Bold lines show significant effects

	Elongation				Asymmetry			
	Estimate	SE	Z	P	Estimate	SE	Z	P
Intercept	-0.44	0.09	-4.88	<0.01	-0.56	0.14	-3.94	<0.01
Prec. dri. m.	-0.01	0.02	-0.61	0.54	**-0.04**	**0.02**	**-2.65**	**<0.01**
Prec. wet. m.	-0.01	0.02	-0.34	0.74	-0.01	0.02	-0.39	0.70
Min. temp. col. m.	-0.01	0.02	-0.79	0.43	0.03	0.02	1.68	0.09
Max. temp. war. m.	0.01	0.02	0.27	0.78	-0.04	0.02	-1.86	0.06
Egg volume	**0.09**	**0.02**	**4.75**	**<0.01**	0.02	0.02	0.73	0.47
Diet - herbivore	0.11	0.06	1.84	0.07	**0.15**	**0.07**	**2.01**	**0.04**
Diet - omnivore	**0.14**	**0.05**	**2.78**	**0.01**	0.04	0.06	0.68	0.50
Clutch size	**0.14**	**0.02**	**7.32**	**<0.01**	**0.17**	**0.02**	**8.63**	**<0.01**
Nest type - open	-0.03	0.04	-0.85	0.39	0.08	0.05	1.55	0.12

Table 2. Parameter estimates (z-transformed), standard errors (SE), and tests for Phylogenetic Generalized Linear Mixed Models (PGLMMs) with short-term (one month before the egg-laying month) climate anomalies, egg volume, diet (carnivore, herbivore, and omnivore), clutch size, and nest type (closed and open) as predictors. Within-clutch variation (coefficient of variation) of egg elongation and egg asymmetry are response variables, and species are the random variable. Bold lines show significant effects

	Elongation				Asymmetry			
	Estimate	SE	Z	P	Estimate	SE	Z	P
Intercept	-0.43	0.10	-4.49	<0.01	-0.57	0.15	-3.88	<0.01
Precipitation	-0.01	0.02	-0.88	0.38	-0.01	0.02	-0.39	0.69
Min. temperature	-0.03	0.02	-1.34	0.18	0.02	0.02	1.04	0.30
Max. temperature	0.02	0.02	1.05	0.29	-0.01	0.02	-0.57	0.57
Egg volume	**0.10**	**0.02**	**4.99**	**<0.01**	0.01	0.02	0.58	0.56
Diet - herbivore	0.11	0.06	1.82	0.07	**0.15**	**0.07**	**2.05**	**0.04**
Diet - omnivore	**0.14**	**0.05**	**2.72**	**<0.01**	0.05	0.06	0.80	0.43
Clutch size	**0.13**	**0.02**	**7.10**	**<0.01**	**0.17**	**0.02**	**8.61**	**<0.01**
Nest type - open	-0.03	0.04	-0.75	0.45	0.08	0.05	1.65	0.10

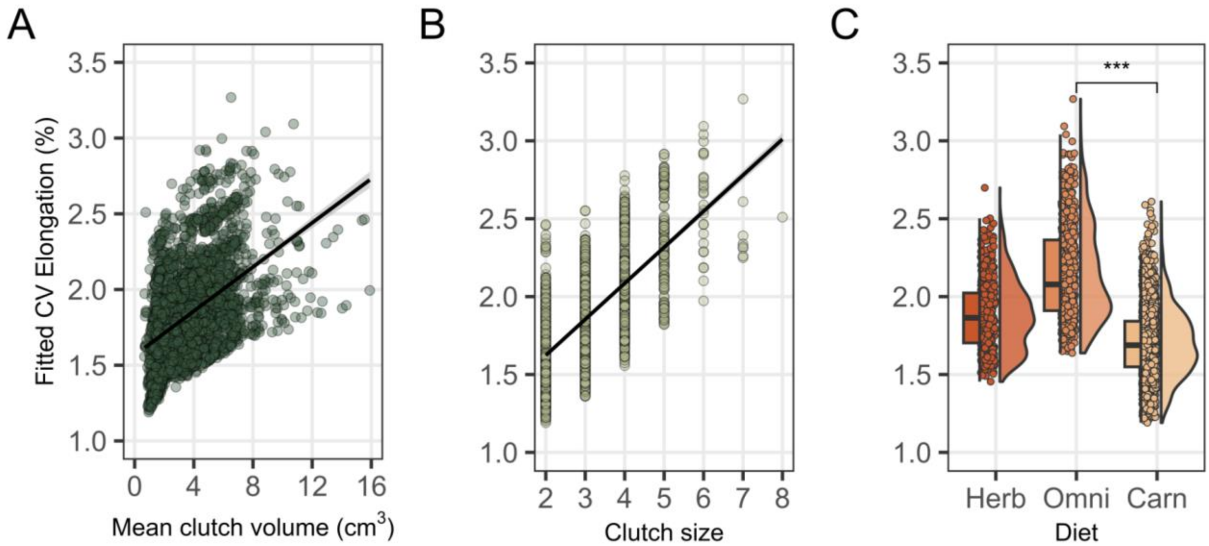

Fig. 2 Phylogenetically controlled linear regressions showing effects on the within-clutch variation of egg elongation measured by the coefficient of variation in Neotropical passerine species. A– Effect of mean clutch volume. B– Effect of clutch size. C– Effect of diet (Carn = carnivore, Herb = herbivore, Omni = omnivore). Grey shaded area represents the 95% confidence interval, and asterisks represent significant contrasts

PGLMM models showed within-clutch variation of egg asymmetry increased with long-term negative anomalies of precipitation of the driest month and maximum temperature of the warmest month (marginal effect), larger clutch sizes, and herbivore diets (Table 1 and 2, Fig. 3).

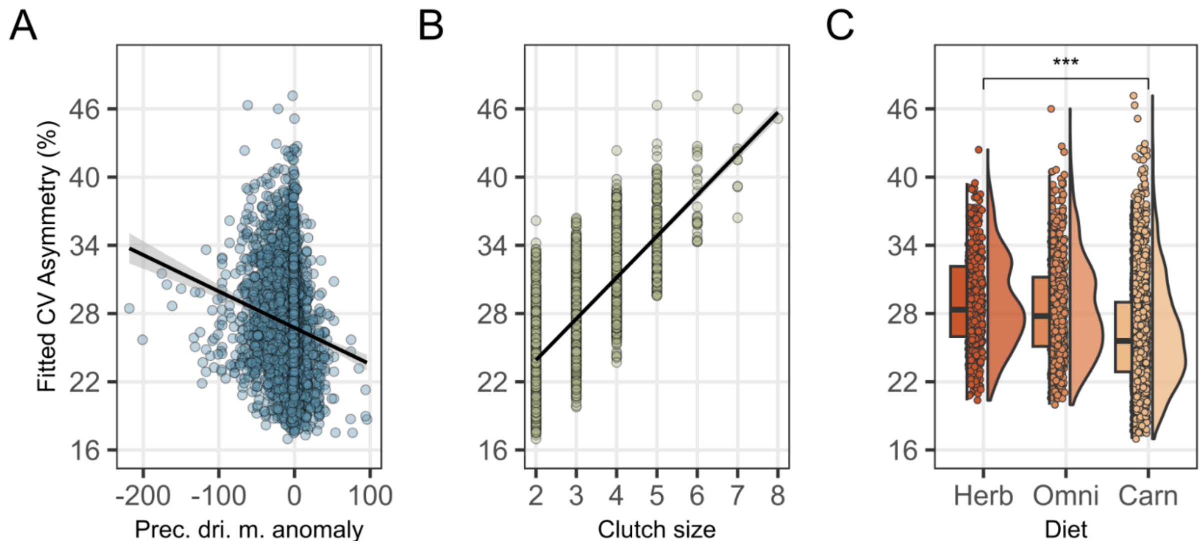

Fig. 3 Phylogenetically controlled linear regressions showing effects on the within-clutch variation of egg asymmetry measured by the coefficient of variation in Neotropical passerine species. A– Effect of precipitation of the driest month anomaly one year before egg-laying months. B– Effect of clutch size. C– Effect of diet (Carn = carnivore, Herb = herbivore, Omni = omnivore). Grey shaded area represents the 95% confidence interval, and asterisks represent significant contrasts

4. Discussion

Here, we explored a little-known component of egg morphology, the within-clutch egg shape variation, and its correlation with long- and short-term climatic anomalies and life-history traits. We showed that within-clutch variation in passerine egg shape is related to precipitation anomalies, diet type, clutch size, and egg volume. Clutch size and diet affected both egg elongation and asymmetry. In contrast, egg volume only affected egg elongation, and long-term anomalies in precipitation during the driest month only affected egg asymmetry.

Therefore, our results suggest that besides variation among species, within-clutch egg shape variation can also respond to climate and life-history variation.

Previous studies reported within-clutch egg shape variation but showed contrasting effects of environmental conditions and life-history traits. Egg shape within-clutch repeatability (opposite of variation used here) was correlated with incubation period, coloniality, and ontogeny in bird species (Schmitz Ornés et al. 2023). Despite not evaluating climate variables, those authors included clutch size, nest type, and bird size (which positively correlated with egg volume) in model analysis but did not find significant effects. Their database included a broad taxonomic range, including species from several bird orders displaying consistent variation in incubation length, coloniality, and ontogeny levels. On the other hand, we focused on passerine species, which show lower variation in such traits, with all species having altricial ontogeny and shorter incubation periods (Ricklefs et al. 2017).

Our data showed that within-clutch variation in egg elongation and asymmetry increased with clutch size. Increased clutch size may constrain optimal investment between eggs in a clutch (Martin 1987). Within-clutch variations in egg size and shape are directly proportional to changes in egg composition, which in altricial passerines are related to differential investment in protein- and water-rich albumen (Williams 1994). Therefore, higher within-clutch variation in egg shape may indicate a limitation in resource acquisition for producing equally albumen-rich eggs during egg-laying periods. However, no relationship was found between clutch size and the within-clutch coefficient of variation of egg elongation in *Corvus monedula* (Corvidae) (Tryjanowski et al. 2001). Thus, this general clutch size effect on within-clutch egg-shape variation may not occur in some passerines species.

Egg shape variation may reflect differences in the egg's calcium allocation. We found a higher within-clutch variation of egg elongation in omnivores and egg asymmetry in herbivores compared to carnivores. Passerines do not store calcium before breeding, so they depend on calcium intake near egg laying (Graveland and van Gijzen 1994). Calcium-rich food is generally more prevalent in animal than plant-based diets (Graveland and van Gijzen 1994; Reynolds and Perrins 2010), so one can assume that calcium limitation follows herbivores > omnivores > carnivores. However, calcium intake from omnivores may vary according to the proportions of animal and vegetal items ingested, and birds tend to increase calcium-rich feeding during pre-laying periods (Reynolds and Perrins 2010). An increase in egg elongation and asymmetry may be associated with a decreased surface-to-volume ratio in passerine species (Silva and Marini unpublished data), resulting in lower calcium allocation to eggshell formation. However, more asymmetric eggs may also require larger amounts of calcium than symmetric eggs, as the pointed end demands more eggshell materials to be formed (Andersson 1978; Deeming 2018). Therefore, our results indicate that higher within-clutch variation in egg elongation and asymmetry in species with lower-calcium diets may result from limited calcium supply, resulting in egg shapes requiring less eggshell material when less calcium-rich food is consumed before laying.

Drier months than average a year before egg-laying increased within-clutch variation in egg asymmetry. Precipitation is associated with food availability, with increased rainfall followed by increased insect and fruit abundance (Houston 2013; Winkler et al. 2013; Arbeiter et al. 2016). According to our data, drier months during the year before breeding seem to be associated with carry-over effects in egg investment, reflected by higher within-clutch variation in egg asymmetry. Larger eggs are commonly more elongated and asymmetric and contain relatively less lipid-rich yolk than protein- and water-rich albumen (Deeming 2018). Therefore, our results suggest that higher limitations in egg investment during stringent years may result in less albumen-rich eggs represented by less elongated and asymmetric eggs within clutches of altricial passerines. As climate change increases the frequency of extreme climate events (Ummenhofer and Meehl 2017), within-clutch variation in egg shape may also increase, especially in species with calcium-poor diets.

In conclusion, egg-shape variation within clutches of passerines in the Neotropical region correlates with climate conditions and diet. Decreased precipitation from a year before egg-laying may cause carry-over effects on breeding investment, reflecting differential investment in eggshell formation. Such limitation could be more pronounced in calcium-limited diets.

CONCLUSÃO GERAL

- Essa tese indica que o formato dos ovos em Passeriformes Neotropicais é fortemente determinado pela filogenia, mas também responde a variação climática e as características reprodutivas e ecológicas das espécies.

- Os índices de alongamento e assimetria dos ovos apresentaram sinal filogenético significativo em todos os modelos analisados, seja a nível espécie-específico ou comunitário, e seja pelo valor médio ou pelo coeficiente de variação por ninhada. Tais resultados confirmam o papel relevante da filogenia na variação do formato dos ovos mesmo dentro de uma mesma ordem taxonômica.

- Em relação ao clima, a precipitação destaca-se entre as variáveis climáticas avaliadas, com efeitos de longo a curto prazo sobre a média e sobre a variação do formato dos ovos dentro das ninhadas.

- O alongamento e a assimetria dos ovos correlacionaram-se de maneira diferente às características reprodutivas das espécies avaliadas. O alongamento relaciona-se ao crescimento limitado em largura dos ovos, na qual ovos de maior tamanho resultam em ovos com maior alongamento. A assimetria dos ovos foi influenciada pelo número de ovos da ninhada, indicando um possível papel para a otimização da incubação dos ovos. O papel microclimático dos ninhos foi confirmado pela influência da variação climática dos meses de postura apenas em ovos de espécies com ninhos abertos.

- O habitat onde a espécie se reproduz, a limitação de cálcio na dieta e se a espécie realiza movimentos migratórios são também fatores relevantes para explicar a variação do formato dos ovos em Passeriformes Neotropicais.

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Table S1. Abbreviations and locations of 36 museums where passerine's reproductive data were collected for Chapters 1 and 2.

Museum	Abbreviation	Location
American Museum of Natural History	AMNH	New York, USA
California Academy of Sciences	CAS	San Francisco, USA
Coleção Ornitológica Marcelo Bagno, Universidade de Brasília	COMB	Brasília, Brazil
Cris-River Regional Museum	CRRP	Oradea, Romania
Delaware Museum of Natural History	DMNH	Wilmington, USA
Fundación Miguel Lillo	FML	Tucumán, Argentina
Fundação Zoobotânica do Rio Grande do Sul	FZB	Porto Alegre, Brazil
Instituto de Investigaciones de Recursos Biológicos "Alexander von Humboldt"	IAvH	Vila de Leyva, Colombia
Coleção Zoológica da Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística	IBGE	Brasília, Brazil
Museo Argentino de Ciencias Naturales	MACN	Buenos Aires, Argentina
Museum of Comparative Zoology, Harvard University	MCZ	Cambridge, USA
Muséum d'Histoire Naturelle de Genève	MHNG	Geneva, Switzerland
Museo de La Plata	MLP	La Plata, Argentina
Zentralmagazin Naturwissenschaftlicher Sammlungen, Martin Luther University HalleWittenberg	MLUH	Halle (Saale), Germany
Museu Nacional	MN	Rio de Janeiro, Brazil
Museo Ñuble Naturaleza	MNN	Chillán, Chile
Museo Nacional de Costa Rica	MNCR	San José, Costa Rica
Muséum National d'Histoire Naturelle	MNHN	Paris, France
Museu Paraense Emilio Goeldi	MPEG	Belém, Brazil
Musée Zoologique de l'Université Louis Pasteur et de la ville de Strasbourg	MZS	Strasbourg, France
Museo Zoológico, Universidad de Concepción	MZUC	Concepción, Chile
Museu de Zoologia, Universidade de São Paulo	MZUSP	São Paulo, Brazil
Naturalis, Nationaal Natuurhistorisch Museum	NBCN	Leiden, The Netherlands
The Natural History Museum	NHM	Tring, UK
Landesmuseum Hannover	NLMH	Hannover, Germany
Naturhistorisches Museum Bern	NMBE	Bern, Switzerland
National Museums Scotland	NMS	Edinburgh, UK
Naturhistorisches Museum Wien	NMW	Vienna, Austria
Museu de Ciências e Tecnologia da PUCRS	PUCRS	Porto Alegre, Brazil
San Bernardino County Museum	SBCM	Redlands, USA
Staatliches Naturhistorisches Museum	SNMB	Braunschweig, Germany
Museo de Zoologia, Universidad de Costa Rica	UCR	San José, Costa Rica
Museu de Zoologia, Universidade Federal Rural do Rio de Janeiro	UFRRJ	Seropédica, Brazil
National Museum of Natural History	USNM	Washington, D.C., USA
Western Foundation of Vertebrate Zoology	WFVZ	Camarillo, USA
Museum für Naturkunde	ZMB	Berlin, Germany

Table S2. Museum catalogs used to review the taxonomic names of passerine's egg sets deposited in egg collections.

Catalogs of the British Museum of Natural History (BMNH) – (Sharpe 1877, 1881, 1883, 1885, 1888, 1890; Sclater 1886)
Catalogs of the Field Museum of Natural History (FMNH) – (Cory and Hellmayr 1924, 1925, 1927; Hellmayr 1929, 1934, 1935, 1936, 1937, 1938)
Catalogs of the Museum of Comparative Zoology (MCZ) – (Peters 1951; Mayr and Greenway Jr. 1960, 1962; Mayr and Paynter Jr. 1964; Paynter Jr. 1968, 1970; Traylor Jr. 1979)

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Cory, C. B. & Hellmayr, C. E. 1925. Catalogue of the birds of the Americas. Part IV. Furnariidae - Dendrocolaptidae. Zoological Series, Field Museum of Natural History, Vol. XIII, Part IV, Publication 234, Field Museum of Natural History, Chicago.

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Table S3. Species (Jetz et al. 2012), N (number of clutches used to calculate egg shape mean and standard deviation), M Clu (mean clutch size), Mo Clu (mode clutch size), M Vol (mean volume in cm^3), nest type, habitat, diet (Carn = carnivore, Omni = omnivore, Herb = Herbivore), migration (Migr = migratory, Part = partially migratory, Seden = sedentary), M Elon (mean elongation), SD Elo (standard deviation elongation), M Asym (mean asymmetry), and SD Asym (standard deviation asymmetry) of Neotropical passerines evaluated in Chapter 1.

Family	Species	N	M Clu	Mo Clu	M Vol	Nest	Habitat	Diet	Migra tion	M Elon	SD Elon	M Asym	SD Asym
Aegithalidae	*Psaltriparus minimus*	13	5.19	4	0.74	closed	Closed	Carn	Seden	1.34	0.051	0.00024	0.00014
Alaudidae	*Eremophila alpestris*	3	4.00	4	2.59	closed	Open	Omni	Migr	1.36	0.062	0.00031	0.00012
Cardinalidae	*Cardinalis cardinalis*	6	3.44	3	4.48	open	Open	Omni	Seden	1.34	0.098	0.00023	0.00012
Cardinalidae	*Cardinalis sinuatus*	3	3.73	4	3.44	open	Open	Omni	Seden	1.36	0.092	0.00016	0.00011
Cardinalidae	*Chlorothraupis carmioli*	5	2.11	2	4.31	open	Closed	Carn	Seden	1.46	0.054	0.00011	0.00007
Cardinalidae	*Cyanocompsa brissonii*	15	2.49	2	3.07	open	Closed	Herb	Seden	1.41	0.051	0.00025	0.00012
Cardinalidae	*Cyanocompsa cyanoides*	7	1.73	2	3.56	open	Closed	Herb	Seden	1.39	0.050	0.00023	0.00009
Cardinalidae	*Cyanocompsa parellina*	6	1.91	2	2.86	open	Closed	Herb	Seden	1.32	0.055	0.00021	0.00009
Cardinalidae	*Cyanoloxia glaucocaerulea*	3	2.20	3	2.49	open	Closed	Omni	Part	1.38	0.031	0.00025	0.00010
Cardinalidae	*Granatellus sallaei*	3	1.80	2	2.15	open	Closed	Carn	Seden	1.34	0.014	0.00045	0.00016
Cardinalidae	*Habia fuscicauda*	3	2.43	2	4.36	open	Closed	Carn	Seden	1.35	0.061	0.00024	0.00007
Cardinalidae	*Habia rubica*	7	3.29	5	4.08	open	Closed	Carn	Seden	1.37	0.070	0.00018	0.00008
Cardinalidae	*Passerina caerulea*	5	2.67	3	3.66	open	Closed	Carn	Migr	1.29	0.068	0.00017	0.00008
Cardinalidae	*Passerina rositae*	3	3.00	3	2.38	open	Closed	Herb	Seden	1.35	0.032	0.00029	0.00017
Cardinalidae	*Piranga bidentata*	3	2.71	3	3.54	open	Closed	Carn	Part	1.32	0.037	0.00026	0.00009
Cardinalidae	*Piranga flava*	16	2.76	3	3.68	open	Closed	Carn	Part	1.37	0.087	0.00027	0.00018
Cardinalidae	*Piranga rubra*	3	2.33	3	3.65	open	Closed	Carn	Migr	1.40	0.058	0.00037	0.00019
Cinclidae	*Cinclus mexicanus*	4	2.14	3	4.58	closed	Water-associated	Carn	Seden	1.44	0.071	0.00023	0.00011
Conopophagidae	*Conopophaga lineata*	8	2.07	2	3.38	open	Closed	Carn	Seden	1.30	0.051	0.00021	0.00011
Corvidae	*Aphelocoma californica*	4	3.85	5	5.96	open	Open	Omni	Seden	1.37	0.068	0.00025	0.00017
Corvidae	*Cyanocorax caeruleus*	6	2.17	2	10.23	open	Closed	Omni	Seden	1.42	0.061	0.00043	0.00017
Corvidae	*Cyanocorax chrysops*	13	3.15	3	8.78	open	Closed	Carn	Seden	1.35	0.070	0.00025	0.00017
Corvidae	*Cyanocorax cristatellus*	5	4.64	6	9.08	open	Closed	Omni	Seden	1.45	0.074	0.00034	0.00012
Corvidae	*Cyanocorax cyanomelas*	11	4.33	5	7.95	open	Closed	Omni	Seden	1.41	0.050	0.00052	0.00021
Corvidae	*Cyanocorax cyanopogon*	3	2.43	2	9.06	open	Closed	Omni	Seden	1.40	0.036	0.00032	0.00005
Corvidae	*Cyanocorax dickeyi*	4	3.45	3	9.84	open	Closed	Omni	Seden	1.43	0.048	0.00031	0.00020
Corvidae	*Cyanocorax melanocyaneus*	5	2.78	3	7.25	open	Closed	Carn	Seden	1.38	0.062	0.00029	0.00013
Corvidae	*Cyanocorax morio*	3	4.67	6	10.25	open	Closed	Omni	Seden	1.50	0.088	0.00047	0.00015
Corvidae	*Cyanocorax mystacalis*	4	2.00	1	8.10	open	Closed	Omni	Seden	1.42	0.053	0.00041	0.00024
Corvidae	*Cyanocorax yncas*	15	4.32	4	6.08	open	Closed	Omni	Seden	1.34	0.065	0.00023	0.00012
Corvidae	*Cyanocorax yucatanicus*	7	2.08	2	7.53	open	Closed	Omni	Seden	1.38	0.057	0.00038	0.00015

Cotingidae	*Carpornis cucullata*	7	1.70	2	9.74	open	Closed	Herb	Seden	1.39	0.059	0.00008	0.00008
Cotingidae	*Phibalura flavirostris*	7	2.50	3	4.32	open	Closed	Herb	Migr	1.37	0.064	0.00032	0.00016
Cotingidae	*Phytotoma rara*	14	3.21	3	4.38	open	Open	Herb	Seden	1.38	0.086	0.00025	0.00013
Cotingidae	*Phytotoma rutila*	51	3.16	3	3.43	open	Open	Herb	Seden	1.35	0.071	0.00026	0.00014
Cotingidae	*Pipreola riefferii*	4	1.86	2	5.41	open	Closed	Herb	Seden	1.31	0.065	0.00021	0.00013
Cotingidae	*Rupicola peruvianus*	7	1.67	2	26.64	open	Closed	Herb	Seden	1.44	0.099	0.00045	0.00021
Cotingidae	*Rupicola rupicola*	5	1.71	2	22.72	open	Closed	Herb	Seden	1.37	0.060	0.00038	0.00025
Donacobiidae	*Donacobius atricapilla*	4	2.33	2	3.56	open	Water-associated	Carn	Seden	1.38	0.067	0.00022	0.00008
Formicariidae	*Chamaeza campanisona*	5	1.75	2	7.35	closed	Closed	Carn	Seden	1.24	0.072	0.00008	0.00009
Fringillidae	*Carduelis barbata*	3	3.60	5	1.47	open	Closed	Herb	Seden	1.29	0.086	0.00031	0.00010
Fringillidae	*Carduelis magellanica*	4	2.82	3	1.48	open	Open	Herb	Seden	1.35	0.038	0.00029	0.00017
Fringillidae	*Carduelis psaltria*	5	3.40	4	1.17	open	Open	Herb	Seden	1.32	0.062	0.00036	0.00018
Fringillidae	*Carduelis spinescens*	3	3.00	3	1.66	open	Open	Herb	Seden	1.34	0.073	0.00037	0.00018
Fringillidae	*Carpodacus mexicanus*	56	3.89	4	2.01	open	Open	Herb	Part	1.36	0.064	0.00036	0.00018
Fringillidae	*Chlorophonia cyanea*	8	3.00	3	1.58	closed	Closed	Herb	Seden	1.37	0.071	0.00021	0.00009
Fringillidae	*Euphonia affinis*	3	3.89	5	1.49	closed	Closed	Herb	Seden	1.34	0.053	0.00034	0.00008
Fringillidae	*Euphonia chlorotica*	3	3.50	4	1.37	closed	Closed	Herb	Seden	1.34	0.070	0.00039	0.00027
Fringillidae	*Euphonia elegantissima*	4	2.00	1	1.55	closed	Closed	Herb	Part	1.26	0.056	0.00014	0.00009
Fringillidae	*Euphonia hirundinacea*	3	4.00	4	1.55	closed	Closed	Herb	Seden	1.32	0.052	0.00028	0.00013
Fringillidae	*Euphonia laniirostris*	6	3.74	4	1.43	closed	Closed	Herb	Seden	1.35	0.036	0.00034	0.00015
Fringillidae	*Euphonia luteicapilla*	3	2.43	2	1.36	closed	Closed	Herb	Seden	1.36	0.044	0.00018	0.00007
Fringillidae	*Euphonia pectoralis*	3	3.25	4	1.69	closed	Closed	Herb	Seden	1.35	0.051	0.00031	0.00007
Fringillidae	*Euphonia trinitatis*	3	3.29	4	1.24	closed	Closed	Herb	Seden	1.31	0.020	0.00020	0.00009
Fringillidae	*Euphonia violacea*	6	4.00	4	1.38	closed	Closed	Herb	Seden	1.40	0.072	0.00029	0.00013
Furnariidae	*Anumbius annumbi*	15	4.21	4	3.78	closed	Open	Carn	Seden	1.33	0.044	0.00019	0.00010
Furnariidae	*Aphrastura spinicauda*	5	3.00	3	1.95	closed	Closed	Carn	Seden	1.32	0.082	0.00036	0.00018
Furnariidae	*Asthenes baeri*	4	3.57	4	2.64	closed	Open	Carn	Seden	1.33	0.033	0.00010	0.00005
Furnariidae	*Asthenes hudsoni*	3	3.40	3	3.21	closed	Open	Carn	Seden	1.29	0.047	0.00019	0.00009
Furnariidae	*Asthenes humicola*	10	3.19	3	3.25	closed	Open	Carn	Seden	1.31	0.056	0.00015	0.00010
Furnariidae	*Asthenes modesta*	31	3.08	4	2.39	closed	Open	Carn	Seden	1.33	0.052	0.00018	0.00012
Furnariidae	*Asthenes pyrrholeuca*	12	2.87	3	2.46	closed	Open	Carn	Part	1.31	0.059	0.00016	0.00010
Furnariidae	*Automolus rubiginosus*	3	2.00	2	7.19	closed	Closed	Carn	Seden	1.43	0.069	0.00008	0.00005
Furnariidae	*Certhiaxis cinnamomeus*	18	2.84	3	2.22	closed	Water-associated	Carn	Seden	1.29	0.059	0.00017	0.00010
Furnariidae	*Cinclodes antarcticus*	11	2.76	4	6.95	closed	Water-associated	Carn	Part	1.37	0.064	0.00024	0.00012
Furnariidae	*Cinclodes atacamensis*	2	2.60	3	6.69	closed	Open	Carn	Seden	1.28	0.025	0.00014	0.00008
Furnariidae	*Cinclodes fuscus*	15	2.61	3	5.28	closed	Open	Carn	Migr	1.30	0.054	0.00025	0.00014
Furnariidae	*Cinclodes nigrofumosus*	11	2.00	2	5.88	closed	Open	Carn	Seden	1.33	0.060	0.00029	0.00013
Furnariidae	*Cinclodes patagonicus*	9	2.80	3	5.45	closed	Water-associated	Carn	Migr	1.34	0.072	0.00028	0.00015

Furnariidae	*Coryphistera alaudina*	5	4.00	4	3.49	closed	Open	Carn	Seden	1.29	0.046	0.00020	0.00014
Furnariidae	*Cranioleuca pyrrhophia*	8	3.00	3	2.18	closed	Closed	Carn	Seden	1.33	0.048	0.00023	0.00014
Furnariidae	*Drymornis bridgesii*	5	2.67	3	10.41	closed	Closed	Carn	Seden	1.31	0.048	0.00027	0.00016
Furnariidae	*Furnarius cristatus*	4	2.60	3	4.28	closed	Open	Carn	Seden	1.33	0.067	0.00014	0.00006
Furnariidae	*Furnarius leucopus*	3	3.00	2	5.30	closed	Open	Carn	Seden	1.28	0.034	0.00017	0.00009
Furnariidae	*Furnarius rufus*	26	3.64	4	6.21	closed	Open	Carn	Seden	1.31	0.076	0.00024	0.00015
Furnariidae	*Geositta cunicularia*	16	2.71	3	4.11	closed	Open	Carn	Seden	1.30	0.033	0.00022	0.00012
Furnariidae	*Geositta rufipennis*	5	2.55	3	5.44	closed	Open	Carn	Seden	1.33	0.053	0.00016	0.00012
Furnariidae	*Lepidocolaptes angustirostris*	6	3.22	4	4.78	closed	Closed	Carn	Seden	1.36	0.046	0.00017	0.00010
Furnariidae	*Leptasthenura aegithaloides*	17	3.23	3	1.68	closed	Open	Carn	Seden	1.30	0.047	0.00034	0.00017
Furnariidae	*Limnornis curvirostris*	5	2.27	2	4.04	closed	Water-associated	Carn	Seden	1.34	0.050	0.00019	0.00015
Furnariidae	*Ochetorhynchus melanura*	7	3.11	3	4.36	closed	Open	Carn	Seden	1.36	0.059	0.00015	0.00007
Furnariidae	*Ochetorhynchus phoenicurus*	4	2.82	3	3.23	closed	Open	Carn	Seden	1.32	0.045	0.00026	0.00008
Furnariidae	*Phacellodomus ruber*	8	3.22	3	3.92	closed	Open	Carn	Seden	1.43	0.076	0.00023	0.00010
Furnariidae	*Phacellodomus rufifrons*	6	3.42	3	3.17	closed	Open	Carn	Seden	1.37	0.064	0.00025	0.00012
Furnariidae	*Phacellodomus sibilatrix*	6	3.55	4	2.53	closed	Closed	Carn	Seden	1.34	0.044	0.00014	0.00010
Furnariidae	*Phleocryptes melanops*	30	2.67	3	2.61	closed	Water-associated	Carn	Seden	1.33	0.071	0.00022	0.00012
Furnariidae	*Premnoplex brunnescens*	3	2.00	2	3.10	closed	Closed	Carn	Seden	1.29	0.038	0.00017	0.00012
Furnariidae	*Pseudoseisura gutturalis*	3	3.80	4	6.29	closed	Open	Carn	Seden	1.31	0.070	0.00010	0.00008
Furnariidae	*Pseudoseisura lophotes*	7	2.78	2	6.36	closed	Closed	Carn	Seden	1.41	0.070	0.00027	0.00019
Furnariidae	*Pygarrhichas albogularis*	3	2.71	3	3.56	closed	Closed	Carn	Seden	1.30	0.008	0.00035	0.00022
Furnariidae	*Schoeniophylax phryganophilus*	8	3.60	4	2.52	closed	Open	Carn	Seden	1.32	0.043	0.00020	0.00010
Furnariidae	*Sclerurus albigularis*	3	2.00	2	5.35	closed	Closed	Carn	Seden	1.25	0.029	0.00017	0.00009
Furnariidae	*Spartonoica maluroides*	3	3.00	3	1.79	open	Water-associated	Carn	Seden	1.23	0.040	0.00018	0.00008
Furnariidae	*Sylviorthorhynchus desmursii*	4	3.00	2	2.60	closed	Closed	Carn	Seden	1.32	0.035	0.00046	0.00029
Furnariidae	*Synallaxis albescens*	22	3.11	3	2.15	closed	Open	Carn	Seden	1.26	0.053	0.00022	0.00010
Furnariidae	*Synallaxis azarae*	5	3.62	3	2.56	closed	Closed	Carn	Seden	1.29	0.040	0.00018	0.00007
Furnariidae	*Synallaxis brachyura*	8	2.00	2	2.78	closed	Open	Carn	Seden	1.27	0.044	0.00025	0.00016
Furnariidae	*Synallaxis frontalis*	6	3.32	3	2.73	closed	Closed	Carn	Seden	1.29	0.036	0.00015	0.00009
Furnariidae	*Synallaxis spixi*	5	3.93	6	2.32	closed	Open	Carn	Seden	1.32	0.043	0.00017	0.00010
Furnariidae	*Tarphonomus certhioides*	5	2.69	3	3.99	closed	Open	Carn	Seden	1.30	0.049	0.00036	0.00015
Furnariidae	*Upucerthia dumetaria*	12	2.93	3	6.07	closed	Open	Carn	Seden	1.38	0.046	0.00024	0.00016
Furnariidae	*Xiphocolaptes major*	3	2.43	2	11.60	closed	Closed	Carn	Seden	1.30	0.096	0.00018	0.00007
Furnariidae	*Xiphorhynchus flavigaster*	3	2.71	3	6.08	closed	Closed	Carn	Seden	1.33	0.029	0.00004	0.00004
Furnariidae	*Xiphorhynchus susurrans*	4	2.00	2	6.00	closed	Closed	Carn	Seden	1.33	0.036	0.00017	0.00019
Grallariidae	*Grallaria guatimalensis*	4	2.00	2	11.09	open	Closed	Carn	Seden	1.23	0.037	0.00015	0.00016

Hirundinidae	*Alopochelidon fucata*	5	3.69	3	1.56	closed	Open	Carn	Migr	1.41	0.061	0.00026	0.00010
Hirundinidae	*Notiochelidon murina*	11	2.32	2	1.70	closed	Open	Carn	Part	1.39	0.104	0.00032	0.00018
Hirundinidae	*Progne chalybea*	11	3.72	5	2.96	closed	Open	Carn	Seden	1.46	0.092	0.00048	0.00020
Hirundinidae	*Progne elegans*	3	5.09	6	2.79	closed	Open	Carn	Migr	1.42	0.054	0.00029	0.00018
Hirundinidae	*Progne tapera*	6	3.86	3	3.17	closed	Open	Carn	Seden	1.45	0.052	0.00033	0.00013
Hirundinidae	*Pygochelidon cyanoleuca*	19	3.62	4	1.52	closed	Open	Carn	Part	1.42	0.108	0.00029	0.00013
Hirundinidae	*Stelgidopteryx ruficollis*	11	4.23	5	1.77	closed	Open	Carn	Seden	1.40	0.054	0.00034	0.00019
Hirundinidae	*Stelgidopteryx serripennis*	6	5.04	6	1.73	closed	Open	Carn	Migr	1.38	0.051	0.00032	0.00015
Hirundinidae	*Tachycineta albiventer*	3	3.00	4	1.81	closed	Water-associated	Carn	Seden	1.41	0.041	0.00035	0.00016
Hirundinidae	*Tachycineta thalassina*	4	4.78	5	2.00	closed	Closed	Carn	Migr	1.42	0.084	0.00045	0.00024
Icteridae	*Agelaioides badius*	7	3.58	4	3.91	closed	Closed	Omni	Seden	1.42	0.100	0.00023	0.00012
Icteridae	*Agelaius phoeniceus*	11	3.12	3	3.58	open	Water-associated	Herb	Migr	1.39	0.074	0.00024	0.00013
Icteridae	*Agelasticus cyanopus*	4	2.67	3	3.21	open	Water-associated	Omni	Seden	1.38	0.079	0.00020	0.00007
Icteridae	*Agelasticus thilius*	32	3.24	3	3.34	open	Water-associated	Carn	Seden	1.37	0.057	0.00025	0.00014
Icteridae	*Amblyramphus holosericeus*	10	2.69	3	4.51	open	Water-associated	Carn	Seden	1.38	0.045	0.00027	0.00015
Icteridae	*Cacicus cela*	10	2.00	2	5.34	closed	Closed	Omni	Seden	1.54	0.105	0.00050	0.00017
Icteridae	*Cacicus chrysopterus*	5	4.05	4	3.78	closed	Closed	Omni	Seden	1.49	0.102	0.00030	0.00016
Icteridae	*Cacicus haemorrhous*	8	2.00	2	5.88	closed	Closed	Carn	Seden	1.50	0.073	0.00043	0.00022
Icteridae	*Cacicus solitarius*	5	2.40	2	5.54	closed	Closed	Carn	Seden	1.58	0.153	0.00042	0.00017
Icteridae	*Chrysomus icterocephalus*	8	2.70	3	3.29	open	Water-associated	Herb	Part	1.40	0.109	0.00033	0.00011
Icteridae	*Chrysomus ruficapillus*	14	3.15	3	3.44	open	Water-associated	Herb	Migr	1.36	0.068	0.00028	0.00015
Icteridae	*Curaeus curaeus*	14	3.73	4	6.97	open	Closed	Omni	Part	1.41	0.067	0.00026	0.00010
Icteridae	*Dives dives*	6	3.76	4	5.96	open	Closed	Omni	Seden	1.40	0.062	0.00032	0.00013
Icteridae	*Gnorimopsar chopi*	31	4.03	4	4.96	closed	Open	Omni	Seden	1.40	0.081	0.00031	0.00015
Icteridae	*Icterus cayanensis*	3	2.33	2	3.13	open	Closed	Carn	Seden	1.42	0.106	0.00039	0.00024
Icteridae	*Icterus cucullatus*	7	3.00	3	2.94	open	Closed	Omni	Part	1.41	0.043	0.00052	0.00017
Icteridae	*Icterus gularis*	27	4.43	4	4.82	closed	Closed	Omni	Seden	1.52	0.078	0.00053	0.00021
Icteridae	*Icterus nigrogularis*	10	3.25	4	3.68	closed	Closed	Omni	Seden	1.53	0.066	0.00059	0.00025
Icteridae	*Icterus pustulatus*	22	4.12	4	3.75	closed	Closed	Carn	Seden	1.52	0.083	0.00049	0.00016
Icteridae	*Psarocolius angustifrons*	3	2.00	2	10.55	closed	Closed	Omni	Seden	1.50	0.073	0.00022	0.00012
Icteridae	*Psarocolius decumanus*	4	2.33	2	10.63	closed	Closed	Omni	Seden	1.48	0.050	0.00039	0.00014
Icteridae	*Psarocolius montezuma*	12	2.24	2	12.67	closed	Closed	Omni	Seden	1.41	0.097	0.00027	0.00017
Icteridae	*Psarocolius wagleri*	3	3.75	4	10.17	closed	Closed	Omni	Part	1.52	0.061	0.00021	0.00007
Icteridae	*Pseudoleistes guirahuro*	5	4.68	6	5.03	open	Water-associated	Omni	Part	1.39	0.037	0.00036	0.00016
Icteridae	*Pseudoleistes virescens*	13	4.04	5	5.12	open	Water-associated	Omni	Part	1.37	0.065	0.00025	0.00014
Icteridae	*Quiscalus lugubris*	8	2.70	3	4.68	open	Open	Omni	Seden	1.40	0.064	0.00022	0.00013

Icteridae	*Quiscalus mexicanus*	6	3.33	3	8.48	open	Open	Omni	Seden	1.49	0.047	0.00033	0.00019
Icteridae	*Quiscalus nicaraguensis*	3	3.00	3	4.45	open	Water-associated	Omni	Seden	1.36	0.037	0.00030	0.00019
Icteridae	*Sturnella bellicosa*	7	3.45	4	4.75	open	Open	Omni	Part	1.34	0.040	0.00022	0.00012
Icteridae	*Sturnella defilippii*	6	3.90	4	5.18	open	Open	Omni	Part	1.40	0.088	0.00025	0.00020
Icteridae	*Sturnella loyca*	39	3.36	4	6.10	open	Open	Omni	Part	1.41	0.073	0.00021	0.00014
Icteridae	*Sturnella militaris*	5	3.00	3	3.46	open	Open	Carn	Part	1.33	0.034	0.00020	0.00006
Icteridae	*Sturnella superciliaris*	5	3.47	3	4.00	open	Open	Carn	Part	1.35	0.074	0.00025	0.00012
Icteriidae	*Icteria virens*	3	3.73	4	3.56	open	Closed	Carn	Seden	1.34	0.050	0.00015	0.00007
Laniidae	*Lanius ludovicianus*	17	4.58	4	4.36	open	Open	Carn	Migr	1.33	0.051	0.00039	0.00014
Mimidae	*Melanotis caerulescens*	17	2.46	2	5.88	open	Closed	Omni	Seden	1.45	0.065	0.00031	0.00012
Mimidae	*Mimus gilvus*	6	2.75	3	5.03	open	Open	Carn	Seden	1.40	0.065	0.00029	0.00016
Mimidae	*Mimus parvulus*	3	3.63	4	4.57	open	Open	Omni	Seden	1.41	0.046	0.00025	0.00011
Mimidae	*Mimus polyglottos*	8	3.44	3	4.39	open	Open	Omni	Migr	1.36	0.045	0.00030	0.00013
Mimidae	*Mimus saturninus*	26	3.64	3	6.12	open	Open	Omni	Part	1.40	0.069	0.00021	0.00011
Mimidae	*Mimus thenca*	5	2.67	3	6.13	open	Open	Omni	Part	1.42	0.082	0.00026	0.00012
Mimidae	*Toxostoma cinereum*	10	2.50	2	5.45	open	Open	Carn	Seden	1.42	0.070	0.00026	0.00012
Oxyruncidae	*Myiobius atricaudus*	5	1.88	2	1.54	closed	Closed	Carn	Seden	1.35	0.047	0.00015	0.00012
Oxyruncidae	*Myiobius sulphureipygius*	13	2.00	2	1.77	closed	Closed	Carn	Seden	1.37	0.065	0.00018	0.00014
Oxyruncidae	*Onychorhynchus coronatus*	6	2.58	3	2.34	closed	Closed	Carn	Part	1.38	0.074	0.00028	0.00013
Parulidae	*Basileuterus culicivorus*	9	2.74	2	1.77	closed	Closed	Carn	Seden	1.29	0.048	0.00024	0.00007
Parulidae	*Basileuterus rufifrons*	5	2.86	3	1.76	closed	Open	Carn	Seden	1.32	0.064	0.00025	0.00012
Parulidae	*Basileuterus tristriatus*	4	1.86	2	1.93	closed	Closed	Carn	Seden	1.34	0.030	0.00022	0.00010
Parulidae	*Dendroica petechia*	10	2.69	3	1.68	open	Open	Carn	Migr	1.34	0.057	0.00028	0.00015
Parulidae	*Euthlypis lachrymosa*	2	4.00	4	2.53	open	Closed	Carn	Seden	1.32	0.009	0.00024	0.00005
Parulidae	*Geothlypis beldingi*	3	3.38	3	2.14	open	Water-associated	Carn	Seden	1.27	0.072	0.00019	0.00010
Parulidae	*Geothlypis velata*	7	2.84	3	1.98	open	Open	Carn	Seden	1.31	0.092	0.00021	0.00010
Parulidae	*Myioborus miniatus*	22	2.33	2	1.47	closed	Closed	Carn	Seden	1.33	0.062	0.00023	0.00016
Parulidae	*Phaeothlypis fulvicauda*	5	2.00	2	2.44	closed	Closed	Carn	Seden	1.42	0.036	0.00024	0.00009
Passerellidae	*Arremon brunneinucha*	31	1.97	2	4.25	open	Closed	Carn	Seden	1.40	0.067	0.00023	0.00012
Passerellidae	*Arremon castaneiceps*	4	1.86	2	4.15	closed	Closed	Omni	Seden	1.39	0.054	0.00034	0.00021
Passerellidae	*Arremon flavirostris*	3	3.00	3	3.80	closed	Closed	Omni	Seden	1.51	0.089	0.00018	0.00008
Passerellidae	*Arremon torquatus*	5	2.27	2	4.23	open	Closed	Omni	Seden	1.36	0.057	0.00024	0.00010
Passerellidae	*Arremon virenticeps*	4	2.00	2	4.12	open	Closed	Omni	Seden	1.44	0.038	0.00032	0.00011
Passerellidae	*Atlapetes albinucha*	5	3.00	2	3.66	open	Closed	Omni	Seden	1.38	0.039	0.00023	0.00004
Passerellidae	*Atlapetes citrinellus*	8	2.81	3	3.33	open	Closed	Omni	Seden	1.33	0.043	0.00014	0.00007
Passerellidae	*Atlapetes fulviceps*	2	2.60	3	3.19	open	Closed	Omni	Seden	1.41	0.042	0.00029	0.00011
Passerellidae	*Atlapetes pileatus*	5	2.27	2	2.79	open	Closed	Omni	Seden	1.41	0.068	0.00028	0.00016
Passerellidae	*Chlorospingus pileatus*	2	1.67	2	2.69	open	Closed	Omni	Seden	1.33	0.059	0.00008	0.00007
Passerellidae	*Zonotrichia capensis*	150	2.88	3	2.40	open	Open	Omni	Seden	1.34	0.064	0.00022	0.00012

Pipridae	*Antilophia galeata*	6	2.00	2	3.17	open	Closed	Herb	Seden	1.46	0.056	0.00029	0.00013
Pipridae	*Chiroxiphia caudata*	7	1.83	2	3.52	open	Closed	Omni	Seden	1.48	0.111	0.00010	0.00005
Pipridae	*Chiroxiphia lanceolata*	6	1.89	2	2.70	open	Closed	Herb	Seden	1.42	0.045	0.00019	0.00008
Pipridae	*Chiroxiphia linearis*	8	2.00	2	2.77	open	Closed	Herb	Seden	1.39	0.045	0.00019	0.00012
Pipridae	*Chiroxiphia pareola*	3	2.00	2	3.16	open	Closed	Herb	Seden	1.38	0.031	0.00012	0.00007
Pipridae	*Manacus aurantiacus*	6	2.00	2	2.39	open	Closed	Herb	Seden	1.36	0.044	0.00012	0.00007
Pipridae	*Manacus candei*	5	2.00	2	2.71	open	Closed	Herb	Seden	1.36	0.029	0.00012	0.00006
Pipridae	*Manacus manacus*	8	2.13	2	2.60	open	Closed	Herb	Seden	1.39	0.039	0.00016	0.00007
Pipridae	*Manacus vitellinus*	3	2.00	2	2.53	open	Closed	Herb	Seden	1.40	0.036	0.00022	0.00008
Pipridae	*Pipra aureola*	4	1.86	2	2.51	open	Closed	Herb	Seden	1.43	0.043	0.00024	0.00010
Pipridae	*Pipra erythrocephala*	5	1.57	2	2.25	open	Closed	Herb	Seden	1.38	0.086	0.00019	0.00006
Polioptilidae	*Polioptila dumicola*	7	3.19	3	1.01	open	Closed	Carn	Seden	1.28	0.052	0.00017	0.00012
Polioptilidae	*Ramphocaenus melanurus*	4	2.00	2	1.84	open	Closed	Carn	Seden	1.38	0.047	0.00017	0.00011
Ptiliogonatidae	*Phainopepla nitens*	4	2.38	2	2.97	open	Open	Herb	Seden	1.42	0.041	0.00037	0.00012
Ptiliogonatidae	*Ptilogonys cinereus*	4	1.86	2	3.21	open	Closed	Omni	Seden	1.52	0.088	0.00053	0.00014
Remizidae	*Auriparus flaviceps*	10	2.88	3	1.01	closed	Open	Carn	Seden	1.34	0.061	0.00024	0.00009
Rhinocryptidae	*Pteroptochos megapodius*	7	2.38	2	12.82	closed	Open	Carn	Seden	1.31	0.062	0.00023	0.00014
Rhinocryptidae	*Rhinocrypta lanceolata*	7	2.00	2	6.69	closed	Open	Carn	Seden	1.31	0.071	0.00013	0.00006
Rhinocryptidae	*Scelorchilus albicollis*	4	2.82	3	6.89	closed	Open	Carn	Seden	1.25	0.030	0.00012	0.00005
Rhinocryptidae	*Scytalopus fuscus*	5	2.60	3	3.42	closed	Closed	Carn	Seden	1.26	0.018	0.00026	0.00016
Rhinocryptidae	*Scytalopus magellanicus*	4	2.33	2	3.24	closed	Closed	Carn	Seden	1.30	0.050	0.00028	0.00020
Thamnophilidae	*Dysithamnus mentalis*	3	2.00	2	2.26	open	Closed	Carn	Seden	1.33	0.055	0.00018	0.00011
Thamnophilidae	*Formicivora grisea*	3	2.00	2	1.71	open	Open	Carn	Seden	1.35	0.072	0.00015	0.00007
Thamnophilidae	*Myrmeciza exsul*	4	2.00	2	3.47	open	Closed	Carn	Seden	1.36	0.034	0.00028	0.00016
Thamnophilidae	*Taraba major*	14	2.30	2	6.75	open	Closed	Carn	Seden	1.33	0.055	0.00011	0.00009
Thamnophilidae	*Thamnophilus bridgesi*	3	2.00	2	3.95	open	Closed	Carn	Seden	1.38	0.077	0.00018	0.00008
Thamnophilidae	*Thamnophilus caerulescens*	8	2.83	2	2.67	open	Closed	Carn	Seden	1.36	0.053	0.00018	0.00013
Thamnophilidae	*Thamnophilus doliatus*	14	2.08	2	3.45	open	Closed	Carn	Seden	1.36	0.061	0.00027	0.00013
Thamnophilidae	*Thamnophilus ruficapillus*	4	3.00	2	4.05	open	Open	Carn	Seden	1.37	0.061	0.00017	0.00013
Thraupidae	*Acanthidops bairdii*	5	3.75	5	1.90	open	Closed	Carn	Part	1.34	0.057	0.00016	0.00008
Thraupidae	*Coereba flaveola*	5	2.20	2	1.34	open	Open	Herb	Seden	1.38	0.039	0.00029	0.00013
Thraupidae	*Coryphospingus pileatus*	4	2.25	2	1.98	open	Open	Omni	Seden	1.40	0.060	0.00025	0.00011
Thraupidae	*Dacnis cayana*	5	2.11	2	1.73	open	Closed	Herb	Seden	1.30	0.083	0.00021	0.00015
Thraupidae	*Diglossa albilatera*	4	1.86	2	1.47	open	Closed	Herb	Seden	1.34	0.069	0.00027	0.00023
Thraupidae	*Diglossa cyanea*	4	1.67	2	2.27	open	Closed	Herb	Seden	1.39	0.086	0.00013	0.00005
Thraupidae	*Diglossa humeralis*	2	2.00	2	1.85	open	Open	Herb	Seden	1.29	0.053	0.00023	0.00009
Thraupidae	*Diglossa lafresnayii*	2	2.00	2	2.26	open	Closed	Herb	Seden	1.39	0.049	0.00030	0.00004
Thraupidae	*Diglossa plumbea*	2	2.00	2	1.31	open	Closed	Herb	Seden	1.28	0.066	0.00018	0.00015
Thraupidae	*Emberizoides herbicola*	3	2.43	2	3.68	open	Open	Herb	Seden	1.39	0.050	0.00017	0.00011
Thraupidae	*Embernagra platensis*	3	3.73	4	4.97	open	Open	Herb	Seden	1.32	0.034	0.00015	0.00007

Thraupidae	*Eucometis penicillata*	4	2.33	2	3.40	open	Closed	Carn	Seden	1.37	0.055	0.00023	0.00012
Thraupidae	*Geospiza fortis*	6	3.91	4	2.34	closed	Open	Herb	Seden	1.33	0.049	0.00028	0.00010
Thraupidae	*Geospiza fuliginosa*	5	3.43	3	1.87	closed	Open	Herb	Seden	1.36	0.104	0.00030	0.00017
Thraupidae	*Oryzoborus angolensis*	9	2.00	2	1.87	open	Open	Herb	Seden	1.33	0.061	0.00021	0.00011
Thraupidae	*Oryzoborus funereus*	4	2.00	2	2.35	open	Open	Herb	Part	1.35	0.081	0.00027	0.00014
Thraupidae	*Paroaria capitata*	3	2.71	3	2.48	open	Open	Omni	Seden	1.35	0.035	0.00040	0.00018
Thraupidae	*Paroaria coronata*	4	2.50	2	3.61	open	Open	Omni	Seden	1.41	0.072	0.00062	0.00018
Thraupidae	*Phrygilus alaudinus*	23	2.84	3	2.75	open	Open	Herb	Seden	1.40	0.067	0.00030	0.00013
Thraupidae	*Phrygilus atriceps*	5	2.67	3	3.30	open	Open	Herb	Seden	1.46	0.096	0.00038	0.00025
Thraupidae	*Phrygilus fruticeti*	46	2.53	2	3.80	open	Open	Herb	Part	1.43	0.092	0.00035	0.00017
Thraupidae	*Phrygilus gayi*	20	3.99	4	2.81	open	Open	Herb	Seden	1.35	0.056	0.00030	0.00016
Thraupidae	*Phrygilus patagonicus*	4	2.78	4	2.56	open	Closed	Herb	Seden	1.33	0.053	0.00032	0.00011
Thraupidae	*Phrygilus plebejus*	4	2.25	2	2.01	open	Open	Herb	Seden	1.31	0.076	0.00009	0.00007
Thraupidae	*Phrygilus unicolor*	4	3.18	3	2.99	open	Open	Herb	Seden	1.40	0.081	0.00028	0.00014
Thraupidae	*Poospiza melanoleuca*	3	2.43	2	1.72	open	Open	Omni	Seden	1.34	0.048	0.00025	0.00009
Thraupidae	*Poospiza nigrorufa*	4	2.25	2	2.17	open	Open	Omni	Seden	1.34	0.049	0.00026	0.00012
Thraupidae	*Ramphocelus carbo*	24	2.11	2	3.05	open	Closed	Omni	Seden	1.36	0.085	0.00028	0.00013
Thraupidae	*Ramphocelus dimidiatus*	5	2.67	2	3.17	open	Open	Omni	Seden	1.45	0.069	0.00017	0.00005
Thraupidae	*Ramphocelus flammigerus*	4	2.00	2	3.61	open	Closed	Herb	Seden	1.44	0.115	0.00033	0.00012
Thraupidae	*Ramphocelus passerinii*	8	2.00	2	3.39	open	Closed	Omni	Seden	1.40	0.107	0.00030	0.00015
Thraupidae	*Saltator atriceps*	6	2.00	2	6.92	open	Open	Omni	Seden	1.44	0.061	0.00030	0.00012
Thraupidae	*Saltator aurantiirostris*	6	2.23	2	5.68	open	Closed	Herb	Seden	1.36	0.079	0.00012	0.00006
Thraupidae	*Saltator coerulescens*	14	2.38	2	5.34	open	Closed	Omni	Seden	1.43	0.070	0.00023	0.00011
Thraupidae	*Saltator maximus*	16	2.00	2	5.06	open	Open	Herb	Seden	1.41	0.072	0.00029	0.00015
Thraupidae	*Saltator similis*	19	2.57	3	4.95	open	Closed	Carn	Seden	1.40	0.063	0.00024	0.00014
Thraupidae	*Saltator striatipectus*	10	2.24	2	4.19	open	Open	Omni	Seden	1.40	0.083	0.00035	0.00016
Thraupidae	*Saltatricula multicolor*	4	2.60	3	2.67	open	Open	Omni	Seden	1.30	0.055	0.00022	0.00017
Thraupidae	*Sicalis flaveola*	30	3.56	4	2.02	closed	Open	Herb	Seden	1.36	0.075	0.00033	0.00015
Thraupidae	*Sicalis lutea*	3	4.00	5	1.33	closed	Open	Herb	Seden	1.40	0.062	0.00022	0.00015
Thraupidae	*Sicalis luteola*	75	4.00	4	1.74	open	Open	Herb	Part	1.34	0.080	0.00029	0.00016
Thraupidae	*Sporophila bouvronides*	3	2.50	3	1.30	open	Open	Herb	Migr	1.43	0.069	0.00036	0.00012
Thraupidae	*Sporophila caerulescens*	7	2.36	2	1.48	open	Open	Herb	Part	1.38	0.041	0.00026	0.00014
Thraupidae	*Sporophila castaneiventris*	3	2.00	2	1.23	open	Open	Herb	Seden	1.27	0.031	0.00021	0.00010
Thraupidae	*Sporophila corvina*	19	2.11	2	1.48	open	Open	Herb	Part	1.32	0.054	0.00025	0.00014
Thraupidae	*Sporophila hypoxantha*	4	2.89	2	1.33	open	Open	Herb	Part	1.30	0.088	0.00026	0.00015
Thraupidae	*Sporophila intermedia*	4	2.80	3	1.68	open	Open	Herb	Seden	1.38	0.065	0.00025	0.00017
Thraupidae	*Sporophila lineola*	5	2.27	2	1.53	open	Open	Herb	Migr	1.36	0.093	0.00034	0.00030
Thraupidae	*Sporophila minuta*	6	2.27	2	1.24	open	Open	Herb	Seden	1.28	0.077	0.00029	0.00015
Thraupidae	*Sporophila nigricollis*	9	2.00	2	1.36	open	Open	Herb	Seden	1.33	0.033	0.00021	0.00008
Thraupidae	*Sporophila peruviana*	4	2.56	3	1.64	open	Open	Herb	Seden	1.42	0.069	0.00027	0.00017

Thraupidae	*Sporophila telasco*	5	2.00	2	1.33	open	Open	Herb	Seden	1.40	0.052	0.00021	0.00007
Thraupidae	*Sporophila torqueola*	22	2.96	4	1.38	open	Open	Herb	Seden	1.31	0.056	0.00022	0.00013
Thraupidae	*Stephanophorus diadematus*	3	2.00	2	3.61	open	Closed	Herb	Part	1.36	0.057	0.00026	0.00007
Thraupidae	*Tachyphonus coronatus*	3	2.43	2	3.29	open	Closed	Carn	Part	1.37	0.054	0.00032	0.00011
Thraupidae	*Tachyphonus rufus*	13	2.37	2	3.90	open	Open	Carn	Seden	1.33	0.079	0.00017	0.00013
Thraupidae	*Tangara cayana*	3	2.00	2	2.91	open	Closed	Herb	Seden	1.43	0.063	0.00033	0.00007
Thraupidae	*Tersina viridis*	5	2.40	2	3.09	closed	Closed	Herb	Seden	1.37	0.109	0.00023	0.00008
Thraupidae	*Thraupis bonariensis*	10	2.48	2	3.66	open	Closed	Omni	Part	1.40	0.057	0.00037	0.00012
Thraupidae	*Thraupis episcopus*	27	2.08	2	3.37	open	Closed	Omni	Seden	1.41	0.086	0.00032	0.00017
Thraupidae	*Thraupis palmarum*	11	2.14	2	3.72	open	Closed	Omni	Seden	1.43	0.089	0.00030	0.00014
Thraupidae	*Thraupis sayaca*	22	2.86	3	3.43	open	Closed	Omni	Seden	1.42	0.094	0.00037	0.00018
Thraupidae	*Tiaris bicolor*	5	3.63	3	1.33	closed	Open	Herb	Seden	1.31	0.064	0.00024	0.00010
Thraupidae	*Tiaris canorus*	5	3.00	3	1.26	closed	Open	Herb	Seden	1.28	0.068	0.00026	0.00013
Thraupidae	*Tiaris obscurus*	5	2.91	3	1.44	closed	Open	Herb	Part	1.34	0.046	0.00024	0.00016
Thraupidae	*Tiaris olivaceus*	16	2.62	3	1.33	closed	Open	Herb	Part	1.32	0.058	0.00022	0.00009
Thraupidae	*Volatinia jacarina*	70	2.32	2	1.32	open	Open	Herb	Seden	1.33	0.065	0.00020	0.00011
Tityridae	*Pachyramphus aglaiae*	19	4.96	5	3.65	closed	Closed	Omni	Part	1.40	0.059	0.00031	0.00014
Tityridae	*Pachyramphus castaneus*	3	3.00	3	2.35	closed	Closed	Carn	Seden	1.33	0.021	0.00034	0.00015
Tityridae	*Pachyramphus polychopterus*	3	2.75	3	2.53	closed	Closed	Carn	Seden	1.39	0.048	0.00035	0.00011
Tityridae	*Pachyramphus validus*	7	2.89	3	3.28	closed	Closed	Carn	Migr	1.36	0.088	0.00035	0.00021
Troglodytidae	*Campylorhynchus brunneicapillus*	10	3.00	3	3.69	closed	Open	Carn	Seden	1.45	0.056	0.00022	0.00009
Troglodytidae	*Campylorhynchus jocosus*	3	3.73	4	2.81	closed	Open	Carn	Seden	1.35	0.059	0.00028	0.00010
Troglodytidae	*Campylorhynchus rufinucha*	17	3.75	4	2.76	closed	Open	Carn	Seden	1.41	0.070	0.00023	0.00012
Troglodytidae	*Campylorhynchus turdinus*	3	3.13	4	3.19	closed	Closed	Carn	Seden	1.41	0.046	0.00025	0.00010
Troglodytidae	*Catherpes mexicanus*	6	4.10	4	1.92	closed	Open	Carn	Seden	1.34	0.042	0.00027	0.00018
Troglodytidae	*Cistothorus platensis*	14	4.39	5	1.42	closed	Open	Carn	Part	1.34	0.044	0.00032	0.00013
Troglodytidae	*Henicorhina leucophrys*	8	2.61	3	2.09	closed	Closed	Carn	Seden	1.37	0.054	0.00026	0.00013
Troglodytidae	*Thryothorus felix*	3	3.40	3	1.95	closed	Closed	Carn	Seden	1.35	0.034	0.00026	0.00016
Troglodytidae	*Thryothorus genibarbis*	3	2.00	2	2.35	closed	Closed	Carn	Seden	1.41	0.022	0.00017	0.00009
Troglodytidae	*Thryothorus modestus*	5	2.45	2	2.16	closed	Closed	Carn	Seden	1.42	0.073	0.00023	0.00009
Troglodytidae	*Thryothorus nigricapillus*	2	2.00	2	3.11	closed	Closed	Carn	Seden	1.54	0.079	0.00020	0.00010
Troglodytidae	*Thryothorus pleurostictus*	10	3.61	4	2.32	closed	Closed	Carn	Seden	1.38	0.065	0.00024	0.00014
Troglodytidae	*Thryothorus rufalbus*	5	3.00	3	2.73	closed	Closed	Carn	Seden	1.45	0.053	0.00036	0.00022
Troglodytidae	*Thryothorus sinaloa*	3	4.38	4	1.90	closed	Closed	Carn	Seden	1.42	0.047	0.00025	0.00010
Troglodytidae	*Troglodytes aedon*	161	4.15	4	1.54	closed	Open	Carn	Seden	1.33	0.061	0.00033	0.00015
Turdidae	*Catharus aurantiirostris*	47	2.37	2	3.86	open	Closed	Carn	Seden	1.37	0.065	0.00025	0.00012
Turdidae	*Catharus dryas*	2	2.00	2	5.12	open	Closed	Carn	Seden	1.47	0.052	0.00058	0.00006
Turdidae	*Catharus frantzii*	10	2.00	2	3.79	open	Closed	Carn	Seden	1.38	0.088	0.00034	0.00012

Turdidae	*Catharus fuscater*	5	2.00	2	4.55	open	Closed	Carn	Seden	1.40	0.044	0.00031	0.00012
Turdidae	*Catharus gracilirostris*	10	1.89	2	3.09	open	Closed	Carn	Seden	1.32	0.062	0.00015	0.00008
Turdidae	*Catharus mexicanus*	12	2.25	2	4.22	open	Closed	Carn	Seden	1.41	0.050	0.00025	0.00015
Turdidae	*Catharus occidentalis*	26	2.36	2	3.49	open	Closed	Carn	Seden	1.39	0.065	0.00036	0.00014
Turdidae	*Myadestes genibarbis*	2	2.00	2	3.97	open	Closed	Herb	Seden	1.38	0.054	0.00038	0.00018
Turdidae	*Myadestes melanops*	7	2.65	3	4.11	open	Closed	Herb	Seden	1.38	0.041	0.00034	0.00013
Turdidae	*Myadestes occidentalis*	19	2.80	3	4.10	open	Closed	Herb	Part	1.35	0.059	0.00022	0.00011
Turdidae	*Myadestes ralloides*	4	2.00	2	3.65	open	Closed	Carn	Part	1.36	0.026	0.00030	0.00012
Turdidae	*Turdus albicollis*	33	2.49	2	5.19	open	Closed	Carn	Seden	1.38	0.078	0.00031	0.00016
Turdidae	*Turdus amaurochalinus*	21	2.63	3	5.60	open	Closed	Carn	Migr	1.39	0.068	0.00033	0.00015
Turdidae	*Turdus assimilis*	31	2.51	3	6.27	open	Closed	Carn	Seden	1.41	0.070	0.00036	0.00015
Turdidae	*Turdus chiguanco*	9	2.55	3	8.72	open	Open	Carn	Seden	1.46	0.064	0.00031	0.00013
Turdidae	*Turdus falcklandii*	31	2.90	3	8.24	open	Closed	Carn	Part	1.41	0.075	0.00022	0.00012
Turdidae	*Turdus fumigatus*	18	2.58	3	6.04	open	Closed	Carn	Seden	1.37	0.070	0.00030	0.00018
Turdidae	*Turdus fuscater*	6	2.09	2	9.89	open	Closed	Carn	Seden	1.51	0.106	0.00029	0.00020
Turdidae	*Turdus grayi*	67	2.84	3	5.87	open	Closed	Omni	Seden	1.41	0.080	0.00033	0.00014
Turdidae	*Turdus ignobilis*	4	2.57	3	5.10	open	Closed	Omni	Seden	1.38	0.052	0.00037	0.00013
Turdidae	*Turdus infuscatus*	2	2.00	2	6.28	open	Closed	Carn	Seden	1.37	0.026	0.00036	0.00004
Turdidae	*Turdus leucomelas*	20	2.96	3	5.81	open	Closed	Herb	Seden	1.39	0.074	0.00031	0.00012
Turdidae	*Turdus leucops*	3	1.83	2	4.38	open	Closed	Herb	Seden	1.41	0.084	0.00038	0.00022
Turdidae	*Turdus migratorius*	4	2.67	3	6.74	open	Closed	Carn	Migr	1.54	0.054	0.00020	0.00009
Turdidae	*Turdus nigrescens*	4	2.00	2	8.91	open	Closed	Omni	Seden	1.41	0.041	0.00034	0.00010
Turdidae	*Turdus nigriceps*	7	2.90	3	5.37	open	Closed	Carn	Part	1.39	0.065	0.00030	0.00014
Turdidae	*Turdus nudigenis*	25	2.85	3	5.42	open	Closed	Carn	Seden	1.40	0.062	0.00028	0.00011
Turdidae	*Turdus olivater*	3	2.00	2	4.92	open	Closed	Omni	Seden	1.40	0.019	0.00017	0.00010
Turdidae	*Turdus rufiventris*	55	2.92	3	6.39	open	Closed	Carn	Part	1.40	0.075	0.00031	0.00015
Turdidae	*Turdus serranus*	5	2.27	2	6.00	open	Closed	Carn	Seden	1.44	0.099	0.00034	0.00017
Tyrannidae	*Agriornis lividus*	7	3.00	4	7.79	open	Open	Carn	Seden	1.35	0.045	0.00023	0.00009
Tyrannidae	*Agriornis micropterus*	3	3.17	4	6.11	open	Open	Carn	Part	1.33	0.033	0.00019	0.00009
Tyrannidae	*Agriornis montanus*	4	3.55	2	7.20	open	Open	Omni	Seden	1.38	0.035	0.00039	0.00026
Tyrannidae	*Alectrurus tricolor*	2	3.50	4	3.60	open	Open	Carn	Part	1.39	0.080	0.00026	0.00012
Tyrannidae	*Anairetes flavirostris*	3	1.67	2	1.03	open	Open	Carn	Part	1.36	0.031	0.00016	0.00020
Tyrannidae	*Anairetes parulus*	28	2.89	3	1.20	open	Open	Carn	Seden	1.32	0.039	0.00028	0.00012
Tyrannidae	*Arundinicola leucocephala*	9	2.73	3	1.87	closed	Water-associated	Carn	Seden	1.36	0.046	0.00023	0.00008
Tyrannidae	*Attila rufus*	9	2.64	3	4.95	open	Closed	Carn	Seden	1.42	0.084	0.00028	0.00011
Tyrannidae	*Camptostoma imberbe*	4	2.80	3	1.23	closed	Closed	Carn	Migr	1.32	0.086	0.00038	0.00018
Tyrannidae	*Camptostoma obsoletum*	26	2.36	2	1.46	closed	Open	Carn	Seden	1.38	0.071	0.00037	0.00019
Tyrannidae	*Cnemotriccus fuscatus*	10	2.18	2	2.04	open	Closed	Carn	Part	1.34	0.065	0.00028	0.00019
Tyrannidae	*Colonia colonus*	5	1.75	2	2.05	closed	Closed	Carn	Seden	1.48	0.094	0.00032	0.00015

Tyrannidae	*Colorhamphus parvirostris*	3	1.75	2	1.74	open	Closed	Carn	Migr	1.32	0.031	0.00031	0.00021
Tyrannidae	*Conopias parvus*	2	2.20	3	4.19	closed	Closed	Carn	Seden	1.29	0.037	0.00021	0.00005
Tyrannidae	*Contopus caribaeus*	6	1.90	1	1.57	open	Closed	Carn	Seden	1.28	0.030	0.00036	0.00018
Tyrannidae	*Contopus cinereus*	15	2.26	2	1.75	open	Closed	Carn	Part	1.27	0.043	0.00027	0.00017
Tyrannidae	*Contopus fumigatus*	4	1.67	2	1.96	open	Closed	Carn	Seden	1.27	0.036	0.00051	0.00028
Tyrannidae	*Contopus hispaniolensis*	3	2.33	2	2.01	open	Closed	Carn	Seden	1.28	0.040	0.00029	0.00009
Tyrannidae	*Contopus latirostris*	4	1.83	2	1.59	open	Closed	Carn	Seden	1.31	0.049	0.00056	0.00014
Tyrannidae	*Contopus pertinax*	5	2.92	3	2.82	open	Closed	Carn	Seden	1.36	0.072	0.00034	0.00014
Tyrannidae	*Contopus sordidulus*	9	2.29	3	1.50	open	Closed	Carn	Migr	1.31	0.075	0.00021	0.00016
Tyrannidae	*Contopus virens*	2	2.60	3	1.76	open	Closed	Carn	Migr	1.31	0.039	0.00032	0.00011
Tyrannidae	*Culicivora caudacuta*	3	1.50	1	0.84	open	Open	Carn	Part	1.27	0.049	0.00013	0.00011
Tyrannidae	*Elaenia albiceps*	20	2.19	2	2.19	open	Closed	Carn	Part	1.36	0.055	0.00039	0.00018
Tyrannidae	*Elaenia chiriquensis*	25	2.07	2	2.08	open	Open	Omni	Part	1.33	0.058	0.00029	0.00015
Tyrannidae	*Elaenia cristata*	4	1.60	2	2.36	open	Open	Carn	Seden	1.32	0.048	0.00024	0.00008
Tyrannidae	*Elaenia flavogaster*	58	2.09	2	2.76	open	Closed	Carn	Seden	1.37	0.071	0.00027	0.00014
Tyrannidae	*Elaenia martinica*	7	1.89	2	2.71	open	Closed	Carn	Seden	1.31	0.038	0.00039	0.00021
Tyrannidae	*Elaenia obscura*	5	2.20	2	3.00	open	Closed	Carn	Seden	1.38	0.067	0.00050	0.00028
Tyrannidae	*Elaenia parvirostris*	14	2.23	2	1.95	open	Closed	Carn	Migr	1.36	0.051	0.00033	0.00016
Tyrannidae	*Elaenia strepera*	9	1.79	2	2.52	open	Closed	Carn	Migr	1.42	0.063	0.00046	0.00025
Tyrannidae	*Empidonax difficilis*	4	3.57	4	1.54	open	Closed	Carn	Migr	1.28	0.031	0.00016	0.00006
Tyrannidae	*Empidonax flavescens*	20	2.57	3	1.79	open	Closed	Carn	Seden	1.27	0.039	0.00013	0.00007
Tyrannidae	*Empidonax fulvifrons*	3	3.22	4	1.22	open	Closed	Carn	Seden	1.27	0.040	0.00025	0.00019
Tyrannidae	*Empidonomus aurantioatrocristatus*	27	2.78	2	2.57	open	Closed	Carn	Migr	1.33	0.075	0.00040	0.00016
Tyrannidae	*Empidonomus varius*	21	2.59	2	2.81	open	Closed	Carn	Migr	1.34	0.064	0.00028	0.00014
Tyrannidae	*Fluvicola albiventer*	18	2.74	3	1.81	closed	Water-associated	Carn	Part	1.39	0.079	0.00026	0.00014
Tyrannidae	*Fluvicola nengeta*	5	2.64	3	2.05	closed	Water-associated	Carn	Part	1.40	0.079	0.00024	0.00008
Tyrannidae	*Fluvicola pica*	19	2.48	3	1.70	closed	Water-associated	Carn	Part	1.35	0.048	0.00018	0.00008
Tyrannidae	*Hemitriccus margaritaceiventer*	13	2.28	2	1.38	closed	Closed	Carn	Seden	1.41	0.055	0.00026	0.00015
Tyrannidae	*Hirundinea ferruginea*	6	2.62	2	2.53	open	Open	Carn	Part	1.30	0.076	0.00043	0.00023
Tyrannidae	*Hymenops perspicillatus*	45	2.63	3	2.96	open	Water-associated	Carn	Migr	1.33	0.049	0.00026	0.00012
Tyrannidae	*Knipolegus aterrimus*	9	2.21	2	2.72	open	Open	Carn	Part	1.30	0.055	0.00022	0.00013
Tyrannidae	*Knipolegus cyanirostris*	5	2.20	2	2.60	open	Closed	Carn	Part	1.34	0.053	0.00030	0.00017
Tyrannidae	*Knipolegus lophotes*	6	2.38	2	3.84	open	Open	Carn	Seden	1.34	0.060	0.00025	0.00016
Tyrannidae	*Knipolegus signatus*	13	1.91	2	3.03	open	Closed	Carn	Seden	1.33	0.057	0.00022	0.00012
Tyrannidae	*Knipolegus striaticeps*	9	2.13	2	2.12	open	Open	Carn	Seden	1.29	0.045	0.00024	0.00011
Tyrannidae	*Lathrotriccus euleri*	11	2.56	3	1.67	open	Closed	Carn	Part	1.34	0.075	0.00033	0.00014
Tyrannidae	*Legatus leucophaius*	34	2.08	2	2.92	closed	Closed	Herb	Seden	1.37	0.067	0.00027	0.00013

Tyrannidae	*Leptopogon amaurocephalus*	6	2.57	3	1.88	closed	Closed	Carn	Seden	1.33	0.089	0.00023	0.00012
Tyrannidae	*Lessonia oreas*	3	3.00	3	2.19	open	Water-associated	Carn	Part	1.36	0.041	0.00023	0.00006
Tyrannidae	*Lessonia rufa*	39	2.82	3	1.86	open	Water-associated	Carn	Migr	1.33	0.050	0.00024	0.00012
Tyrannidae	*Machetornis rixosa*	27	3.00	3	3.77	closed	Open	Carn	Seden	1.34	0.068	0.00027	0.00015
Tyrannidae	*Mecocerculus leucophrys*	4	2.17	2	1.97	open	Closed	Carn	Seden	1.34	0.055	0.00020	0.00015
Tyrannidae	*Megarynchus pitangua*	31	2.78	3	6.14	open	Closed	Carn	Seden	1.38	0.062	0.00026	0.00012
Tyrannidae	*Mionectes oleagineus*	13	2.91	3	2.10	closed	Closed	Herb	Seden	1.36	0.051	0.00020	0.00009
Tyrannidae	*Muscisaxicola albilora*	3	2.43	2	4.02	closed	Open	Carn	Migr	1.34	0.050	0.00027	0.00004
Tyrannidae	*Muscisaxicola capistratus*	3	3.00	3	3.58	closed	Open	Carn	Migr	1.38	0.054	0.00028	0.00008
Tyrannidae	*Muscisaxicola flavinucha*	4	2.57	3	4.42	closed	Open	Carn	Part	1.35	0.025	0.00031	0.00016
Tyrannidae	*Muscisaxicola maclovianus*	5	3.00	3	3.97	closed	Open	Carn	Migr	1.39	0.046	0.00025	0.00007
Tyrannidae	*Muscisaxicola maculirostris*	14	2.95	3	2.17	open	Open	Carn	Seden	1.31	0.048	0.00027	0.00013
Tyrannidae	*Myiarchus antillarum*	4	2.14	3	3.17	closed	Closed	Carn	Seden	1.25	0.047	0.00016	0.00010
Tyrannidae	*Myiarchus barbirostris*	2	3.00	3	2.12	closed	Closed	Carn	Seden	1.30	0.015	0.00023	0.00010
Tyrannidae	*Myiarchus cinerascens*	10	4.14	4	3.20	closed	Open	Carn	Migr	1.34	0.056	0.00028	0.00010
Tyrannidae	*Myiarchus ferox*	19	2.92	3	3.05	closed	Closed	Carn	Seden	1.35	0.075	0.00036	0.00018
Tyrannidae	*Myiarchus nugator*	2	3.60	4	4.09	closed	Closed	Carn	Seden	1.27	0.059	0.00036	0.00006
Tyrannidae	*Myiarchus nuttingi*	3	3.56	4	3.01	closed	Closed	Carn	Part	1.29	0.020	0.00020	0.00009
Tyrannidae	*Myiarchus panamensis*	2	3.40	3	3.17	closed	Closed	Carn	Seden	1.29	0.082	0.00035	0.00016
Tyrannidae	*Myiarchus sagrae*	3	2.00	2	2.78	closed	Closed	Carn	Seden	1.29	0.030	0.00027	0.00008
Tyrannidae	*Myiarchus semirufus*	2	2.00	3	3.19	closed	Open	Carn	Seden	1.36	0.040	0.00035	0.00000
Tyrannidae	*Myiarchus stolidus*	6	3.33	3	2.81	closed	Closed	Carn	Seden	1.32	0.047	0.00028	0.00013
Tyrannidae	*Myiarchus swainsoni*	8	2.41	2	3.24	closed	Closed	Carn	Migr	1.31	0.060	0.00027	0.00011
Tyrannidae	*Myiarchus tuberculifer*	20	3.45	3	2.70	closed	Closed	Carn	Seden	1.29	0.063	0.00031	0.00018
Tyrannidae	*Myiarchus tyrannulus*	36	3.89	3	3.55	closed	Closed	Carn	Part	1.35	0.061	0.00032	0.00017
Tyrannidae	*Myiodynastes bairdii*	6	2.69	2	5.95	closed	Closed	Carn	Seden	1.45	0.068	0.00041	0.00010
Tyrannidae	*Myiodynastes chrysocephalus*	6	2.90	3	4.50	closed	Closed	Carn	Seden	1.36	0.063	0.00026	0.00009
Tyrannidae	*Myiodynastes luteiventris*	12	2.88	3	4.75	closed	Closed	Omni	Migr	1.35	0.057	0.00019	0.00009
Tyrannidae	*Myiodynastes maculatus*	38	2.74	3	4.79	closed	Closed	Carn	Migr	1.38	0.058	0.00032	0.00015
Tyrannidae	*Myiopagis gaimardii*	5	2.00	2	1.66	open	Closed	Carn	Seden	1.28	0.035	0.00020	0.00013
Tyrannidae	*Myiopagis viridicata*	8	2.00	2	1.90	open	Closed	Carn	Migr	1.30	0.048	0.00018	0.00009
Tyrannidae	*Myiophobus fasciatus*	79	2.15	2	1.61	open	Open	Carn	Migr	1.35	0.059	0.00041	0.00017
Tyrannidae	*Myiophobus flavicans*	4	1.67	2	1.65	open	Closed	Carn	Seden	1.41	0.074	0.00025	0.00007
Tyrannidae	*Myiornis auricularis*	2	1.67	2	0.99	closed	Closed	Carn	Seden	1.37	0.024	0.00017	0.00007
Tyrannidae	*Myiornis ecaudatus*	2	2.00	2	1.11	closed	Closed	Carn	Seden	1.36	0.123	0.00021	0.00012
Tyrannidae	*Myiozetetes cayanensis*	27	2.36	2	2.88	closed	Open	Carn	Seden	1.40	0.075	0.00029	0.00013
Tyrannidae	*Myiozetetes granadensis*	16	3.22	3	3.33	closed	Closed	Carn	Seden	1.41	0.062	0.00036	0.00017
Tyrannidae	*Myiozetetes similis*	119	3.26	3	3.28	closed	Open	Carn	Part	1.41	0.071	0.00032	0.00016

Tyrannidae	*Neoxolmis rufiventris*	6	1.88	2	6.85	open	Open	Carn	Migr	1.48	0.073	0.00039	0.00027
Tyrannidae	*Ochthoeca fumicolor*	7	2.08	2	2.15	open	Open	Carn	Seden	1.31	0.072	0.00019	0.00014
Tyrannidae	*Phaeomyias murina*	12	2.25	2	1.53	open	Open	Carn	Seden	1.31	0.046	0.00027	0.00011
Tyrannidae	*Phaeomyias tumbezana*	5	1.50	1	1.74	open	Open	Carn	Seden	1.28	0.031	0.00023	0.00012
Tyrannidae	*Phylloscartes ventralis*	6	3.00	3	1.80	closed	Closed	Carn	Seden	1.42	0.129	0.00021	0.00010
Tyrannidae	*Pitangus sulphuratus*	257	3.77	4	6.14	closed	Closed	Omni	Seden	1.38	0.068	0.00033	0.00015
Tyrannidae	*Platyrinchus cancrominus*	2	1.67	2	1.34	open	Closed	Carn	Seden	1.31	0.058	0.00011	0.00008
Tyrannidae	*Platyrinchus coronatus*	8	1.77	2	1.47	open	Closed	Carn	Seden	1.28	0.053	0.00019	0.00010
Tyrannidae	*Platyrinchus mystaceus*	6	1.78	2	1.50	open	Closed	Carn	Seden	1.27	0.078	0.00022	0.00011
Tyrannidae	*Poecilotriccus plumbeiceps*	4	2.60	3	1.31	closed	Closed	Carn	Seden	1.37	0.040	0.00025	0.00006
Tyrannidae	*Polystictus pectoralis*	5	2.20	2	1.10	open	Open	Carn	Part	1.34	0.086	0.00034	0.00016
Tyrannidae	*Pseudocolopteryx flaviventris*	20	2.77	3	1.38	open	Water-associated	Carn	Part	1.32	0.043	0.00022	0.00009
Tyrannidae	*Pseudocolopteryx sclateri*	2	2.00	2	1.18	open	Water-associated	Carn	Part	1.32	0.065	0.00018	0.00006
Tyrannidae	*Pyrocephalus rubinus*	85	2.77	3	1.60	open	Closed	Carn	Migr	1.32	0.052	0.00035	0.00015
Tyrannidae	*Rhynchocyclus brevirostris*	8	2.35	2	3.48	closed	Closed	Carn	Seden	1.50	0.139	0.00024	0.00012
Tyrannidae	*Rhynchocyclus olivaceus*	5	2.00	1	2.12	closed	Closed	Carn	Seden	1.34	0.144	0.00018	0.00008
Tyrannidae	*Satrapa icterophrys*	36	2.74	3	2.64	open	Open	Carn	Migr	1.35	0.054	0.00034	0.00018
Tyrannidae	*Sayornis nigricans*	43	3.17	3	2.15	open	Open	Carn	Seden	1.32	0.048	0.00028	0.00011
Tyrannidae	*Sayornis saya*	2	3.00	3	2.38	open	Closed	Carn	Migr	1.28	0.045	0.00022	0.00015
Tyrannidae	*Serpophaga cinerea*	7	1.80	2	1.33	open	Water-associated	Carn	Seden	1.30	0.059	0.00018	0.00009
Tyrannidae	*Serpophaga nigricans*	15	2.35	2	1.34	open	Open	Carn	Part	1.33	0.058	0.00025	0.00013
Tyrannidae	*Serpophaga subcristata*	30	2.26	2	1.03	open	Closed	Carn	Migr	1.30	0.047	0.00029	0.00014
Tyrannidae	*Stigmatura budytoides*	6	2.00	2	1.39	open	Open	Carn	Seden	1.29	0.040	0.00047	0.00017
Tyrannidae	*Sublegatus arenarum*	8	1.77	2	1.78	open	Closed	Carn	Seden	1.36	0.096	0.00026	0.00013
Tyrannidae	*Sublegatus modestus*	8	1.85	2	1.69	open	Open	Carn	Migr	1.31	0.055	0.00034	0.00013
Tyrannidae	*Suiriri suiriri*	6	2.38	3	1.96	open	Closed	Carn	Seden	1.33	0.077	0.00047	0.00019
Tyrannidae	*Tachuris rubrigastra*	37	2.70	3	1.34	open	Water-associated	Carn	Seden	1.32	0.059	0.00019	0.00010
Tyrannidae	*Todirostrum cinereum*	32	2.42	2	1.11	closed	Open	Carn	Seden	1.41	0.057	0.00026	0.00010
Tyrannidae	*Todirostrum maculatum*	6	2.00	2	1.22	closed	Closed	Carn	Seden	1.45	0.080	0.00028	0.00011
Tyrannidae	*Tolmomyias flaviventris*	29	2.48	3	1.84	closed	Closed	Carn	Seden	1.47	0.063	0.00031	0.00013
Tyrannidae	*Tolmomyias sulphurescens*	20	2.65	3	2.35	closed	Closed	Carn	Seden	1.50	0.070	0.00036	0.00016
Tyrannidae	*Tyrannus albogularis*	6	1.67	2	3.82	open	Open	Carn	Migr	1.40	0.044	0.00027	0.00011
Tyrannidae	*Tyrannus caudifasciatus*	12	2.44	2	4.38	open	Closed	Carn	Seden	1.36	0.073	0.00037	0.00018
Tyrannidae	*Tyrannus couchii*	43	3.67	4	4.12	open	Closed	Carn	Seden	1.37	0.057	0.00037	0.00017
Tyrannidae	*Tyrannus crassirostris*	7	3.86	5	4.42	open	Closed	Carn	Seden	1.35	0.075	0.00035	0.00019
Tyrannidae	*Tyrannus cubensis*	4	2.00	3	4.72	open	Closed	Carn	Seden	1.43	0.053	0.00033	0.00011
Tyrannidae	*Tyrannus dominicensis*	55	2.57	2	4.24	open	Closed	Omni	Part	1.40	0.069	0.00039	0.00018
Tyrannidae	*Tyrannus forficatus*	4	4.14	4	3.32	open	Open	Carn	Migr	1.31	0.067	0.00040	0.00016

Tyrannidae	*Tyrannus melancholicus*	215	2.91	3	3.87	open	Open	Carn	Seden	1.37	0.071	0.00037	0.00015
Tyrannidae	*Tyrannus niveigularis*	12	2.48	2	3.75	open	Open	Carn	Part	1.35	0.059	0.00038	0.00020
Tyrannidae	*Tyrannus savana*	168	3.20	3	2.94	open	Open	Carn	Migr	1.36	0.072	0.00044	0.00020
Tyrannidae	*Tyrannus tyrannus*	4	3.54	4	3.97	open	Closed	Carn	Migr	1.39	0.039	0.00028	0.00019
Tyrannidae	*Tyrannus verticalis*	5	3.38	4	3.60	open	Open	Carn	Migr	1.35	0.082	0.00040	0.00016
Tyrannidae	*Tyrannus vociferans*	12	3.54	4	3.60	open	Closed	Carn	Migr	1.33	0.057	0.00021	0.00009
Tyrannidae	*Xenotriccus mexicanus*	5	3.00	3	1.77	open	Open	Carn	Seden	1.36	0.039	0.00028	0.00012
Tyrannidae	*Xolmis cinereus*	20	2.86	4	5.08	open	Open	Carn	Part	1.37	0.062	0.00026	0.00013
Tyrannidae	*Xolmis coronatus*	13	2.37	2	4.71	open	Open	Carn	Migr	1.34	0.064	0.00022	0.00010
Tyrannidae	*Xolmis dominicanus*	2	2.00	2	4.84	open	Open	Carn	Seden	1.31	0.019	0.00021	0.00006
Tyrannidae	*Xolmis irupero*	19	2.98	3	3.40	closed	Open	Carn	Part	1.34	0.047	0.00032	0.00021
Tyrannidae	*Xolmis pyrope*	18	3.17	3	4.23	open	Closed	Carn	Part	1.35	0.055	0.00020	0.00010
Tyrannidae	*Xolmis velatus*	7	2.53	3	5.36	closed	Open	Carn	Part	1.39	0.081	0.00032	0.00011
Vireonidae	*Cyclarhis gujanensis*	7	2.21	2	2.98	open	Closed	Carn	Seden	1.37	0.059	0.00036	0.00017
Vireonidae	*Hylophilus pectoralis*	3	2.00	2	1.66	open	Closed	Carn	Seden	1.35	0.051	0.00031	0.00017
Vireonidae	*Vireo altiloquus*	3	2.75	3	2.53	open	Closed	Carn	Seden	1.45	0.060	0.00052	0.00018
Vireonidae	*Vireo flavoviridis*	8	3.18	4	2.26	open	Closed	Carn	Migr	1.41	0.093	0.00032	0.00014
Vireonidae	*Vireo olivaceus*	11	2.75	3	2.14	open	Closed	Carn	Migr	1.35	0.056	0.00038	0.00019

Table S4. Species (Jetz et al. 2012), body mass (g), nest type, number of clutches (N), mean elongation and mean asymmetry of Neotropical passerines evaluated in Chapter 2.

Family	Species	Body mass	Nest type	N	Elongation	Asymmetry
Aegithalidae	*Psaltriparus minimus*	5.3	closed	12	1.35	0.00026
Alaudidae	*Eremophila alpestris*	33.33	closed	3	1.36	0.00031
Cardinalidae	*Cardinalis cardinalis*	42.64	open	6	1.33	0.00022
Cardinalidae	*Cardinalis sinuatus*	35.19	open	3	1.37	0.00015
Cardinalidae	*Chlorothraupis carmioli*	37.6	open	5	1.46	0.00010
Cardinalidae	*Cyanocompsa brissonii*	27.5	open	14	1.41	0.00024
Cardinalidae	*Cyanocompsa cyanoides*	32.5	open	3	1.38	0.00023
Cardinalidae	*Habia fuscicauda*	36.84	open	3	1.34	0.00024
Cardinalidae	*Passerina rositae*	20	open	3	1.35	0.00029
Cardinalidae	*Piranga flava*	37.7	open	15	1.37	0.00026
Conopophagidae	*Conopophaga lineata*	25.21	open	8	1.29	0.00020
Corvidae	*Aphelocoma californica*	85.74	open	4	1.36	0.00028
Corvidae	*Cyanocorax chrysops*	166	open	13	1.35	0.00027
Corvidae	*Cyanocorax cristatellus*	178	open	5	1.42	0.00034
Corvidae	*Cyanocorax cyanomelas*	207	open	11	1.41	0.00053
Corvidae	*Cyanocorax cyanopogon*	146	open	3	1.41	0.00032
Corvidae	*Cyanocorax morio*	204	open	3	1.47	0.00047
Corvidae	*Cyanocorax yncas*	78.5	open	14	1.34	0.00022
Cotingidae	*Phytotoma rara*	47	open	14	1.39	0.00026
Cotingidae	*Phytotoma rutila*	40.5	open	36	1.35	0.00025
Donacobiidae	*Donacobius atricapilla*	36.8	open	3	1.36	0.00020
Fringillidae	*Carduelis magellanica*	13.6	open	4	1.35	0.00031
Fringillidae	*Carpodacus mexicanus*	21.4	open	35	1.35	0.00033
Fringillidae	*Euphonia laniirostris*	15	closed	6	1.36	0.00030
Fringillidae	*Euphonia luteicapilla*	13	closed	3	1.35	0.00018
Fringillidae	*Euphonia violacea*	15	closed	6	1.41	0.00030
Furnariidae	*Anumbius annumbi*	41.5	closed	15	1.34	0.00018
Furnariidae	*Aphrastura spinicauda*	11.5	closed	5	1.31	0.00037
Furnariidae	*Asthenes baeri*	17.8	closed	4	1.33	0.00010
Furnariidae	*Asthenes hudsoni*	19	closed	3	1.29	0.00018
Furnariidae	*Asthenes humicola*	20.83	closed	10	1.31	0.00014
Furnariidae	*Asthenes modesta*	16.8	closed	17	1.33	0.00017
Furnariidae	*Asthenes pyrrholeuca*	13.2	closed	11	1.31	0.00017
Furnariidae	*Automolus rubiginosus*	39.8	closed	3	1.43	0.00008
Furnariidae	*Certhiaxis cinnamomeus*	15.2	closed	18	1.29	0.00017
Furnariidae	*Cinclodes albiventris*	30	closed	1	1.33	0.00023
Furnariidae	*Cinclodes atacamensis*	53	closed	2	1.28	0.00013
Furnariidae	*Cinclodes comechingonus*	28.28	closed	1	1.32	0.00021
Furnariidae	*Cinclodes fuscus*	30	closed	9	1.32	0.00028
Furnariidae	*Cinclodes nigrofumosus*	64.96	closed	1	1.35	0.00037
Furnariidae	*Cinclodes patagonicus*	30.7	closed	8	1.33	0.00025
Furnariidae	*Coryphistera alaudina*	30	closed	5	1.29	0.00018
Furnariidae	*Cranioleuca pyrrhophia*	14.9	closed	8	1.32	0.00024
Furnariidae	*Drymornis bridgesii*	92.62	closed	5	1.31	0.00028
Furnariidae	*Furnarius cristatus*	25.5	closed	4	1.33	0.00014
Furnariidae	*Furnarius leucopus*	54.8	closed	3	1.28	0.00019
Furnariidae	*Furnarius rufus*	46.42	closed	26	1.31	0.00023

Furnariidae	*Geositta cunicularia*	28.5	closed	16	1.30	0.00021
Furnariidae	*Geositta rufipennis*	32.37	closed	5	1.33	0.00018
Furnariidae	*Lepidocolaptes angustirostris*	29.59	closed	6	1.36	0.00018
Furnariidae	*Leptasthenura aegithaloides*	10.72	closed	17	1.30	0.00034
Furnariidae	*Limnornis curvirostris*	28.6	closed	5	1.34	0.00019
Furnariidae	*Ochetorhynchus melanura*	40	closed	5	1.36	0.00015
Furnariidae	*Ochetorhynchus phoenicurus*	30.16	closed	2	1.30	0.00028
Furnariidae	*Phacellodomus ruber*	41	closed	8	1.42	0.00022
Furnariidae	*Phacellodomus rufifrons*	24.6	closed	6	1.37	0.00024
Furnariidae	*Phacellodomus sibilatrix*	15.5	closed	6	1.33	0.00014
Furnariidae	*Phleocryptes melanops*	14.6	closed	30	1.33	0.00022
Furnariidae	*Premnoplex brunnescens*	16.3	closed	3	1.29	0.00017
Furnariidae	*Pseudoseisura gutturalis*	70.4	closed	3	1.32	0.00011
Furnariidae	*Pseudoseisura lophotes*	72.2	closed	7	1.41	0.00027
Furnariidae	*Pygarrhichas albogularis*	24	closed	3	1.30	0.00035
Furnariidae	*Schoeniophylax phryganophilus*	18.6	closed	8	1.31	0.00020
Furnariidae	*Sclerurus albigularis*	34.8	closed	3	1.25	0.00017
Furnariidae	*Spartonoica maluroides*	11	open	3	1.23	0.00018
Furnariidae	*Sylviorthorhynchus desmursii*	10.9	closed	4	1.31	0.00041
Furnariidae	*Synallaxis albescens*	11.2	closed	22	1.26	0.00021
Furnariidae	*Synallaxis azarae*	16.9	closed	5	1.29	0.00018
Furnariidae	*Synallaxis brachyura*	18.3	closed	8	1.27	0.00026
Furnariidae	*Synallaxis frontalis*	14	closed	6	1.29	0.00015
Furnariidae	*Synallaxis spixi*	12.6	closed	5	1.32	0.00015
Furnariidae	*Tarphonomus certhioides*	22.09	closed	5	1.30	0.00034
Furnariidae	*Upucerthia albigula*	39.9	closed	1	1.34	0.00017
Furnariidae	*Upucerthia dumetaria*	48.68	closed	9	1.38	0.00022
Furnariidae	*Xiphocolaptes major*	156	closed	3	1.31	0.00018
Furnariidae	*Xiphorhynchus flavigaster*	46.19	closed	3	1.34	0.00004
Furnariidae	*Xiphorhynchus susurrans*	46.72	closed	4	1.33	0.00017
Grallariidae	*Grallaria guatimalensis*	94.2	open	4	1.24	0.00013
Hirundinidae	*Alopochelidon fucata*	13.96	closed	5	1.41	0.00027
Hirundinidae	*Notiochelidon murina*	11.7	closed	5	1.40	0.00026
Hirundinidae	*Progne chalybea*	50	closed	11	1.47	0.00049
Hirundinidae	*Progne elegans*	50.6	closed	3	1.43	0.00030
Hirundinidae	*Progne tapera*	32	closed	6	1.45	0.00034
Hirundinidae	*Pygochelidon cyanoleuca*	9.7	closed	19	1.42	0.00031
Hirundinidae	*Stelgidopteryx ruficollis*	16.1	closed	11	1.40	0.00035
Hirundinidae	*Stelgidopteryx serripennis*	15.69	closed	6	1.38	0.00034
Hirundinidae	*Tachycineta albiventer*	17.7	closed	3	1.40	0.00032
Hirundinidae	*Tachycineta thalassina*	14.14	closed	4	1.42	0.00044
Icteridae	*Agelaioides badius*	45.25	closed	5	1.41	0.00022
Icteridae	*Agelaius phoeniceus*	50.78	open	11	1.40	0.00025
Icteridae	*Agelasticus cyanopus*	37.21	open	4	1.36	0.00020
Icteridae	*Agelasticus thilius*	31.5	open	30	1.37	0.00026
Icteridae	*Amblycercus holosericeus*	70.42	open	1	1.53	0.00022
Icteridae	*Amblyramphus holosericeus*	56.76	open	9	1.38	0.00028
Icteridae	*Cacicus cela*	85.45	closed	10	1.54	0.00050
Icteridae	*Cacicus chrysopterus*	36.16	closed	5	1.49	0.00030
Icteridae	*Cacicus haemorrhous*	83.71	closed	8	1.50	0.00043
Icteridae	*Cacicus solitarius*	79.76	closed	5	1.57	0.00041

Icteridae	*Chrysomus icterocephalus*	30.68	open	6	1.39	0.00034
Icteridae	*Chrysomus ruficapillus*	32	open	13	1.36	0.00029
Icteridae	*Curaeus curaeus*	83.7	open	14	1.42	0.00025
Icteridae	*Dives dives*	91.32	open	6	1.39	0.00030
Icteridae	*Gnorimopsar chopi*	65.9	closed	27	1.41	0.00031
Icteridae	*Icterus cayanensis*	33.3	open	3	1.42	0.00039
Icteridae	*Icterus cucullatus*	24.3	open	7	1.40	0.00053
Icteridae	*Icterus gularis*	55.16	closed	26	1.52	0.00054
Icteridae	*Icterus nigrogularis*	40.2	closed	10	1.52	0.00057
Icteridae	*Icterus pustulatus*	36.78	closed	22	1.53	0.00049
Icteridae	*Psarocolius angustifrons*	271.5	closed	2	1.48	0.00022
Icteridae	*Psarocolius decumanus*	206.3	closed	3	1.48	0.00036
Icteridae	*Psarocolius montezuma*	309.87	closed	10	1.42	0.00029
Icteridae	*Psarocolius wagleri*	155.5	closed	3	1.51	0.00021
Icteridae	*Pseudoleistes guirahuro*	86.42	open	5	1.39	0.00037
Icteridae	*Pseudoleistes virescens*	79.93	open	11	1.35	0.00023
Icteridae	*Quiscalus lugubris*	63.03	open	8	1.40	0.00022
Icteridae	*Quiscalus mexicanus*	160.47	open	5	1.50	0.00031
Icteridae	*Quiscalus nicaraguensis*	63.36	open	3	1.36	0.00030
Icteridae	*Sturnella bellicosa*	58	open	7	1.34	0.00024
Icteridae	*Sturnella defilippii*	48.01	open	6	1.42	0.00023
Icteridae	*Sturnella loyca*	113	open	38	1.41	0.00021
Icteridae	*Sturnella militaris*	48.01	open	5	1.33	0.00019
Icteridae	*Sturnella superciliaris*	45.32	open	5	1.36	0.00025
Icteriidae	*Icteria virens*	24.89	open	3	1.34	0.00015
Laniidae	*Lanius ludovicianus*	51.59	open	17	1.34	0.00040
Mimidae	*Melanotis caerulescens*	61.57	open	14	1.43	0.00030
Mimidae	*Mimus gilvus*	51.99	open	6	1.40	0.00029
Mimidae	*Mimus parvulus*	53.64	open	3	1.42	0.00024
Mimidae	*Mimus polyglottos*	48.5	open	8	1.36	0.00030
Mimidae	*Mimus saturninus*	63.7	open	22	1.40	0.00020
Mimidae	*Mimus thenca*	65.99	open	5	1.42	0.00026
Mimidae	*Toxostoma cinereum*	58.95	open	1	1.39	0.00029
Oxyruncidae	*Myiobius atricaudus*	10	closed	2	1.37	0.00017
Oxyruncidae	*Myiobius sulphureipygius*	11.64	closed	13	1.37	0.00019
Oxyruncidae	*Onychorhynchus coronatus*	14	closed	6	1.39	0.00027
Parulidae	*Basileuterus culicivorus*	10.5	closed	9	1.29	0.00024
Parulidae	*Basileuterus rufifrons*	10.4	closed	5	1.32	0.00026
Parulidae	*Basileuterus tristriatus*	12.03	closed	1	1.32	0.00024
Parulidae	*Dendroica petechia*	10.22	open	10	1.34	0.00028
Parulidae	*Euthlypis lachrymosa*	25.6	open	2	1.32	0.00024
Parulidae	*Geothlypis beldingi*	15.7	open	3	1.27	0.00020
Parulidae	*Geothlypis velata*	13.1	open	7	1.32	0.00022
Parulidae	*Phaeothlypis fulvicauda*	14.9	closed	5	1.43	0.00024
Parulidae	*Myioborus miniatus*	9	closed	18	1.34	0.00022
Passerellidae	*Arremon brunneinucha*	43.97	open	14	1.39	0.00023
Passerellidae	*Arremon castaneiceps*	36.9	closed	2	1.41	0.00043
Passerellidae	*Arremon flavirostris*	26.13	closed	3	1.51	0.00018
Passerellidae	*Arremon torquatus*	41.96	open	4	1.35	0.00022
Passerellidae	*Arremon virenticeps*	41	open	3	1.43	0.00029
Passerellidae	*Atlapetes albinucha*	33.84	open	4	1.37	0.00023

Passerellidae	*Atlapetes citrinellus*	28	open	6	1.35	0.00013
Passerellidae	*Atlapetes fulviceps*	28.2	open	2	1.42	0.00030
Passerellidae	*Atlapetes pileatus*	24	open	3	1.39	0.00025
Passerellidae	*Chlorospingus pileatus*	21	open	1	1.30	0.00012
Passerellidae	*Zonotrichia capensis*	20.31	open	114	1.34	0.00022
Pipridae	*Antilophia galeata*	21.48	open	6	1.45	0.00028
Pipridae	*Chiroxiphia linearis*	17.44	open	8	1.39	0.00019
Pipridae	*Chiroxiphia pareola*	16.84	open	3	1.37	0.00014
Pipridae	*Manacus aurantiacus*	15.5	open	6	1.37	0.00012
Pipridae	*Manacus candei*	19.82	open	5	1.36	0.00012
Pipridae	*Manacus manacus*	16.7	open	8	1.39	0.00015
Pipridae	*Pipra aureola*	16.14	open	3	1.42	0.00023
Polioptilidae	*Polioptila dumicola*	7	open	7	1.28	0.00019
Polioptilidae	*Ramphocaenus melanurus*	9.7	open	4	1.38	0.00017
Ptiliogonatidae	*Phainopepla nitens*	22.1	open	4	1.42	0.00039
Remizidae	*Auriparus flaviceps*	6.8	closed	10	1.35	0.00024
Rhinocryptidae	*Pteroptochos megapodius*	114	closed	7	1.31	0.00022
Rhinocryptidae	*Rhinocrypta lanceolata*	61.9	closed	7	1.31	0.00013
Rhinocryptidae	*Scelorchilus albicollis*	47.28	closed	4	1.25	0.00013
Rhinocryptidae	*Scytalopus fuscus*	13.7	closed	5	1.26	0.00025
Rhinocryptidae	*Scytalopus magellanicus*	13.67	closed	4	1.31	0.00027
Thamnophilidae	*Dysithamnus mentalis*	14.87	open	3	1.33	0.00018
Thamnophilidae	*Formicivora grisea*	10.36	open	3	1.37	0.00015
Thamnophilidae	*Myrmeciza exsul*	26.5	open	4	1.36	0.00026
Thamnophilidae	*Taraba major*	59.2	open	14	1.32	0.00012
Thamnophilidae	*Thamnophilus bridgesi*	27	open	3	1.38	0.00018
Thamnophilidae	*Thamnophilus caerulescens*	21.1	open	8	1.36	0.00017
Thamnophilidae	*Thamnophilus doliatus*	27.03	open	14	1.36	0.00028
Thamnophilidae	*Thamnophilus ruficapillus*	20.4	open	4	1.37	0.00018
Thraupidae	*Acanthidops bairdii*	16	open	1	1.28	0.00015
Thraupidae	*Catamenia inornata*	13.4	open	1	1.42	0.00041
Thraupidae	*Coryphospingus pileatus*	15.3	open	2	1.38	0.00021
Thraupidae	*Diglossa gloriosa*	11	open	1	1.35	0.00046
Thraupidae	*Diglossa lafresnayii*	16	open	1	1.43	0.00031
Thraupidae	*Diglossa plumbea*	10	open	1	1.23	0.00008
Thraupidae	*Emberizoides herbicola*	27.55	open	3	1.40	0.00016
Thraupidae	*Embernagra platensis*	27.55	open	3	1.32	0.00015
Thraupidae	*Eucometis penicillata*	27	open	4	1.38	0.00023
Thraupidae	*Geospiza fortis*	24	closed	6	1.33	0.00029
Thraupidae	*Geospiza fuliginosa*	14.5	closed	5	1.35	0.00029
Thraupidae	*Oryzoborus angolensis*	13	open	9	1.32	0.00021
Thraupidae	*Oryzoborus funereus*	13	open	2	1.36	0.00030
Thraupidae	*Paroaria capitata*	22.3	open	3	1.36	0.00040
Thraupidae	*Paroaria coronata*	37.79	open	4	1.39	0.00066
Thraupidae	*Phrygilus alaudinus*	23.93	open	18	1.39	0.00030
Thraupidae	*Phrygilus atriceps*	24.3	open	5	1.46	0.00042
Thraupidae	*Phrygilus fruticeti*	38.8	open	23	1.43	0.00034
Thraupidae	*Phrygilus gayi*	25.59	open	13	1.36	0.00028
Thraupidae	*Phrygilus patagonicus*	22.6	open	3	1.32	0.00031
Thraupidae	*Phrygilus plebejus*	14.68	open	3	1.31	0.00006
Thraupidae	*Phrygilus unicolor*	21.9	open	4	1.39	0.00025

Thraupidae	*Poospiza melanoleuca*	13.1	open	3	1.34	0.00024
Thraupidae	*Poospiza nigrorufa*	17.4	open	4	1.34	0.00026
Thraupidae	*Ramphocelus carbo*	25.92	open	24	1.36	0.00027
Thraupidae	*Ramphocelus dimidiatus*	28	open	5	1.44	0.00017
Thraupidae	*Ramphocelus flammigerus*	33	open	4	1.44	0.00033
Thraupidae	*Ramphocelus passerinii*	32	open	8	1.41	0.00031
Thraupidae	*Saltator atriceps*	83.79	open	6	1.43	0.00028
Thraupidae	*Saltator aurantiirostris*	41.89	open	6	1.36	0.00012
Thraupidae	*Saltator coerulescens*	54.9	open	14	1.43	0.00024
Thraupidae	*Saltator maximus*	47.62	open	16	1.41	0.00029
Thraupidae	*Saltator similis*	43.3	open	17	1.40	0.00026
Thraupidae	*Saltator striatipectus*	39	open	10	1.40	0.00035
Thraupidae	*Saltatricula multicolor*	22.2	open	4	1.30	0.00023
Thraupidae	*Sicalis flaveola*	16.89	closed	29	1.36	0.00034
Thraupidae	*Sicalis lutea*	16.3	closed	3	1.40	0.00022
Thraupidae	*Sicalis luteola*	15.9	open	56	1.34	0.00031
Thraupidae	*Sporophila bouvronides*	9.1	open	3	1.42	0.00032
Thraupidae	*Sporophila caerulescens*	9.73	open	7	1.38	0.00024
Thraupidae	*Sporophila castaneiventris*	7.8	open	3	1.27	0.00021
Thraupidae	*Sporophila corvina*	10.62	open	14	1.32	0.00023
Thraupidae	*Sporophila hypoxantha*	10.5	open	3	1.31	0.00031
Thraupidae	*Sporophila intermedia*	12.1	open	4	1.38	0.00023
Thraupidae	*Sporophila lineola*	9.8	open	5	1.37	0.00037
Thraupidae	*Sporophila minuta*	7.8	open	6	1.28	0.00027
Thraupidae	*Sporophila nigricollis*	9.6	open	9	1.33	0.00021
Thraupidae	*Sporophila peruviana*	12.6	open	4	1.41	0.00028
Thraupidae	*Sporophila telasco*	9.6	open	5	1.39	0.00019
Thraupidae	*Sporophila torqueola*	8.7	open	11	1.31	0.00020
Thraupidae	*Stephanophorus diadematus*	35.4	open	3	1.36	0.00026
Thraupidae	*Tachyphonus coronatus*	29.3	open	3	1.37	0.00031
Thraupidae	*Tachyphonus rufus*	34.4	open	12	1.33	0.00017
Thraupidae	*Tangara cayana*	18	open	3	1.43	0.00033
Thraupidae	*Tersina viridis*	29	closed	5	1.39	0.00024
Thraupidae	*Thraupis bonariensis*	36	open	9	1.40	0.00037
Thraupidae	*Thraupis episcopus*	35	open	27	1.41	0.00032
Thraupidae	*Thraupis palmarum*	39	open	11	1.43	0.00029
Thraupidae	*Thraupis sayaca*	32.49	open	18	1.43	0.00039
Thraupidae	*Tiaris bicolor*	9.8	closed	5	1.31	0.00024
Thraupidae	*Tiaris canorus*	8.1	closed	5	1.28	0.00025
Thraupidae	*Tiaris obscurus*	11.2	closed	5	1.34	0.00026
Thraupidae	*Tiaris olivaceus*	8.5	closed	16	1.33	0.00021
Thraupidae	*Volatinia jacarina*	9.94	open	45	1.33	0.00021
Tityridae	*Pachyramphus aglaiae*	29.69	closed	19	1.40	0.00030
Tityridae	*Pachyramphus castaneus*	19.5	closed	3	1.33	0.00034
Tityridae	*Pachyramphus polychopterus*	20.8	closed	3	1.40	0.00035
Tityridae	*Pachyramphus validus*	43	closed	7	1.36	0.00037
Troglodytidae	*Campylorhynchus brunneicapillus*	38.9	closed	10	1.44	0.00022
Troglodytidae	*Campylorhynchus jocosus*	27.6	closed	3	1.35	0.00028
Troglodytidae	*Campylorhynchus rufinucha*	31	closed	17	1.41	0.00021
Troglodytidae	*Campylorhynchus turdinus*	32.6	closed	3	1.40	0.00025
Troglodytidae	*Cistothorus platensis*	9.04	closed	12	1.34	0.00031

Troglodytidae	*Henicorhina leucophrys*	16.19	closed	6	1.36	0.00029
Troglodytidae	*Thryothorus felix*	12.75	closed	3	1.35	0.00025
Troglodytidae	*Thryothorus genibarbis*	19.2	closed	3	1.41	0.00017
Troglodytidae	*Thryothorus modestus*	17.57	closed	5	1.42	0.00024
Troglodytidae	*Thryothorus nigricapillus*	23.9	closed	1	1.47	0.00022
Troglodytidae	*Thryothorus pleurostictus*	17.7	closed	10	1.39	0.00023
Troglodytidae	*Thryothorus rufalbus*	24.87	closed	5	1.44	0.00035
Troglodytidae	*Thryothorus sinaloa*	15.1	closed	3	1.42	0.00025
Troglodytidae	*Troglodytes aedon*	10.85	closed	129	1.32	0.00032
Turdidae	*Catharus aurantiirostris*	29.8	open	25	1.36	0.00023
Turdidae	*Catharus dryas*	37.7	open	1	1.44	0.00054
Turdidae	*Catharus frantzii*	28.9	open	10	1.37	0.00033
Turdidae	*Catharus fuscater*	33.7	open	5	1.40	0.00031
Turdidae	*Catharus gracilirostris*	21	open	4	1.29	0.00014
Turdidae	*Catharus mexicanus*	33	open	8	1.43	0.00028
Turdidae	*Catharus occidentalis*	26.2	open	12	1.40	0.00037
Turdidae	*Myadestes genibarbis*	29.2	open	1	1.34	0.00023
Turdidae	*Myadestes melanops*	32.1	open	7	1.38	0.00036
Turdidae	*Myadestes occidentalis*	36.4	open	13	1.36	0.00024
Turdidae	*Myadestes ralloides*	29.1	open	1	1.38	0.00022
Turdidae	*Myadestes unicolor*	37.9	open	1	1.52	0.00051
Turdidae	*Turdus albicollis*	54	open	33	1.38	0.00032
Turdidae	*Turdus amaurochalinus*	57.9	open	18	1.39	0.00031
Turdidae	*Turdus assimilis*	70.2	open	21	1.42	0.00037
Turdidae	*Turdus chiguanco*	93.29	open	9	1.45	0.00032
Turdidae	*Turdus falcklandii*	93.89	open	30	1.41	0.00021
Turdidae	*Turdus fumigatus*	75.7	open	17	1.38	0.00032
Turdidae	*Turdus fuscater*	143	open	6	1.52	0.00026
Turdidae	*Turdus grayi*	79.5	open	63	1.41	0.00034
Turdidae	*Turdus infuscatus*	72.4	open	1	1.39	0.00037
Turdidae	*Turdus leucomelas*	69.1	open	15	1.38	0.00030
Turdidae	*Turdus leucops*	62.4	open	2	1.42	0.00040
Turdidae	*Turdus migratorius*	78.5	open	3	1.53	0.00020
Turdidae	*Turdus nigrescens*	96	open	4	1.42	0.00034
Turdidae	*Turdus nigriceps*	52.7	open	7	1.39	0.00030
Turdidae	*Turdus nudigenis*	63.89	open	19	1.40	0.00030
Turdidae	*Turdus olivater*	86.63	open	3	1.39	0.00020
Turdidae	*Turdus rufiventris*	69.44	open	55	1.40	0.00031
Turdidae	*Turdus serranus*	84.9	open	1	1.43	0.00022
Tyrannidae	*Agriornis lividus*	99.1	open	4	1.37	0.00024
Tyrannidae	*Agriornis micropterus*	67.79	open	1	1.31	0.00017
Tyrannidae	*Agriornis montanus*	63.3	open	2	1.39	0.00060
Tyrannidae	*Alectrurus tricolor*	16	open	1	1.45	0.00036
Tyrannidae	*Anairetes parulus*	6.2	open	19	1.32	0.00027
Tyrannidae	*Arundinicola leucocephala*	13.8	closed	9	1.35	0.00022
Tyrannidae	*Attila rufus*	42.6	open	2	1.44	0.00027
Tyrannidae	*Camptostoma imberbe*	7.4	closed	3	1.31	0.00037
Tyrannidae	*Camptostoma obsoletum*	8.1	closed	13	1.37	0.00040
Tyrannidae	*Cnemotriccus fuscatus*	13.6	open	4	1.34	0.00026
Tyrannidae	*Colonia colonus*	18.3	closed	2	1.48	0.00024
Tyrannidae	*Colorhamphus parvirostris*	10.6	open	1	1.33	0.00013

Tyrannidae	*Conopias parvus*	21	closed	1	1.26	0.00019
Tyrannidae	*Contopus caribaeus*	10.5	open	1	1.26	0.00020
Tyrannidae	*Contopus cinereus*	11.6	open	8	1.28	0.00025
Tyrannidae	*Contopus hispaniolensis*	11.7	open	2	1.26	0.00028
Tyrannidae	*Contopus latirostris*	11.2	open	2	1.30	0.00063
Tyrannidae	*Contopus pertinax*	27.2	open	1	1.37	0.00023
Tyrannidae	*Elaenia albiceps*	15.5	open	18	1.37	0.00040
Tyrannidae	*Elaenia chiriquensis*	15.4	open	17	1.33	0.00032
Tyrannidae	*Elaenia cristata*	18.2	open	1	1.37	0.00031
Tyrannidae	*Elaenia flavogaster*	24.8	open	47	1.36	0.00026
Tyrannidae	*Elaenia obscura*	23.9	open	5	1.38	0.00050
Tyrannidae	*Elaenia parvirostris*	13.8	open	2	1.32	0.00036
Tyrannidae	*Elaenia strepera*	19.3	open	2	1.38	0.00041
Tyrannidae	*Empidonax albigularis*	9.58	open	1	1.29	0.00006
Tyrannidae	*Empidonax difficilis*	10.7	open	4	1.28	0.00017
Tyrannidae	*Empidonax flavescens*	12.5	open	13	1.28	0.00014
Tyrannidae	*Empidonax fulvifrons*	7.9	open	2	1.26	0.00022
Tyrannidae	*Empidonax occidentalis*	11.6	open	1	1.31	0.00019
Tyrannidae	*Empidonomus aurantioatrocristatus*	33	open	18	1.36	0.00042
Tyrannidae	*Empidonomus varius*	27.1	open	8	1.35	0.00032
Tyrannidae	*Euscarthmus meloryphus*	6.8	open	1	1.37	0.00085
Tyrannidae	*Fluvicola albiventer*	11.6	closed	15	1.38	0.00025
Tyrannidae	*Fluvicola nengeta*	21	closed	3	1.41	0.00026
Tyrannidae	*Fluvicola pica*	12.3	closed	15	1.36	0.00017
Tyrannidae	*Hemitriccus margaritaceiventer*	8.4	closed	7	1.41	0.00025
Tyrannidae	*Hirundinea ferruginea*	30.6	open	5	1.31	0.00041
Tyrannidae	*Hymenops perspicillatus*	22.9	open	29	1.34	0.00025
Tyrannidae	*Knipolegus aterrimus*	20.2	open	7	1.30	0.00024
Tyrannidae	*Knipolegus cyanirostris*	15.4	open	3	1.35	0.00034
Tyrannidae	*Knipolegus lophotes*	31.8	open	4	1.32	0.00021
Tyrannidae	*Knipolegus signatus*	17.8	open	6	1.32	0.00029
Tyrannidae	*Knipolegus striaticeps*	11	open	6	1.29	0.00027
Tyrannidae	*Lathrotriccus euleri*	11.33	open	6	1.32	0.00036
Tyrannidae	*Legatus leucophaius*	22.2	closed	15	1.37	0.00028
Tyrannidae	*Leptopogon amaurocephalus*	11.7	closed	3	1.28	0.00019
Tyrannidae	*Lessonia oreas*	13.8	open	2	1.37	0.00022
Tyrannidae	*Lessonia rufa*	13.4	open	34	1.33	0.00023
Tyrannidae	*Machetornis rixosa*	29.6	closed	21	1.33	0.00024
Tyrannidae	*Mecocerculus leucophrys*	10.98	open	1	1.32	0.00013
Tyrannidae	*Megarynchus pitangua*	69.91	open	13	1.37	0.00028
Tyrannidae	*Mionectes oleagineus*	11.17	closed	13	1.36	0.00021
Tyrannidae	*Muscisaxicola albifrons*	34	closed	1	1.43	0.00038
Tyrannidae	*Muscisaxicola albilora*	22.6	closed	3	1.34	0.00028
Tyrannidae	*Muscisaxicola capistratus*	26.6	closed	2	1.35	0.00030
Tyrannidae	*Muscisaxicola cinereus*	18.59	closed	1	1.36	0.00042
Tyrannidae	*Muscisaxicola flavinucha*	36.23	closed	4	1.35	0.00025
Tyrannidae	*Muscisaxicola juninensis*	22.2	closed	1	1.43	0.00027
Tyrannidae	*Muscisaxicola maclovianus*	23.79	closed	4	1.40	0.00025
Tyrannidae	*Muscisaxicola maculirostris*	14.2	open	10	1.31	0.00027
Tyrannidae	*Myiarchus barbirostris*	13.4	closed	1	1.30	0.00018
Tyrannidae	*Myiarchus cinerascens*	28.2	closed	10	1.34	0.00028

Tyrannidae	*Myiarchus ferox*	27.5	closed	14	1.35	0.00038
Tyrannidae	*Myiarchus nuttingi*	23	closed	3	1.29	0.00020
Tyrannidae	*Myiarchus oberi*	34.71	closed	1	1.27	0.00024
Tyrannidae	*Myiarchus panamensis*	31.7	closed	2	1.30	0.00038
Tyrannidae	*Myiarchus phaeocephalus*	26.3	closed	1	1.38	0.00036
Tyrannidae	*Myiarchus sagrae*	19.28	closed	1	1.27	0.00033
Tyrannidae	*Myiarchus semirufus*	22.5	closed	1	1.38	0.00035
Tyrannidae	*Myiarchus stolidus*	20.8	closed	3	1.30	0.00030
Tyrannidae	*Myiarchus swainsoni*	25.1	closed	2	1.25	0.00023
Tyrannidae	*Myiarchus tuberculifer*	17.7	closed	11	1.29	0.00032
Tyrannidae	*Myiarchus tyrannulus*	35.45	closed	19	1.35	0.00031
Tyrannidae	*Myiodynastes bairdii*	45	closed	1	1.43	0.00048
Tyrannidae	*Myiodynastes chrysocephalus*	38.3	closed	3	1.35	0.00024
Tyrannidae	*Myiodynastes luteiventris*	46.9	closed	4	1.35	0.00015
Tyrannidae	*Myiodynastes maculatus*	43.2	closed	24	1.37	0.00031
Tyrannidae	*Myiopagis gaimardii*	12.02	open	2	1.25	0.00029
Tyrannidae	*Myiopagis viridicata*	11.51	open	2	1.35	0.00014
Tyrannidae	*Myiophobus cryptoxanthus*	9.8	open	1	1.32	0.00035
Tyrannidae	*Myiophobus fasciatus*	9.9	open	45	1.36	0.00040
Tyrannidae	*Myiophobus inornatus*	11.2	open	1	1.26	0.00018
Tyrannidae	*Myiozetetes cayanensis*	25.9	closed	15	1.41	0.00030
Tyrannidae	*Myiozetetes granadensis*	29.3	closed	10	1.42	0.00044
Tyrannidae	*Myiozetetes similis*	28	closed	63	1.41	0.00031
Tyrannidae	*Neoxolmis rufiventris*	77	open	3	1.52	0.00045
Tyrannidae	*Ochthoeca fumicolor*	16.6	open	1	1.30	0.00020
Tyrannidae	*Oncostoma olivaceum*	6.6	closed	1	1.35	0.00049
Tyrannidae	*Phaeomyias murina*	10	open	5	1.31	0.00026
Tyrannidae	*Phaeomyias tumbezana*	11.5	open	2	1.28	0.00024
Tyrannidae	*Phelpsia inornatus*	29.4	open	1	1.32	0.00023
Tyrannidae	*Phylloscartes ventralis*	8.3	closed	5	1.39	0.00019
Tyrannidae	*Pitangus sulphuratus*	62.85	closed	146	1.38	0.00033
Tyrannidae	*Platyrinchus cancrominus*	9.2	open	1	1.34	0.00007
Tyrannidae	*Platyrinchus coronatus*	9.14	open	3	1.24	0.00017
Tyrannidae	*Poecilotriccus plumbeiceps*	5.7	closed	4	1.37	0.00025
Tyrannidae	*Pseudocolopteryx flaviventris*	7.5	open	8	1.32	0.00021
Tyrannidae	*Pseudocolopteryx sclateri*	8	open	1	1.32	0.00017
Tyrannidae	*Pyrocephalus rubinus*	14.4	open	51	1.32	0.00034
Tyrannidae	*Rhynchocyclus brevirostris*	24.3	closed	8	1.48	0.00022
Tyrannidae	*Rhynchocyclus olivaceus*	21.3	closed	1	1.37	0.00012
Tyrannidae	*Satrapa icterophrys*	21.5	open	22	1.35	0.00034
Tyrannidae	*Sayornis nigricans*	18.63	open	32	1.32	0.00029
Tyrannidae	*Sayornis saya*	20.9	open	1	1.25	0.00013
Tyrannidae	*Serpophaga cinerea*	8.3	open	2	1.33	0.00021
Tyrannidae	*Serpophaga nigricans*	8.5	open	5	1.31	0.00034
Tyrannidae	*Serpophaga subcristata*	6.6	open	14	1.29	0.00028
Tyrannidae	*Stigmatura budytoides*	11.08	open	6	1.29	0.00047
Tyrannidae	*Sublegatus arenarum*	12.3	open	5	1.37	0.00025
Tyrannidae	*Sublegatus modestus*	14	open	3	1.32	0.00034
Tyrannidae	*Tachuris rubrigastra*	7.8	open	25	1.32	0.00020
Tyrannidae	*Todirostrum cinereum*	6.29	closed	29	1.41	0.00026
Tyrannidae	*Todirostrum maculatum*	7.3	closed	6	1.45	0.00027

Tyrannidae	*Tolmomyias flaviventris*	12.2	closed	5	1.44	0.00030
Tyrannidae	*Tolmomyias sulphurescens*	14.3	closed	16	1.49	0.00035
Tyrannidae	*Tyrannus albogularis*	37.1	open	2	1.40	0.00025
Tyrannidae	*Tyrannus caudifasciatus*	42.36	open	1	1.29	0.00038
Tyrannidae	*Tyrannus couchii*	39	open	21	1.37	0.00036
Tyrannidae	*Tyrannus crassirostris*	55.89	open	1	1.37	0.00053
Tyrannidae	*Tyrannus cubensis*	93.6	open	1	1.49	0.00025
Tyrannidae	*Tyrannus dominicensis*	46.5	open	16	1.39	0.00038
Tyrannidae	*Tyrannus melancholicus*	37.4	open	110	1.36	0.00039
Tyrannidae	*Tyrannus niveigularis*	34.4	open	3	1.30	0.00039
Tyrannidae	*Tyrannus savana*	31.9	open	70	1.36	0.00043
Tyrannidae	*Tyrannus verticalis*	39.6	open	1	1.28	0.00029
Tyrannidae	*Tyrannus vociferans*	45.6	open	5	1.34	0.00017
Tyrannidae	*Xenotriccus mexicanus*	13.8	open	3	1.35	0.00026
Tyrannidae	*Xolmis cinereus*	57.1	open	10	1.36	0.00025
Tyrannidae	*Xolmis coronatus*	46.8	open	7	1.34	0.00023
Tyrannidae	*Xolmis irupero*	28.7	closed	14	1.34	0.00030
Tyrannidae	*Xolmis pyrope*	35.3	open	14	1.36	0.00019
Tyrannidae	*Xolmis velatus*	28.7	closed	5	1.40	0.00030
Vireonidae	*Cyclarhis gujanensis*	28.8	open	7	1.37	0.00038
Vireonidae	*Hylophilus pectoralis*	11.6	open	3	1.35	0.00031
Vireonidae	*Vireo altiloquus*	18.97	open	3	1.45	0.00049
Vireonidae	*Vireo flavoviridis*	18	open	8	1.40	0.00031
Vireonidae	*Vireo olivaceus*	16.06	open	11	1.35	0.00038

Table S5. Abbreviations and locations of the 33 museums where passerine's reproductive data were collected for Chapter 3

Museum	Abbreviation	Location
American Museum of Natural History	AMNH	New York, USA
California Academy of Sciences	CAS	San Francisco, USA
Coleção Ornitológica Marcelo Bagno, Universidade de Brasília	COMB	Brasília, Brazil
Cris-River Regional Museum	CRRP	Oradea, Romania
Delaware Museum of Natural History	DMNH	Wilmington, USA
Fundación Miguel Lillo	FML	Tucumán, Argentina
Fundação Zoobotânica do Rio Grande do Sul	FZB	Porto Alegre, Brazil
Instituto de Investigaciones de Recursos Biológicos "Alexander von Humboldt"	IAvH	Vila de Leyva, Colombia
Museo Argentino de Ciencias Naturales	MACN	Buenos Aires, Argentina
Museum of Comparative Zoology, Harvard University	MCZ	Cambridge, USA
Muséum d'Histoire Naturelle de Genève	MHNG	Geneva, Switzerland
Museo de La Plata	MLP	La Plata, Argentina
Zentralmagazin Naturwissenschaftlicher Sammlungen, Martin Luther University HalleWittenberg	MLUH	Halle (Saale), Germany
Museu Nacional	MN	Rio de Janeiro, Brazil
Museo Nacional de Costa Rica	MNCR	San José, Costa Rica
Museo Ñuble Naturaleza	MNN	Chillán, Chile
Museu Paraense Emilio Goeldi	MPEG	Belém, Brazil
Musée Zoologique de l'Université Louis Pasteur et de la ville de Strasbourg	MZS	Strasbourg, France
Museo Zoológico, Universidad de Concepción	MZUC	Concepción, Chile
Museu de Zoologia, Universidade de São Paulo	MZUSP	São Paulo, Brazil
Naturalis, Nationaal Natuurhistorisch Museum	NBCN	Leiden, The Netherlands
The Natural History Museum	NHM	Tring, UK
Landesmuseum Hannover	NLMH	Hannover, Germany
Naturhistorisches Museum Bern	NMBE	Bern, Switzerland
National Museums Scotland	NMS	Edinburgh, UK
Naturhistorisches Museum Wien	NMW	Vienna, Austria
Museu de Ciências e Tecnologia da PUCRS	PUCRS	Porto Alegre, Brazil
San Bernardino County Museum	SBCM	Redlands, USA
Museo de Zoologia, Universidad de Costa Rica	UCR	San José, Costa Rica
Museu de Zoologia, Universidade Federal Rural do Rio de Janeiro	UFRRJ	Seropédica, Brazil
National Museum of Natural History	USNM	Washington, D.C., USA
Western Foundation of Vertebrate Zoology	WFVZ	Camarillo, USA
Museum für Naturkunde	ZMB	Berlin, Germany

Table S6. Species (Jetz et al. 2012), nest type, diet (Car: carnivore, Herb: herbivore, Omn: omnivore), intra-clutch variation (CV = coefficient of variation %) of egg elongation and asymmetry, and number of clutches (N) of Neotropical passerines evaluated in Chapter 3.

Family	Species	Nest type	Diet	CV Elongation	CV Asymmetry	N
Aegithalidae	*Psaltriparus minimus*	closed	Car	1.4012	34.7206	12
Alaudidae	*Eremophila alpestris*	closed	Omn	2.5201	26.2306	3
Cardinalidae	*Habia fuscicauda*	open	Car	2.37624	17.2632	3
Cardinalidae	*Cyanocompsa cyanoides*	open	Her	4.02107	16.7501	3
Cardinalidae	*Passerina rositae*	open	Her	2.39318	34.9947	3
Cardinalidae	*Chlorothraupis carmioli*	open	Car	1.54916	50.3455	4
Cardinalidae	*Cyanocompsa brissonii*	open	Her	2.04653	33.852	14
Cardinalidae	*Piranga flava*	open	Car	3.2521	29.0596	13
Cardinalidae	*Cardinalis sinuatus*	open	Omn	1.98502	46.3212	3
Cardinalidae	*Cardinalis cardinalis*	open	Omn	2.4339	36.1429	6
Conopophagidae	*Conopophaga lineata*	open	Car	2.43071	48.3486	7
Corvidae	*Cyanocorax chrysops*	open	Car	2.82807	35.2962	13
Corvidae	*Cyanocorax cyanomelas*	open	Omn	2.47281	31.4198	11
Corvidae	*Cyanocorax morio*	open	Omn	4.09257	34.1422	3
Corvidae	*Cyanocorax cyanopogon*	open	Omn	3.00785	12.3535	3
Corvidae	*Cyanocorax yncas*	open	Omn	2.64222	41.1355	14
Corvidae	*Cyanocorax cristatellus*	open	Omn	3.06344	27.1534	4
Corvidae	*Aphelocoma californica*	open	Omn	1.70289	44.4959	4
Cotingidae	*Phytotoma rara*	open	Her	2.88375	41.6293	14
Cotingidae	*Phytotoma rutila*	open	Her	2.77547	40.2731	33
Donacobiidae	*Donacobius atricapilla*	open	Car	1.32521	35.1308	3
Fringillidae	*Euphonia violacea*	closed	Her	2.26216	30.8582	6
Fringillidae	*Euphonia luteicapilla*	closed	Her	1.77665	35.9263	3
Fringillidae	*Carpodacus mexicanus*	open	Her	2.71485	36.6256	35
Fringillidae	*Euphonia laniirostris*	closed	Her	1.71981	31.1223	5
Fringillidae	*Carduelis magellanica*	open	Her	2.01639	46.5233	4
Furnariidae	*Synallaxis albescens*	closed	Car	2.55208	30.1141	22
Furnariidae	*Xiphorhynchus susurrans*	closed	Car	2.47478	59.7722	4
Furnariidae	*Cinclodes fuscus*	closed	Car	1.42526	23.5603	7
Furnariidae	*Premnoplex brunnescens*	closed	Car	1.30437	52.011	3
Furnariidae	*Synallaxis brachyura*	closed	Car	1.56651	54.7056	7
Furnariidae	*Cinclodes patagonicus*	closed	Car	2.02653	22.2657	7
Furnariidae	*Geositta cunicularia*	closed	Car	1.29449	20.9678	16
Furnariidae	*Pygarrhichas albogularis*	closed	Car	0.55086	24.694	3
Furnariidae	*Phacellodomus ruber*	closed	Car	1.87178	25.7654	8
Furnariidae	*Certhiaxis cinnamomeus*	closed	Car	2.06036	36.4596	17
Furnariidae	*Phacellodomus rufifrons*	closed	Car	3.40075	25.7775	6
Furnariidae	*Synallaxis azarae*	closed	Car	3.02151	23.4735	5
Furnariidae	*Pseudoseisura lophotes*	closed	Car	2.31252	26.837	7
Furnariidae	*Anumbius annumbi*	closed	Car	2.12747	36.4266	14
Furnariidae	*Sclerurus albigularis*	closed	Car	2.15114	47.7873	3
Furnariidae	*Automolus rubiginosus*	closed	Car	2.06042	68.3384	3
Furnariidae	*Synallaxis spixi*	closed	Car	0.97793	61.6537	5

Furnariidae	*Phleocryptes melanops*	closed	Car	2.52047	40.2507	29
Furnariidae	*Furnarius rufus*	closed	Car	2.28549	43.8765	26
Furnariidae	*Furnarius leucopus*	closed	Car	3.14089	39.9506	3
Furnariidae	*Upucerthia dumetaria*	closed	Car	1.94057	26.2047	7
Furnariidae	*Lepidocolaptes angustirostris*	closed	Car	1.83322	34.9256	6
Furnariidae	*Furnarius cristatus*	closed	Car	3.28177	22.7636	4
Furnariidae	*Xiphocolaptes major*	closed	Car	2.92831	28.4977	3
Furnariidae	*Aphrastura spinicauda*	closed	Car	2.40454	23.9799	5
Furnariidae	*Asthenes modesta*	closed	Car	1.86664	40.5835	17
Furnariidae	*Limnornis curvirostris*	closed	Car	2.38331	47.8517	5
Furnariidae	*Cranioleuca pyrrhophia*	closed	Car	1.09511	35.5296	8
Furnariidae	*Asthenes pyrrholeuca*	closed	Car	1.86526	39.1165	10
Furnariidae	*Schoeniophylax phryganophilus*	closed	Car	2.03453	43.0428	8
Furnariidae	*Phacellodomus sibilatrix*	closed	Car	2.83706	56.4474	6
Furnariidae	*Leptasthenura aegithaloides*	closed	Car	1.95926	27.2724	17
Furnariidae	*Asthenes baeri*	closed	Car	2.34329	38.9397	4
Furnariidae	*Drymornis bridgesii*	closed	Car	3.48413	49.9597	5
Furnariidae	*Tarphonomus certhioides*	closed	Car	2.9703	22.8316	5
Furnariidae	*Asthenes hudsoni*	closed	Car	0.89102	25.8281	3
Furnariidae	*Coryphistera alaudina*	closed	Car	2.53505	41.2348	5
Furnariidae	*Geositta rufipennis*	closed	Car	2.89922	56.8257	4
Furnariidae	*Synallaxis frontalis*	closed	Car	1.33754	51.6957	6
Furnariidae	*Sylviorthorhynchus desmursii*	closed	Car	2.97029	25.8034	4
Furnariidae	*Cinclodes comechingonus*	closed	Car	0.04442	39.4011	1
Furnariidae	*Asthenes humicola*	closed	Car	2.71467	48.058	10
Furnariidae	*Xiphorhynchus flavigaster*	closed	Car	1.44023	96.2374	3
Furnariidae	*Ochetorhynchus phoenicurus*	closed	Car	1.43861	22.0373	2
Furnariidae	*Cinclodes nigrofumosus*	closed	Car	0.99031	3.33084	1
Furnariidae	*Pseudoseisura gutturalis*	closed	Car	2.68267	49.1477	3
Furnariidae	*Spartonoica maluroides*	open	Car	1.06193	32.702	3
Furnariidae	*Ochetorhynchus melanura*	closed	Car	1.2646	29.7881	5
Furnariidae	*Cinclodes atacamensis*	closed	Car	2.02418	73.0078	2
Furnariidae	*Upucerthia albigula*	closed	Car	0.19855	3.54267	1
Grallariidae	*Grallaria guatimalensis*	open	Car	2.36672	55.1187	3
Hirundinidae	*Progne chalybea*	closed	Car	1.62642	23.4605	10
Hirundinidae	*Notiochelidon murina*	closed	Car	5.6044	36.3132	2
Hirundinidae	*Stelgidopteryx serripennis*	closed	Car	2.1111	27.2871	6
Hirundinidae	*Stelgidopteryx ruficollis*	closed	Car	2.05658	29.3193	11
Hirundinidae	*Tachycineta thalassina*	closed	Car	1.62278	40.7814	4
Hirundinidae	*Tachycineta albiventer*	closed	Car	1.43131	19.987	3
Hirundinidae	*Progne tapera*	closed	Car	2.69953	27.2654	6
Hirundinidae	*Pygochelidon cyanoleuca*	closed	Car	3.11449	39.6099	15
Hirundinidae	*Alopochelidon fucata*	closed	Car	1.70717	19.3403	5
Hirundinidae	*Progne elegans*	closed	Car	4.08073	74.2325	3
Icteridae	*Cacicus solitarius*	closed	Car	4.61522	22.5656	4
Icteridae	*Agelaius phoeniceus*	open	Her	2.21222	37.382	11
Icteridae	*Icterus pustulatus*	closed	Car	1.99907	24.4706	21

Icteridae	*Sturnella bellicosa*	open	Omn	1.89718	48.226	6
Icteridae	*Sturnella loyca*	open	Omn	2.80401	38.0854	38
Icteridae	*Curaeus curaeus*	open	Omn	1.99014	27.7245	14
Icteridae	*Chrysomus icterocephalus*	open	Her	2.59961	36.6766	6
Icteridae	*Cacicus chrysopterus*	closed	Omn	2.6321	56.366	5
Icteridae	*Cacicus cela*	closed	Omn	3.21154	21.0942	10
Icteridae	*Icterus cayanensis*	open	Car	1.82337	46.7543	3
Icteridae	*Icterus nigrogularis*	closed	Omn	2.33973	22.4743	9
Icteridae	*Psarocolius decumanus*	closed	Omn	2.7665	16.5126	3
Icteridae	*Amblycercus holosericeus*	open	Car	3.07163	30.3069	1
Icteridae	*Gnorimopsar chopi*	closed	Omn	3.48989	40.8978	27
Icteridae	*Cacicus haemorrhous*	closed	Car	2.9053	26.324	8
Icteridae	*Quiscalus lugubris*	open	Omn	2.94168	35.8945	8
Icteridae	*Psarocolius wagleri*	closed	Omn	3.46649	27.5997	2
Icteridae	*Psarocolius montezuma*	closed	Omn	2.73903	39.9808	9
Icteridae	*Sturnella militaris*	open	Car	2.17066	27.0158	5
Icteridae	*Icterus gularis*	closed	Omn	2.50936	23.6277	25
Icteridae	*Dives dives*	open	Omn	2.49889	27.8624	6
Icteridae	*Quiscalus mexicanus*	open	Omn	2.52487	35.293	5
Icteridae	*Chrysomus ruficapillus*	open	Her	2.96271	36.3541	13
Icteridae	*Amblyramphus holosericeus*	open	Car	2.34532	44.5576	9
Icteridae	*Psarocolius angustifrons*	closed	Omn	6.34474	48.9795	2
Icteridae	*Sturnella superciliaris*	open	Car	2.77259	41.9277	5
Icteridae	*Pseudoleistes virescens*	open	Omn	1.66462	35.7246	11
Icteridae	*Sturnella defilippii*	open	Omn	2.93753	45.4677	5
Icteridae	*Agelaioides badius*	closed	Omn	3.09012	47.088	5
Icteridae	*Pseudoleistes guirahuro*	open	Omn	2.09273	42.1678	5
Icteridae	*Agelasticus thilius*	open	Car	2.14211	41.9953	29
Icteridae	*Agelasticus cyanopus*	open	Omn	4.66326	45.9444	3
Icteridae	*Quiscalus nicaraguensis*	open	Omn	1.70819	46.6181	3
Icteridae	*Icterus cucullatus*	open	Omn	2.00706	18.6528	7
Icteriidae	*Icteria virens*	open	Car	2.3117	25.9373	3
Laniidae	*Lanius ludovicianus*	open	Car	2.17728	25.8089	17
Mimidae	*Melanotis caerulescens*	open	Omn	1.9332	23.2592	13
Mimidae	*Mimus thenca*	open	Omn	1.89625	47.5247	5
Mimidae	*Mimus saturninus*	open	Omn	2.42708	35.4909	22
Mimidae	*Mimus gilvus*	open	Car	1.86209	37.7515	6
Mimidae	*Mimus polyglottos*	open	Omn	1.95919	31.6819	7
Mimidae	*Mimus parvulus*	open	Omn	1.71756	43.6898	3
Mimidae	*Toxostoma cinereum*	open	Car	0.50101	8.79996	1
Oxyruncidae	*Myiobius sulphureipygius*	closed	Car	2.19182	18.3575	9
Oxyruncidae	*Onychorhynchus coronatus*	closed	Car	1.46351	32.4754	5
Oxyruncidae	*Myiobius atricaudus*	closed	Car	2.67702	45.8702	2
Parulidae	*Phaeothlypis fulvicauda*	closed	Car	1.32515	19.6771	4
Parulidae	*Basileuterus culicivorus*	closed	Car	1.71633	22.4617	9
Parulidae	*Basileuterus rufifrons*	closed	Car	1.7601	29.5119	5
Parulidae	*Geothlypis velata*	open	Car	1.80832	39.635	6

Parulidae	*Dendroica petechia*	open	Car	2.29447	40.4405	10
Parulidae	*Euthlypis lachrymosa*	open	Car	0.27574	21.3839	2
Parulidae	*Basileuterus tristriatus*	closed	Car	0.72626	2.00903	1
Parulidae	*Geothlypis beldingi*	open	Car	1.28908	36.7329	3
Parulidae	*Myioborus miniatus*	closed	Car	2.40185	39.5939	16
Passerellidae	*Atlapetes albinucha*	open	Omn	1.00396	17.1184	4
Passerellidae	*Zonotrichia capensis*	open	Omn	2.0797	35.4502	103
Passerellidae	*Arremon flavirostris*	closed	Omn	3.10292	45.0148	3
Passerellidae	*Arremon torquatus*	open	Omn	2.29865	37.4064	4
Passerellidae	*Arremon castaneiceps*	closed	Omn	4.31178	9.95701	2
Passerellidae	*Arremon brunneinucha*	open	Car	1.53524	28.1543	14
Passerellidae	*Atlapetes pileatus*	open	Omn	1.13119	16.602	3
Passerellidae	*Arremon virenticeps*	open	Omn	1.6252	40.4788	3
Passerellidae	*Atlapetes fulviceps*	open	Omn	3.09914	40.624	2
Passerellidae	*Atlapetes citrinellus*	open	Omn	1.5683	37.3311	6
Passerellidae	*Chlorospingus pileatus*	open	Omn	2.41285	11.7744	1
Pipridae	*Manacus manacus*	open	Her	1.36838	32.5038	7
Pipridae	*Manacus aurantiacus*	open	Her	3.01072	64.6398	4
Pipridae	*Manacus candei*	open	Her	1.85406	27.1137	5
Pipridae	*Pipra aureola*	open	Her	2.11509	20.1761	3
Pipridae	*Chiroxiphia linearis*	open	Her	1.01167	39.0962	8
Pipridae	*Antilophia galeata*	open	Her	2.05518	24.6333	3
Pipridae	*Chiroxiphia pareola*	open	Her	0.74184	42.3873	1
Polioptilidae	*Ramphocaenus melanurus*	open	Car	2.83518	30.1525	4
Polioptilidae	*Polioptila dumicola*	open	Car	2.38706	54.3504	7
Ptiliogonatidae	*Phainopepla nitens*	open	Her	2.62932	27.2097	3
Remizidae	*Auriparus flaviceps*	closed	Car	1.93293	36.0088	8
Rhinocryptidae	*Rhinocrypta lanceolata*	closed	Car	2.59962	59.8898	6
Rhinocryptidae	*Pteroptochos megapodius*	closed	Car	1.7302	50.8582	7
Rhinocryptidae	*Scytalopus fuscus*	closed	Car	0.8438	39.7031	3
Rhinocryptidae	*Scytalopus magellanicus*	closed	Car	3.07711	29.3268	2
Rhinocryptidae	*Scelorchilus albicollis*	closed	Car	1.81518	38.2108	4
Thamnophilidae	*Thamnophilus doliatus*	open	Car	1.51111	25.3045	11
Thamnophilidae	*Taraba major*	open	Car	1.89101	48.7447	13
Thamnophilidae	*Myrmeciza exsul*	open	Car	0.62217	38.9612	3
Thamnophilidae	*Dysithamnus mentalis*	open	Car	0.94703	50.773	3
Thamnophilidae	*Formicivora grisea*	open	Car	1.29198	15.7502	2
Thamnophilidae	*Thamnophilus ruficapillus*	open	Car	1.43197	77.1682	4
Thamnophilidae	*Thamnophilus caerulescens*	open	Car	2.36871	48.4104	6
Thamnophilidae	*Thamnophilus bridgesi*	open	Car	1.73104	17.1631	3
Thraupidae	*Saltator striatipectus*	open	Omn	3.01756	27.2752	10
Thraupidae	*Eucometis penicillata*	open	Car	2.59094	12.1685	4
Thraupidae	*Ramphocelus passerinii*	open	Omn	3.62394	24.3185	6
Thraupidae	*Thraupis episcopus*	open	Omn	3.07683	35.3437	24
Thraupidae	*Saltator maximus*	open	Her	2.21843	32.6365	15
Thraupidae	*Volatinia jacarina*	open	Her	2.3231	32.6553	41
Thraupidae	*Ramphocelus carbo*	open	Omn	2.7327	26.9253	21

Thraupidae	*Tachyphonus rufus*	open	Car	2.09654	37.922	12
Thraupidae	*Sporophila corvina*	open	Her	1.7984	35.1874	12
Thraupidae	*Tiaris olivaceus*	closed	Her	1.24563	23.1973	13
Thraupidae	*Tiaris canorus*	closed	Her	2.36735	41.0701	5
Thraupidae	*Sporophila nigricollis*	open	Her	1.55765	20.2089	9
Thraupidae	*Tangara cayana*	open	Her	1.48117	9.929	3
Thraupidae	*Sporophila lineola*	open	Her	2.75263	27.1542	5
Thraupidae	*Phrygilus atriceps*	open	Her	2.55149	31.1171	5
Thraupidae	*Thraupis palmarum*	open	Omn	1.50393	37.0585	9
Thraupidae	*Ramphocelus dimidiatus*	open	Omn	0.98351	23.5872	3
Thraupidae	*Thraupis sayaca*	open	Omn	2.78801	37.4383	17
Thraupidae	*Sporophila torqueola*	open	Her	2.57811	43.5664	11
Thraupidae	*Phrygilus fruticeti*	open	Her	2.42256	38.2169	21
Thraupidae	*Sporophila bouvronides*	open	Her	1.4174	17.9208	2
Thraupidae	*Sporophila intermedia*	open	Her	2.10706	52.6118	4
Thraupidae	*Sicalis flaveola*	closed	Her	2.85199	27.4684	29
Thraupidae	*Saltator coerulescens*	open	Omn	1.77197	26.5051	12
Thraupidae	*Sporophila caerulescens*	open	Her	1.66336	17.8486	6
Thraupidae	*Phrygilus alaudinus*	open	Her	2.06606	25.4259	18
Thraupidae	*Sporophila minuta*	open	Her	2.32412	53.7864	4
Thraupidae	*Tiaris obscurus*	closed	Her	2.51116	31.2838	4
Thraupidae	*Saltator atriceps*	open	Omn	1.83363	27.7955	5
Thraupidae	*Ramphocelus flammigerus*	open	Her	3.59948	14.9847	4
Thraupidae	*Sicalis luteola*	open	Her	2.21843	36.5135	54
Thraupidae	*Phrygilus unicolor*	open	Her	1.53488	24.7186	4
Thraupidae	*Tiaris bicolor*	closed	Her	2.01195	39.1626	5
Thraupidae	*Oryzoborus funereus*	open	Her	1.90472	40.2285	2
Thraupidae	*Emberizoides herbicola*	open	Her	0.89248	35.5729	3
Thraupidae	*Sporophila telasco*	open	Her	2.35405	31.3329	4
Thraupidae	*Oryzoborus angolensis*	open	Her	2.13218	35.949	8
Thraupidae	*Saltator similis*	open	Car	1.96602	29.6633	17
Thraupidae	*Sicalis lutea*	closed	Her	1.93072	44.44	3
Thraupidae	*Saltator aurantiirostris*	open	Her	2.22761	44.2742	6
Thraupidae	*Thraupis bonariensis*	open	Omn	2.84499	22.9769	9
Thraupidae	*Paroaria coronata*	open	Omn	3.39994	25.6659	3
Thraupidae	*Paroaria capitata*	open	Omn	0.77775	26.9849	3
Thraupidae	*Tersina viridis*	closed	Her	2.17149	28.2946	4
Thraupidae	*Stephanophorus diadematus*	open	Her	2.53179	24.7361	3
Thraupidae	*Phrygilus patagonicus*	open	Her	5.1113	45.3742	3
Thraupidae	*Sporophila hypoxantha*	open	Her	3.57412	28.0667	2
Thraupidae	*Tachyphonus coronatus*	open	Car	1.8469	21.6701	3
Thraupidae	*Sporophila castaneiventris*	open	Her	1.8935	26.7475	3
Thraupidae	*Catamenia inornata*	open	Her	2.82531	39.3834	1
Thraupidae	*Phrygilus gayi*	open	Her	1.8545	29.2882	11
Thraupidae	*Poospiza nigrorufa*	open	Omn	3.06336	19.8621	4
Thraupidae	*Phrygilus plebejus*	open	Her	4.35317	64.1493	3
Thraupidae	*Poospiza melanoleuca*	open	Omn	2.61748	44.0472	3

Thraupidae	*Geospiza fortis*	closed	Her	1.95556	27.3455	6
Thraupidae	*Geospiza fuliginosa*	closed	Her	1.62475	29.5215	5
Thraupidae	*Embernagra platensis*	open	Her	1.94516	37.0668	3
Thraupidae	*Coryphospingus pileatus*	open	Omn	5.31503	9.22975	2
Thraupidae	*Sporophila peruviana*	open	Her	2.6304	25.0073	4
Thraupidae	*Diglossa gloriosa*	open	Her	0.51184	6.6686	1
Thraupidae	*Saltatricula multicolor*	open	Omn	2.53608	39.8228	4
Thraupidae	*Acanthidops bairdii*	open	Car	1.14334	55.8126	1
Thraupidae	*Diglossa plumbea*	open	Her	2.64971	2.02984	1
Tityridae	*Pachyramphus castaneus*	closed	Car	1.27629	40.2503	3
Tityridae	*Pachyramphus validus*	closed	Car	2.59723	46.2622	7
Tityridae	*Pachyramphus aglaiae*	closed	Omn	2.34334	25.8684	19
Tityridae	*Pachyramphus polychopterus*	closed	Car	1.23183	22.1906	3
Troglodytidae	*Thryothorus genibarbis*	closed	Car	1.229	71.5488	2
Troglodytidae	*Troglodytes aedon*	closed	Car	1.83943	30.6126	123
Troglodytidae	*Thryothorus modestus*	closed	Car	1.61362	45.6727	5
Troglodytidae	*Cistothorus platensis*	closed	Car	2.14088	28.1807	12
Troglodytidae	*Henicorhina leucophrys*	closed	Car	1.22573	52.0072	6
Troglodytidae	*Campylorhynchus rufinucha*	closed	Car	2.04805	37.5282	16
Troglodytidae	*Thryothorus rufalbus*	closed	Car	2.54352	34.9931	4
Troglodytidae	*Thryothorus pleurostictus*	closed	Car	1.98324	33.1058	10
Troglodytidae	*Campylorhynchus turdinus*	closed	Car	1.30778	28.4259	3
Troglodytidae	*Campylorhynchus jocosus*	closed	Car	2.01511	33.6356	3
Troglodytidae	*Thryothorus felix*	closed	Car	2.62309	28.5434	3
Troglodytidae	*Campylorhynchus brunneicapillus*	closed	Car	1.90298	35.5496	10
Troglodytidae	*Thryothorus nigricapillus*	closed	Car	2.38091	40.3937	1
Troglodytidae	*Thryothorus sinaloa*	closed	Car	1.99152	39.7633	3
Turdidae	*Catharus aurantiirostris*	open	Car	1.7892	27.2358	25
Turdidae	*Turdus fumigatus*	open	Car	1.70407	34.1202	16
Turdidae	*Turdus grayi*	open	Omn	2.13243	27.1506	54
Turdidae	*Turdus assimilis*	open	Car	2.1053	20.3649	21
Turdidae	*Myadestes melanops*	open	Her	1.32586	16.4644	7
Turdidae	*Turdus nudigenis*	open	Car	2.15365	22.4256	19
Turdidae	*Catharus fuscater*	open	Car	2.04553	20.7002	5
Turdidae	*Catharus frantzii*	open	Car	1.38877	16.6996	9
Turdidae	*Turdus fuscater*	open	Car	2.55412	40.8747	5
Turdidae	*Turdus falcklandii*	open	Car	2.2809	29.8489	29
Turdidae	*Turdus rufiventris*	open	Car	2.41668	25.4792	54
Turdidae	*Catharus occidentalis*	open	Car	2.40503	15.9297	12
Turdidae	*Myadestes occidentalis*	open	Her	1.69715	22.7519	13
Turdidae	*Turdus albicollis*	open	Car	2.193	29.8367	31
Turdidae	*Turdus chiguanco*	open	Car	2.1283	22.299	9
Turdidae	*Catharus mexicanus*	open	Car	1.26248	43.031	6
Turdidae	*Turdus amaurochalinus*	open	Car	2.17088	25.3711	18
Turdidae	*Turdus nigriceps*	open	Car	2.5432	29.5395	7
Turdidae	*Catharus gracilirostris*	open	Car	1.32248	12.8491	4
Turdidae	*Turdus leucomelas*	open	Her	2.46079	31.0139	15

Turdidae	*Turdus olivater*	open	Omn	1.51006	13.906	2
Turdidae	*Turdus leucops*	open	Her	2.40644	52.3454	2
Turdidae	*Myadestes genibarbis*	open	Her	0.56406	27.2898	1
Turdidae	*Catharus dryas*	open	Car	4.37106	7.05068	1
Turdidae	*Turdus nigrescens*	open	Omn	1.37205	23.1321	2
Turdidae	*Myadestes ralloides*	open	Car	2.23344	11.0389	1
Turdidae	*Turdus serranus*	open	Car	2.23877	58.4425	1
Turdidae	*Turdus infuscatus*	open	Car	0.93437	15.3531	1
Turdidae	*Turdus migratorius*	open	Car	2.50768	42.4127	2
Turdidae	*Myadestes unicolor*	open	Her	2.33587	16.6	1
Tyrannidae	*Mionectes oleagineus*	closed	Her	2.30995	26.8215	12
Tyrannidae	*Myiozetetes cayanensis*	closed	Car	1.71979	25.5556	12
Tyrannidae	*Myiophobus fasciatus*	open	Car	1.6033	21.267	41
Tyrannidae	*Tolmomyias sulphurescens*	closed	Car	2.07606	23.2764	15
Tyrannidae	*Tyrannus melancholicus*	open	Car	2.32019	25.4571	105
Tyrannidae	*Megarynchus pitangua*	open	Car	1.83788	20.1169	13
Tyrannidae	*Myiozetetes similis*	closed	Car	2.16718	26.2263	56
Tyrannidae	*Elaenia flavogaster*	open	Car	2.77846	30.5608	46
Tyrannidae	*Empidonax flavescens*	open	Car	1.85282	37.1922	11
Tyrannidae	*Myiophobus cryptoxanthus*	open	Car	1.25546	2.11492	1
Tyrannidae	*Pitangus sulphuratus*	closed	Omn	2.87588	34.4801	140
Tyrannidae	*Todirostrum cinereum*	closed	Car	1.34673	23.0712	25
Tyrannidae	*Elaenia chiriquensis*	open	Omn	1.81723	28.5586	12
Tyrannidae	*Tyrannus savana*	open	Car	2.41218	31.9988	68
Tyrannidae	*Camptostoma obsoletum*	closed	Car	2.2435	25.6206	9
Tyrannidae	*Myiodynastes luteiventris*	closed	Omn	2.40266	17.0468	4
Tyrannidae	*Myiozetetes granadensis*	closed	Car	2.85825	34.428	9
Tyrannidae	*Anairetes parulus*	open	Car	1.36778	31.1957	19
Tyrannidae	*Fluvicola albiventer*	closed	Car	1.83176	31.834	15
Tyrannidae	*Phylloscartes ventralis*	closed	Car	1.66542	28.467	5
Tyrannidae	*Fluvicola pica*	closed	Car	1.52235	26.693	14
Tyrannidae	*Myiarchus tuberculifer*	closed	Car	2.54027	33.4504	11
Tyrannidae	*Fluvicola nengeta*	closed	Car	2.10019	15.2122	3
Tyrannidae	*Contopus cinereus*	open	Car	2.52773	41.9239	7
Tyrannidae	*Legatus leucophaius*	closed	Her	1.61462	39.3796	13
Tyrannidae	*Contopus latirostris*	open	Car	2.23956	16.5188	2
Tyrannidae	*Myiarchus oberi*	closed	Car	1.04466	39.7998	1
Tyrannidae	*Rhynchocyclus brevirostris*	closed	Car	1.918	21.6686	7
Tyrannidae	*Todirostrum maculatum*	closed	Car	1.47997	21.3935	5
Tyrannidae	*Muscisaxicola capistratus*	closed	Car	1.29896	23.2082	2
Tyrannidae	*Myiarchus tyrannulus*	closed	Car	1.88921	28.9829	18
Tyrannidae	*Phaeomyias murina*	open	Car	1.62472	15.1975	3
Tyrannidae	*Arundinicola leucocephala*	closed	Car	1.42316	19.5153	8
Tyrannidae	*Myiopagis gaimardii*	open	Car	1.19003	48.2019	1
Tyrannidae	*Tyrannus dominicensis*	open	Omn	3.03451	27.5236	15
Tyrannidae	*Platyrinchus coronatus*	open	Car	0.45511	9.63029	3
Tyrannidae	*Tolmomyias flaviventris*	closed	Car	1.21939	21.3731	5

Tyrannidae	*Myiopagis viridicata*	open	Car	0.24221	14.9881	1
Tyrannidae	*Tyrannus couchii*	open	Car	1.87102	23.3507	21
Tyrannidae	*Serpophaga cinerea*	open	Car	1.71497	9.72186	2
Tyrannidae	*Myiarchus barbirostris*	closed	Car	1.21233	30.056	1
Tyrannidae	*Myiodynastes maculatus*	closed	Car	1.98283	26.1682	23
Tyrannidae	*Colonia colonus*	closed	Car	4.52616	67.707	2
Tyrannidae	*Myiarchus ferox*	closed	Car	1.84777	27.1765	14
Tyrannidae	*Satrapa icterophrys*	open	Car	1.85631	29.2033	20
Tyrannidae	*Myiarchus sagrae*	closed	Car	4.39217	37.9587	1
Tyrannidae	*Contopus caribaeus*	open	Car	2.09556	9.28847	1
Tyrannidae	*Hemitriccus margaritaceiventer*	closed	Car	2.50983	39.2535	5
Tyrannidae	*Contopus hispaniolensis*	open	Car	1.01649	24.2419	2
Tyrannidae	*Pyrocephalus rubinus*	open	Car	1.97002	25.8193	49
Tyrannidae	*Knipolegus lophotes*	open	Car	1.454	36.0793	4
Tyrannidae	*Xolmis velatus*	closed	Car	4.42167	23.1619	5
Tyrannidae	*Myiarchus nuttingi*	closed	Car	0.95339	37.5131	3
Tyrannidae	*Tyrannus albogularis*	open	Car	1.6025	65.3381	2
Tyrannidae	*Xolmis cinereus*	open	Car	2.92949	28.2256	9
Tyrannidae	*Sublegatus arenarum*	open	Car	1.15974	20.5853	5
Tyrannidae	*Tyrannus niveigularis*	open	Car	0.75164	26.2512	2
Tyrannidae	*Empidonomus aurantioatrocristatus*	open	Car	2.65526	27.0805	17
Tyrannidae	*Serpophaga subcristata*	open	Car	1.82807	20.9104	11
Tyrannidae	*Machetornis rixosa*	closed	Car	2.0663	34.8732	19
Tyrannidae	*Empidonomus varius*	open	Car	2.16768	31.7927	6
Tyrannidae	*Alectrurus tricolor*	open	Car	4.06315	19.9087	1
Tyrannidae	*Lessonia rufa*	open	Car	2.02038	30.8948	33
Tyrannidae	*Cnemotriccus fuscatus*	open	Car	3.34115	51.2443	3
Tyrannidae	*Elaenia albiceps*	open	Car	2.23639	25.5001	18
Tyrannidae	*Myiarchus panamensis*	closed	Car	1.49197	12.1578	2
Tyrannidae	*Sayornis nigricans*	open	Car	2.21701	27.8325	29
Tyrannidae	*Elaenia obscura*	open	Car	2.79272	18.0206	5
Tyrannidae	*Myiarchus stolidus*	closed	Car	2.91979	30.6374	2
Tyrannidae	*Myiarchus cinerascens*	closed	Car	1.90744	16.6648	10
Tyrannidae	*Poecilotriccus plumbeiceps*	closed	Car	0.97613	26.3494	4
Tyrannidae	*Attila rufus*	open	Car	1.4256	23.5985	2
Tyrannidae	*Hirundinea ferruginea*	open	Car	1.24106	34.5104	5
Tyrannidae	*Euscarthmus meloryphus*	open	Car	5.10385	23.4014	1
Tyrannidae	*Xolmis coronatus*	open	Car	2.86125	43.4078	5
Tyrannidae	*Knipolegus cyanirostris*	open	Car	0.33647	33.5122	3
Tyrannidae	*Xenotriccus mexicanus*	open	Car	1.11974	25.1322	3
Tyrannidae	*Myiarchus phaeocephalus*	closed	Car	2.54991	51.0419	1
Tyrannidae	*Hymenops perspicillatus*	open	Car	1.9815	34.4127	29
Tyrannidae	*Phelpsia inornatus*	open	Car	1.57705	37.5455	1
Tyrannidae	*Tachuris rubrigastra*	open	Car	1.63471	32.1165	23
Tyrannidae	*Xolmis irupero*	closed	Car	1.66916	29.018	10
Tyrannidae	*Muscisaxicola maclovianus*	closed	Car	0.93325	27.6678	4
Tyrannidae	*Sublegatus modestus*	open	Car	1.56563	19.0566	3

Tyrannidae	*Myiarchus swainsoni*	closed	Car	1.15453	17.8196	2
Tyrannidae	*Lathrotriccus euleri*	open	Car	0.97794	25.5917	6
Tyrannidae	*Tyrannus cubensis*	open	Car	0.48935	5.07089	1
Tyrannidae	*Serpophaga nigricans*	open	Car	1.86165	24.6118	5
Tyrannidae	*Agriornis lividus*	open	Car	1.78579	26.5828	4
Tyrannidae	*Xolmis pyrope*	open	Car	1.90734	41.2129	14
Tyrannidae	*Contopus pertinax*	open	Car	5.07222	52.9343	1
Tyrannidae	*Myiophobus inornatus*	open	Car	0.95976	11.5063	1
Tyrannidae	*Camptostoma imberbe*	closed	Car	2.41382	35.4868	3
Tyrannidae	*Elaenia strepera*	open	Car	0.79912	4.41023	1
Tyrannidae	*Elaenia cristata*	open	Car	0.69666	2.99915	1
Tyrannidae	*Muscisaxicola maculirostris*	open	Car	1.63892	18.1321	10
Tyrannidae	*Stigmatura budytoides*	open	Car	1.45579	10.8552	6
Tyrannidae	*Knipolegus signatus*	open	Car	1.3572	33.3392	6
Tyrannidae	*Knipolegus striaticeps*	open	Car	2.03424	15.3239	4
Tyrannidae	*Leptopogon amaurocephalus*	closed	Car	0.95319	59.5024	3
Tyrannidae	*Conopias parvus*	closed	Car	0.53212	28.6617	1
Tyrannidae	*Agriornis montanus*	open	Omn	1.03332	15.6961	2
Tyrannidae	*Lessonia oreas*	open	Car	1.37361	21.9532	2
Tyrannidae	*Elaenia parvirostris*	open	Car	2.5519	27.3382	2
Tyrannidae	*Muscisaxicola albilora*	closed	Car	1.89239	9.25902	3
Tyrannidae	*Tyrannus caudifasciatus*	open	Car	2.27026	28.6454	1
Tyrannidae	*Pseudocolopteryx sclateri*	open	Car	0.50924	36.7369	1
Tyrannidae	*Empidonax occidentalis*	open	Car	0.34787	20.5504	1
Tyrannidae	*Pseudocolopteryx flaviventris*	open	Car	0.63942	20.4967	6
Tyrannidae	*Myiodynastes chrysocephalus*	closed	Car	1.56446	49.7627	1
Tyrannidae	*Empidonax difficilis*	open	Car	1.31692	31.3522	4
Tyrannidae	*Ochthoeca fumicolor*	open	Car	0.25532	51.8999	1
Tyrannidae	*Platyrinchus cancrominus*	open	Car	2.50409	31.4949	1
Tyrannidae	*Tyrannus crassirostris*	open	Car	2.42821	29.6315	1
Tyrannidae	*Neoxolmis rufiventris*	open	Car	1.93186	27.2644	2
Tyrannidae	*Empidonax fulvifrons*	open	Car	2.14222	33.6895	2
Tyrannidae	*Tyrannus vociferans*	open	Car	2.25504	35.6734	5
Tyrannidae	*Knipolegus aterrimus*	open	Car	1.17619	48.703	3
Tyrannidae	*Myiodynastes bairdii*	closed	Car	1.85118	11.7858	1
Tyrannidae	*Tyrannus verticalis*	open	Car	1.20553	21.8563	1
Tyrannidae	*Agriornis micropterus*	open	Car	1.91273	49.7399	1
Tyrannidae	*Sayornis saya*	open	Car	1.93898	58.9198	1
Tyrannidae	*Muscisaxicola flavinucha*	closed	Car	1.59973	14.6463	2
Tyrannidae	*Phaeomyias tumbezana*	open	Car	1.66713	6.64768	1
Tyrannidae	*Muscisaxicola juninensis*	closed	Car	4.87721	60.3987	1
Tyrannidae	*Muscisaxicola albifrons*	closed	Car	1.41153	39.7722	1
Tyrannidae	*Muscisaxicola cinereus*	closed	Car	2.93793	22.9864	1
Vireonidae	*Cyclarhis gujanensis*	open	Car	1.25614	22.5646	6
Vireonidae	*Hylophilus pectoralis*	open	Car	3.46549	20.9983	3
Vireonidae	*Vireo flavoviridis*	open	Car	1.77432	38.2123	8
Vireonidae	*Vireo olivaceus*	open	Car	1.79872	29.3026	10

Vireonidae	*Vireo altiloquus*	open	Car	3.31661	18.0944	3