Instituto Nacional de Pesquisas da Amazônia - INPA
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS BIOLÓGICAS (BIOLOGIA DE ÁGUA DOCE E PESCA INTERIOR)

INAPROPRIADO PARA MAIS DE 99% DAS ESPÉCIES: UMA CRÍTICA A "*RIVER-BARRIER HYPOTHESIS*" E DEMONSTRAÇÃO DE UMA HIPÓTESE PARA EXPLICAR DUAS ESPÉCIES DISTRIBUÍDAS ALOPATRICAMENTE POR GRANDES RIOS

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Manaus, Amazonas
Agosto, 2019

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Sinopse:

Esse estudo testou a habilidade da hipótese dos grandes rios como explicação para o padrão da diversidade e limite para distribuição das espécies ao redor do Rio Madeira; e propôs uma hipótese para explicar o limite da distribuição das espécies quando o rio não for uma barreira vicariante.

Palavras-chave: Amazônia**,** hipótese dos grandes rios, diversidade, teoria neutra

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.

Inapropriado para mais 99% das espécies: uma crítica a "*River-barrier hypothesis*" e demonstração de uma hipótese alternativa para explicar duas espécies distribuídas alopatricamente por grandes rios

RESUMO:

A importância de grandes rios como barreiras geográficas para dispersão das espécies e como critério para definir áreas de endemismo para várias linhagens filogenéticas na Amazônia ainda é controversa. Dispersão através dos rios é comum, indicando que a maioria dos rios não são barreiras físicas absolutas para a dispersão de espécies. Nesse sentido, nós testamos a capacidade da hipótese de grandes rios para explicar padrões de diversidade de espécies e limites de distribuição espacial para 1952 espécies facilmente detectáveis que ocorrem ao redor do rio Madeira (Capítulo 1); e levantamos a questão de por que indivíduos de espécies semelhantes que atravessam os rios não resultam na exclusão competitiva de uma das espécies (Capítulo 2). No Capítulo 1, nossos resultados indicaram que a hipótese de que o rio Madeira é a borda entre áreas de endemismo e explica grande parte da diversidade encontrada na região foi inadequada para mais de 99% das espécies. No Capítulo 2, nosso estudo demonstrou que processos neutros associados à dispersão reduzida através dos rios podem manter espécies competitivamente idênticas distribuídas alopatricamente por centenas de gerações. Em conclusão, nossos resultados indicam que hipóteses alternativas devem ser propostas para explicar os limites das distribuições de espécies, bem como uma revisão dos critérios que são usados para determinar as áreas de endemismo; e que processos neutros e dispersão reduzida por um grande rio, fornecem um mecanismo potencial para a manutenção da biodiversidade amazônica, facilitando potencialmente outros processos, como deriva genética e adaptação local que podem resultar em isolamento reprodutivo.

Inappropriate for > 99% of species: a critique of river-barrier hypothesis and demonstration of an alternative hypothesis to explain two allopatrically-distributed species by large rivers

ABSTRACT:

The importance of the large rivers as geographical barriers for dispersal of species and as a criterion for defining the limit of species-endemism areas for several phylogenetic lineages in the Amazon is still controversial. Dispersal across rivers is common, indicating that most rivers are not absolute physical barriers for species dispersal. Therefore, we tested the ability of the river-barrier hypothesis to explain patterns of species diversity and spatial-distribution limits for 1952 easily-detected species that occur around the Madeira River (Chapter 1); and raised the question of why individuals of similar species crossing rivers does not result in the competitive exclusion of one of the species (Chapter 2). In the Chapter 1, our results indicated that the hypothesis that the Madeira River is the border between endemism areas and explains much of the diversity found in the region was inappropriate for >99% of species. In the Chapter 2, our study showed that neutral processes associated with reduced dispersal across rivers can maintain competitively identical species allopatrically distributed for hundreds of generations. In conclusion, our results indicates that alternative hypotheses should be proposed to explain the limits of distributions of species, as well as a revision of the criteria that are used to determine species-endemism areas; and that neutral processes and reduced dispersal across rivers provides a potential mechanism for the maintenance of Amazonian biodiversity by potentially facilitating other processes, such as genetic drift and local adaptation that can result in definitive reproductive isolation.

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(c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

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INTRODUÇÃO GERAL

A presença ou ausência de indivíduos de uma espécie em um dado local pode ser atribuída a diversos fatores, como a estrutura física do ambiente (Coudun & Gégout 2007), clima (Arundel 2005, Battisti et al. 2006, Parker & Andrews 2007), interações bióticas (doenças e parasitas, Hochberg & Ives 1999, Briers 2003; predação, Bruelheide & Scheidel 1999, Holt & Barfield 2009; interações interespecíficas, Case et al. 2005; competição, Case & Taper 2000, Cadena & Loiselle 2007, Price & Kirkpatrick 2009, Gutiérrez et al. 2014) e dispersão (Hubbell 2001, Dytham 2009, De Meester et al. 2014). No entanto, o fator principal afetando o limite da distribuição de uma espécie pode depender da escala da investigação (Levin 1992, McGill 2010, Shipley et al. 2012, Chalmandrier et al. 2017).

Em escalas mais abrangentes na Amazônia, muitos estudos sugerem a hipótese de que as distribuições de espécies pudessem ser limitadas por grandes rios amazônicos (Wallace 1852, Ribas et al. 2012). De acordo com essa hipótese, é esperado que o limite das distribuições das espécies frequentemente coincidiriam com grandes rios e que grandes rios subdividam uma população impedindo o fluxo gênico entre indivíduos e promovendo divergência genética entre elas, aumentando a oportunidade para especiação alopátrica (Wiley 1988). Está hipótese é comumente referida na literatura como “river-barrier hypothesis” e tem sido utilizada para indicar possíveis áreas de endemismo para vários taxa na Amazônia (Cracraft 1985, Da Silva et al. 2005). Porém, a hipótese que grandes rios amazônicos são barreiras geográficas para dispersão das espécies ainda é controversa e tem sido questionada para muitos taxa.

Existem evidências indicando que os rios funcionam como barreiras geográficas dependendo das suas larguras e descargas (Ayres & Clutton-Brock 1992); das características de história natural que poderiam afetar a habilidade de uma espécie atravessar para margem oposta (Moraes et al. 2016); e da combinação entre esses dois fatores (Hayes & Sewlal 2004, Nazareno et al. 2017). Outros estudos notaram que a distribuição de muitas espécies de diferentes grupos taxonômicos não são limitadas pela presença de rios (e.g. Gascon et al. 1998, Lougheed et al. 1999, Fairley et al. 2002, Dambros et al. 2016); que a presença de uma espécie ecologicamente similar na margem oposta é mais importante para limitar a distribuição dos organismos do que a presença do rio (Boubli et al. 2015); e que pares de taxa separados por grandes rios tinham diferentes tempos de divergência, demonstrando que o rio foi uma barreira física que limitou a expansão das espécies que divergiram em outro lugar (Naka & Brumfield 2018) .

Alternativa a hipótese que grandes rios são barreiras geográficas causadora de especiação através de vicariância, raros eventos de dispersão através da paisagem tem sido utilizado como explicação para a distribuição de taxa irmãos em áreas de endemismo delimitados por grandes rios (Lynch-Alfaro et al. 2015, Byrne et al. 2018) e como mecanismo de especiação na Amazônia (Burney & Brumfield 2009, Fernandes et al. 2014, Smith et al. 2014, Dexter et al. 2017). Porém, a dispersão através do rio não é um evento raro. Por exemplo, *Tupinambis longilineus* (2 indivíduos) e *Anolis phyllorhinus* (1 indivíduo) foram registrados na margem direita de um rio comumente considerado a borda de uma área de endemismo e limite de distribuição para essas espécies (Moraes et al. 2017, 2019). Padrão similar foi observado para as espécies *Saimiri sciureus* e *Saimiri Collinsi* ao longo das margens norte e sul do rio Amazonas (Mercês et al. 2015). Outras evidências que a dispersão através de um grande rio é comum foram apresentadas por (Hayes & Sewlal 2004, Moraes et al. 2016). Ambos estudos relataram que existem pequenas populações de espécies nas margens opostas de onde está a maioria dos indivíduos. Em geral, esses estudos evidenciam que grandes rios podem manter a maioria dos indivíduos das espécies alopatricamente distribuídas mesmo que o rio não é uma barreira geográfica total para dispersão das espécies.

Os estudos que providenciaram as evidências mais fortes a favor da hipótese que rios são entre os mais importantes geradores da diversidade biológica amazônica enfocaram poucos grupos taxonômicos (e.g. Fernandes et al. 2012, Ribas et al. 2012, Boubli et al. 2015) e não existem estimativas de qual proporção das espécies de animais amazônicos tem suas distribuições limitadas por grandes rios. As numerosas exeções da “river-barrier hypothesis” sugere que avaliar a importância de grandes rios como geradores de diversidade de espécies amazônicas (Wallace 1852, Ribas et al. 2012) e como limites de centros de endemismos (Da Silva et al. 2005) baseados simplesmente nas observações de espécies ou linhagens irmãs em margens opostas de um grande rio (e.g. Hall & Harvey 2002), ou quando o limite da distribuição de uma espécie coincidir com um grande rio (e.g Pomara et al. 2014) tem sérias limitações e que hipóteses alternativas deveriam ser propostas para explicar o limite da distribuição das espécies.

OBJETIVOS

Testar a habilidade da hipótese dos grandes rios como explicação para o padrão da diversidade e limite para distribuição das espécies ao redor do Rio Madeira; e propor uma hipótese para explicar o limite da distribuição das espécies quando o rio não for uma barreira vicariante.

OBJETIVOS ESPECÍFICOS

Capítulo 1: Estimar a proporção de espécies em 14 diferentes grupos taxonômicos [Hymenoptera (Apidae), Hymenoptera (Formicidae), Coleoptera, Lepidoptera, Isoptera, Orthoptera, Serpentes, Lagartos, Anura, Chiroptera, Primatas, Pequenos mamíferos (Didelphimorphia, Rodentia), Grandes mamíferos (Rodentia, Pilosa, Ungulados, Carnivora, Artiodactyla, Cingulata) e Aves] que tiveram sua distribuição limitada pelo rio e o número de espécies que existiam evidências que o rio funcionou como uma barreira vicariante causando especiação.

Capítulo 2: Demonstrar que sob dinâmica da teoria neutra, duas espécies competitivamente idênticas podem permanecer alopatricamente distribuídas quando o rio apenas reduz a chance de uma espécies atravessar para a outra margem.

Capítulo 1

Sergio Santorelli Jr., William E. Magnusson & Claudia P. Deus. 2018. Most species are not limited by an Amazonia river postulated to be a border between endemism areas. *Scientific Reports*,8:2294

Most species are not limited by an Amazonian river postulated to be a border between endemism areas

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Abstract

At broad scales in the Amazon, it is often hypothesized that species distributions are limited by geographical barriers, such as large rivers (river-barrier hypothesis). This hypothesis has been used to explain the spatial-distribution limits of species and to indicate endemism areas for several phylogenetic lineages. We tested the ability of the river-barrier hypothesis to explain patterns of species diversity and spatial-distribution limits for 1952 easily-detected species in 14 taxonomic groups that occur around the Madeira River, and our results indicate that the hypothesis that the Madeira River is the border between endemism areas and explains much of the diversity found in the region is inappropriate for >99% of species. This indicates that alternative hypotheses should be proposed to explain the limits of distributions of species around the Madeira River, as well as a revision of the criteria that are used to determine species-endemism areas.

Introduction

Presence or absence of individuals of a species in the Amazon can be attributed to multiple factors. At local scales, habitat characteristics have been identified as the main determinants of the distribution of various of plants[1–4], lizards[5], anurans[6,7], snakes[8], ants[9], mammals[10–12], termites[13] and birds[14,15]. However, at broader scales, it is often hypothesized that species distributions are mainly related to dispersal limitation caused by geographical barriers, such as large rivers[16,17]. This explanation is commonly referred to as the "river-barrier hypothesis".

Wallace[18] was one of the first to hypothesize that the distributions of Amazonian species could be limited by large Amazonian rivers, such as the Negro, Amazon and Madeira Rivers. According to the modern interpretation of this hypothesis, large rivers are expected to subdivide a population to the point of preventing gene flow between individuals in different areas and to promote genetic divergence between them, increasing the opportunity for allopatric speciation[19,20]. If this hypothesis is correct, it is expected that (i) sister species or lineages will be on opposite river banks[21,22,23], (ii) the similarity in species composition will be greater in localities on the same bank (adjacent sites) than sites on opposite banks separated by the same distance[24,25,26,27] and (iii) the boundaries of species distributions will coincide with large rivers[21–28].

The river-barrier hypothesis has been used to explain the spatial-distribution limits of species and to indicate possible endemism areas[29,30] for several phylogenetic lineages in the several taxa in the Amazon (e.g. primates[23,24],lizards[17,28], anurans[16,17,25], butterflies[21], birds[22,26,27,31]). The hypothesized endemism areas delimited by rivers have been used as surrogates in conservation planning[30]. However, this hypothesis is not always accepted and the role of rivers as the limits to endemism areas has been questioned for many taxa[13,17,26,27,31–41]. For example, the effects of the Tapajós River (for amphibians and squamates[17]) and the Amazon River (for birds[26]) as barriers depend on the life-history characteristics of the species. Dambrós et al.[13] showed that sites separated by large geographic distances had distinct termite-species composition and most of the broad-scale variation in species composition could be explained either by spatial predictors or differences in environmental conditions between regions, and not by large rivers, such as the Madeira, Negro, Branco and Amazon.

In the majority of the studies that accepted the river-barrier hypothesis, the conclusions were based on studies with few species[20,23] and on the assumed absence of species on one bank[16,17,24]. In addition, rivers vary in discharge and width, and these two factors have been considered important in determining when large rivers function as geographic barriers to species dispersal[24,36,42]. Therefore, the acceptance or rejection of the hypothesis may depend mainly on the species and river investigated. These two factors together make it difficult to generalize the importance of large rivers as effective geographical barriers to the distribution of Amazonian species and as a possible hypothesis to explain the species diversity found in the region.

In this study, we estimated the proportion of species in different taxonomic groups [Hymenoptera (Apidae), Hymenoptera (Formicidae), Coleoptera, Lepidoptera, Isoptera, Orthoptera, Snakes, Lizards (excluding snakes), Anura, Chiroptera, Primates, Small mammals (Didelphimorphia, Rodentia), Large mammals (Rodentia, Pilosa, Ungulados, Carnivora, Artiodactyla, Cingulata) and Birds] that have their distributions limited by a river (the generic hypothesis of the river as a barrier) and the number of species for which there is evidence (sister species on opposite banks of the river) that this river functioned as a vicariance barrier causing speciation (the hypothesis of existence of endemism areas based on large rivers). We used only species for which false absences are unlikely to explain the appearance of the river as a barrier. We conducted the study on Madeira River, which has been postulated as a barrier to dispersal for species of various taxa[16,18,22,38,43–47] and the border between two endemism areas[29,30], and we studied an area in the mid reaches where many studies have indicated that it is an effective biogeographic barrier. Our results indicate that the hypothesis that the Madeira River is the border that separates two endemism areas (Inambari and

Rondonia) and that the river-barrier hypothesis explains much of the diversity found in the region is inappropriate for most species, and we suggest that alternative hypotheses should be proposed to explain the limits of distributions of most species found in the region, as well as a revision of the criteria that are used to determine species-endemism areas.

Results

Generic hypothesis of large rivers as barriers

The hypothesis that the distribution of species around the Madeira River is mainly related to dispersal limitation caused by river barriers, was rejected for most species studied (Fig.1, Supplementary Table S1). Of the 1952 species with detection probabilities sufficiently high that false absences are improbable, only 0.10% (Primates: *Saguinus labiatus labiatus* and Aves:*Lepidothrix coronata*) had their distributions limited by the river (Supplementary Fig. S1 and S2).

Because the proportion of species limited to one side of the river depends on our decision as to which species the detection probability was high enough for a valid test, our results might underestimate the number of species limited to one side of the river if the species that are limited by the river are those that are difficult to detect. Therefore, we report the number of species in each taxonomic or functional group that had their distributions limited by the river considering other $P_{expected}$ in Supplementary Table S1 online, and give their distributions in Supplementary Fig. S1 and S2 (only for species with detection probability $\geq$ 0.40). The number of species apparently separated by the river was low in all cases, except when we made absolutely no correction for probable false absences (Supplementary Table S1).

Hypothesis of the existence of endemism areas based on large rivers

Evidence that the Madeira River works as a vicariance barrier causing speciation (presumption of the endemism-areas hypothesis) was not found for 713 (99.45%) of the species investigated for which we could obtain data to erect robust phylogenetic hypotheses (Supplementary Fig. S3 - S7). We found evidence suggesting that the river had functioned as a vicariance barrier only for 4 (0.55%) of the species [Primates: *Callicebus brunneus* e *Callicebus dubius* (Fig.2) and Aves: *Psophia viridis* e *Psophia leucoptera* (Fig.3)].

Discussion

The hypothesis of the Madeira River as the limit of distribution was not supported for most species, so our results are not concordant with the river-barrier hypothesis explaining the origin[20,22] or spatial-distribution limits of species[16,17], nor of the existence of endemism areas[29,30], for most of the species that occur around the Madeira River. Even if the hypothesis is correct that the effectiveness of the river as a barrier depends on the characteristics of life histories of the species for a small proportion of some taxa[17,26], this would explain only a very small part of the biological diversity of the Amazon[40,48,49].

In most studies that accepted the hypotheses about the effects of rivers[24,16,17], the apparent absence of a species on the opposite bank to that sampled was used to conclude that a large river was a geographical barrier. However, any species-sampling technique has some bias and the absence of a species in a certain location might indicate that the species was simply not detected[50].

For example, Dias-Terceiro *et al.*[16] found that the distribution of *Ameerega trivittata* (Anura:Dendrobatidae) was restricted to the left bank of the Madeira River (accepting the generic hypothesis of large rivers). This species was recorded on both banks in the Madeira River in our study and also on the left bank of the Tapajós River in the study by Moraes *et al.*[17]. The Tapajós River is located adjacent to the right bank of the Madeira River, and the presence of a species on the left bank of the Tapajós River implies the presence of *A. trivittata* on the right bank of the Madeira River. Fecchio *et al.*[47] concluded that the composition of parasites in birds was dependent on endemism areas in the Amazon, but some of the host species that supported this conclusion occurred in our samples independent of the endemism area. It is possible that the conclusion of these authors was biased by the false absence of the host in one of the areas of endemism. This possible bias in conclusions has been observed for other species in Cracraft[29], a reference that has been widely used to support and justify studies that determine endemism areas in the Amazon, based only on the apparent absence of a species on the opposite bank of a large river. It is possible that these are not the only cases of doubtful results in the literature, since this type of potential error was detected many times in our analyses. In approximately 40% of the species, the detectability analysis indicated that sampling was inadequate to draw a conclusion. It could be that only hard-to-detect species are affected by rivers, but this seems unlikely since the river-barrier hypotheses were raised based on easily-detected species.

It is unquestionable that large rivers are the distribution limits of some Amazonian species, but the large number of exceptions indicates that the indication of the Madeira River as a border between endemism areas may be inappropriate for most species. It is important to emphasize that rivers can function as species limits without necessarily indicating that they represent barriers that caused vicariance speciation[51], an assumption of the existence of endemism areas based on large rivers. Alternatively, sympatric speciation via sexual selection[52,53], environmental differences[54-56] or ecological interactions[57,58]; combined with dispersal limitation[51,59] and competition[60] could produce the same patterns of allopatric distribution observed in Figure 2 and Figure 3, and also in Ribas *et al.*[22], Fernandes *et al.*[20], Boubli *et al.*[23] and are likely more important mechanisms for generating and maintaining Amazonian biodiversity than rivers. However, these alternative hypotheses are often ignored in studies that accept the hypothesis of large rivers as the cause of speciation. Moreover, most of the conclusions relating to the river-barrier hypotheses assume that the geographical distribution of a species does not change over time, but there is evidence that many distributions in the past were different from current distributions[61-65].

The lack of evidence found to support the river-barrier hypotheses (generic hypothesis of large rivers as barriers, and the hypothesis of centers of endemism based on large rivers) in a stretch of river commonly postulated as the border between endemism areas[16,18,29,30,38,44-47], suggests that the hypothesis of existence of endemism areas based only on the distributions of a few species and very large rivers, should be reevaluated for the majority of species. With the reevaluation of these limits, the need for new hypotheses will arise to explain the Madeira River's role in the origin and distribution of Amazonian biodiversity. More importantly, in the absence of information on the distributions of most species, the proposed endemism areas are being used as surrogates in conservation planning[30]. Substitutes should only be used when there is strong evidence of the relationship between the majority of targets and the proposed substitute[66]. In the case of centers of endemism, this evidence is not available for most Amazonian rivers, and specifically for the Madeira River, the evidence that it is a border between endemism areas applies to a very small proportion of biodiversity.

Our results are for only one area and there are taxonomic issues relating to species boundaries that need to be worked out for many taxa. Most of the species we studied are recognized on morphological criteria and with the application of molecular methods more species could be discovered that have the Madeira River as a limit to their distributions. Nevertheless, our results indicate that the roles of large rivers in promoting biological diversity and the use of postulated endemism areas as convenient surrogates for conservation planning in the Amazon still need to be tested for the particular taxonomic group and conservation question being addressed.

Methods

Study area

We undertook the study along the Madeira River (Fig. 4), one of the main tributaries of the Amazon River. The section of the river investigated is in the region where the river has a width of approximately 1.6 km, which has been considered a strong barrier in many previous studies[16,18,22,38,44–47]and the border between endemism areas[29,30].

Data source

To estimate the proportion of species whose distributions are effectively delimited by the river, we took advantage of an intensive study of the fauna associated with the implantation of a hydroelectric dam on the Madeira River. Sampling was carried out on both banks of the river, following the RAPELD protocol[67] (Supplementary Fig. S8). Some species may be limited by rivers but not occur on the immediate banks due to habitat-type (e.g. flooded area) avoidance. However, the field infrastructure comprised two parallel 5-km trails (Supplementary Fig. S8) and also sampled non-flooded area. The number of samples per bank and taxonomic groups surveyed are listed in Supplementary Table S2 online. In this study, we investigated only the distributions of animal species, since none of the evidence used to propose the river–barrier hypothesis was based on information about plants or microorganisms.

Data analysis

Generic hypothesis of large rivers as barriers

It was not possible to test the hypothesis for all the species of the region, because little is known about the distributions of many species, and many Amazonian species have not yet been described. As surveys of each taxonomic or functional group were made by the same researchers, we could include non-described species (hereafter referred to as morphospecies), for those species for which detectability analyses indicated that the absence of records on one bank of the river had little chance of being due to false absences.

In order to obtain an unbiased estimate of the proportion of species in each taxonomic or functional group [Hymenoptera (Apidae), Hymenoptera (Formicidae), Coleoptera, Lepidoptera, Isoptera, Orthoptera, Snakes, Lizards (excluding snakes), Anura, Chiroptera, Primates, Small mammals (Didelphimorphia, Rodentia), Large mammals (Rodentia, Pilosa, Ungulados, Carnivora, Artiodactyla, Cingulata) and Birds] that had their distributions limited by the river, we considered that the river was a potential geographical barrier only when detectability analyses indicated that the expected probability ($P_{expected}$) of the species truly being absent from one of the banks (right or left) was $P_{expected} \geq 0.50$. This criterion allows us to conclude that the absence of a species on the opposite bank to which it was present is unlikely to be due to false absences caused by failures in the detection of the species. This expected probability was estimated according to the formula:

$$P_{expected} = 1 - [1-(N/N_{sampleBank})/N_{sampleBank}]^{NsampleOppositeBank}$$

where: $P_{expected}$, is the expected probability of the species occurring on the bank opposite to that on which it was recorded; N is the number of samples where the species occurred; *NsampleBank* is the total number of samples on the bank where the species was present (right or left bank); *NsampleOppositeBank,* is the total number of samples on the opposite bank to which the species was recorded.

Hypothesis of the existence of centers of endemism based on large rivers

The hypothesis of the existence of endemism areas based on large rivers was tested for 717 species (no false absences taken into account) of vertebrates for which it was possible to obtain phylogenetic information. To indicate if the river worked as a vicariance barrier independent of the taxonomic or functional group, we constructed a phylogenetic hypothesis separately for each group (Fig. S3 - S7). For small, large and non-flying mammals (72 spp), snakes (66 spp), lizards (35 spp) and frogs (98 spp), the phylogenetic relationships were obtained with the R package "rotl"[68], and for birds (446 spp) the information was obtained through the website birdtree.org[69-71].

To determine the number of sister species or lineages for which the river was an apparent vicariance barrier, we associated each species in the phylogenetic hypotheses (referring to the different taxonomic or functional groups) with their location of occurrence (right or left bank of the river). If sister species or lineages (indicated by the phylogenetic hypothesis) were present on opposite banks (allopatric distribution), this result could be an indication that the river functioned as a vicariance barrier.

Avoiding potential sample biases

Before accepting the generic hypothesis of large rivers as barriers, and the hypothesis of existence of endemism areas based on large rivers, and to minimize the effect of sampling on the results, we checked the distribution of each species that apparently occurred only on one bank based on the data from Santo Antônio with records in the literature and in the websites of the Global Biodiversity Information Facility (http://www.gbif.org), *speciesLink* (http://www.splink.org.br, Information system that integrates in real time, primary data of scientific collections), *Portal da Biodiversidade* (https://portaldabiodiversidade.icmbio.gov.br/portal/, this site provides data and information on Brazilian biodiversity generated or received by the Ministry of the Environment and related institutions) and the Smithsonian National Museum of Natural History (https://naturalhistory.si.edu/).

Data Availability

The datasets analyzed during the current study were collected during the environmental-impact studies for the Santo Antônio hydro-electric reservoir and are of open-access through the web site of the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) web site. However, due to some inconsistencies in that data base, the data used here were provided by Santo Antônio Energia and were further quality checked. They are available from the corresponding author on request.

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Author Contributions: SSJ, CD and WEM designed the study, SSJ analyzed the data with contribution of WEM, SSJ wrote the first draft of the manuscript, and all authors contributed substantially to revisions.

Additional Information

Competing financial interests: The author(s) declare no competing financial interests

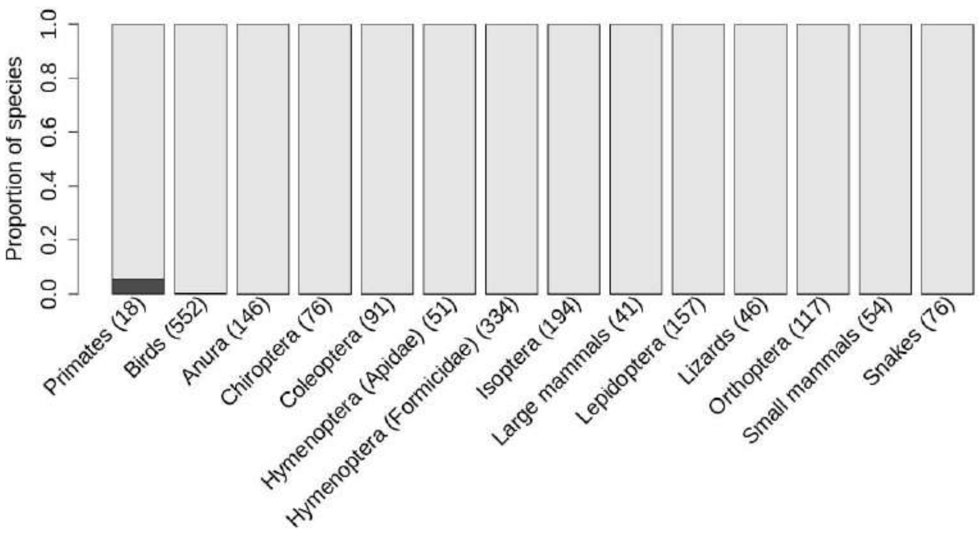

Figure 1 - Estimates of the proportion of species with detectability >50% in each taxonomic or functional group that had their distributions limited by the Madeira River (Dark gray). Light-gray bars show the proportion of species for which the Madeira River was not a geographic barrier. Numbers in parentheses denote the number of species in each taxonomic or functional group.

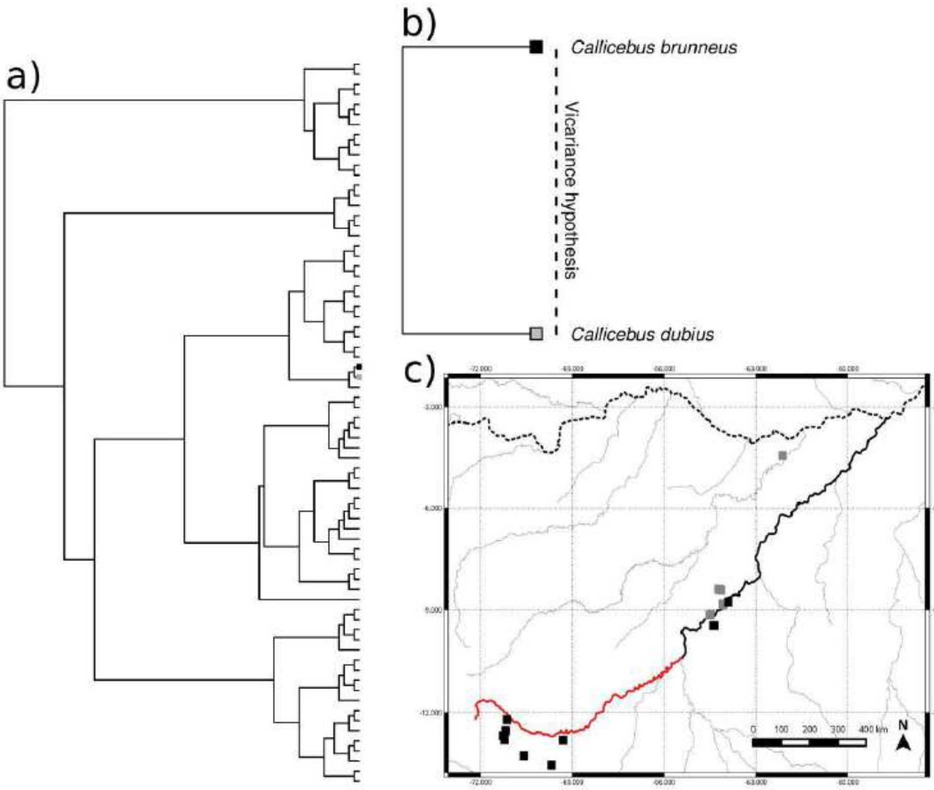

Figure 2 - Evidence suggesting that the Madeira River could have functioned as a vicariance barrier for *Callicebus brunneus* and *Callicebus dubius*. **a)** Phylogenetic hypothesis of small, large and non-flying mammals (72 spp); **b)** Vicariance hypothesis; and **c)** Species distributions along the Madeira River; black squares represent known occurrence of *C. brunneus,* and gray squares represent known occurrence of *C. dubius;* the black solid line represents the Madeira River; the red solid line represents the Madre de Dios River in Bolivia and the dashed line represents the Amazon River. See Supplementary Figure S7 online for detailed phylogenetic hypotheses associated with species distributions along Madeira River (right or left bank of the river). Map generated using QGIS v2.18 (http://www.qgis.org).

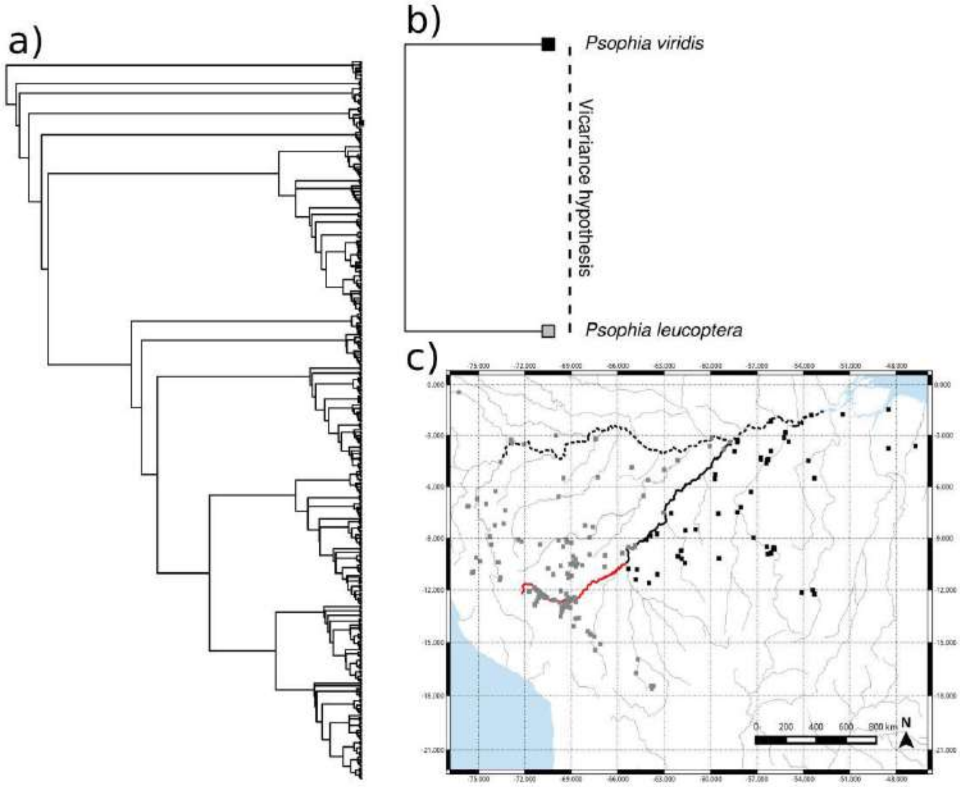

Figure 3 - Evidence suggesting that the Madeira River could have functioned as a vicariance barrier for *Psophia viridis* and *Psophia leucoptera*. **a)** Phylogenetic hypothesis of Aves (446 spp); **b)** Vicariance hypothesis; and **c)** Species distributions along the Madeira River; black squares represent known occurrence of *P. viridis* and gray squares represent known occurrence of *P. leucoptera;* the black solid line represents the Madeira River; red solid line represents the Madre de Dios River in Bolivia; and the dashed line represents the Amazon River. See Supplementary Figure S8 online for detailed phylogenetic hypotheses associated with species distributions along the Madeira River (right or left bank of the river). Map generated using QGIS v2.18 (http://www.qgis.org).

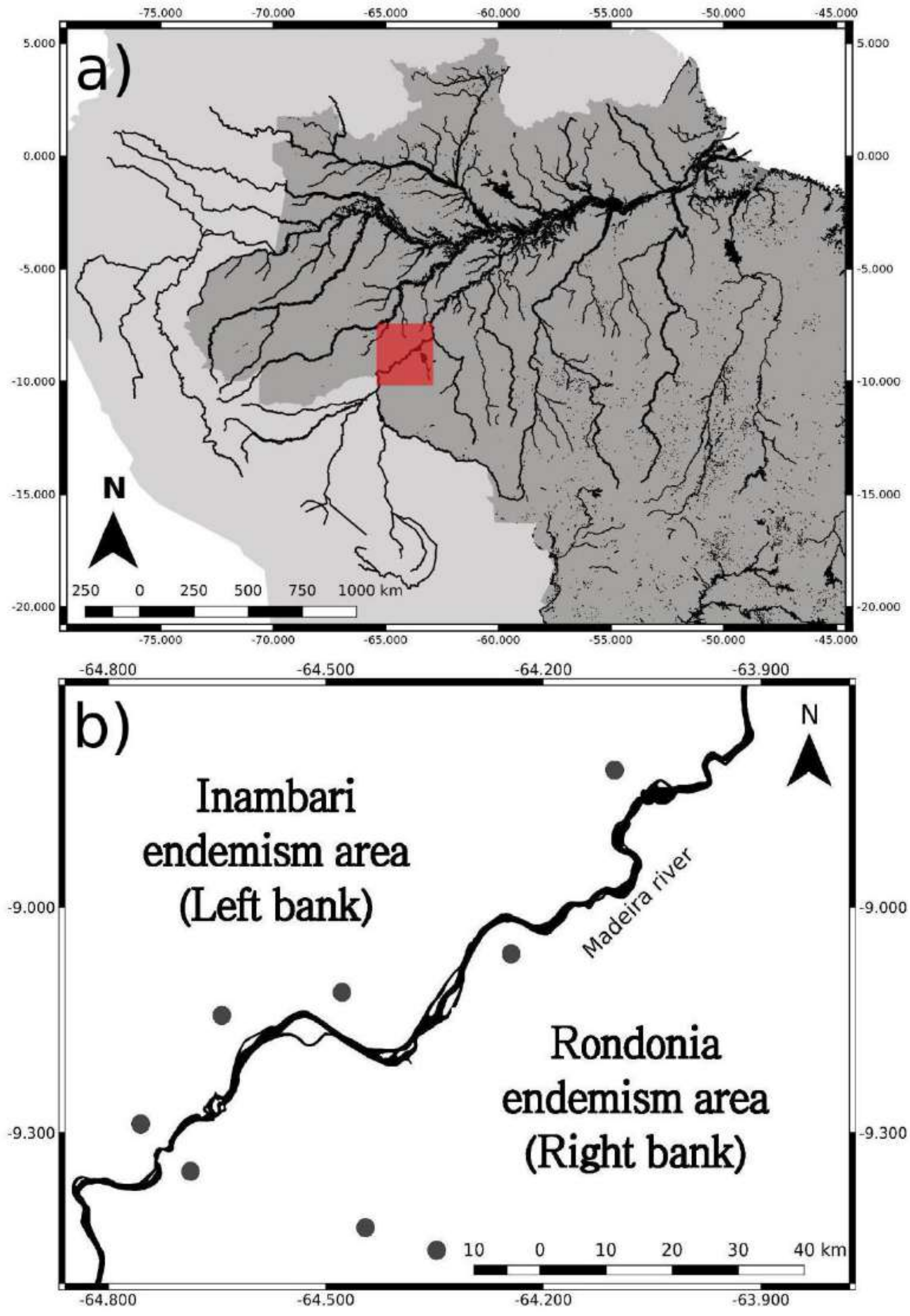

Figure 4 - Location of study area (maps generated using QGIS v2.18, http://www.qgis.org). **a)** Section of the river investigated (red square); and **b)** Location of sample grids (black dots) along the Madeira River (see sample-grid details in Fig.S8).

Appendices

Most species are not limited by an Amazonian river postulated to be a border between endemism areas

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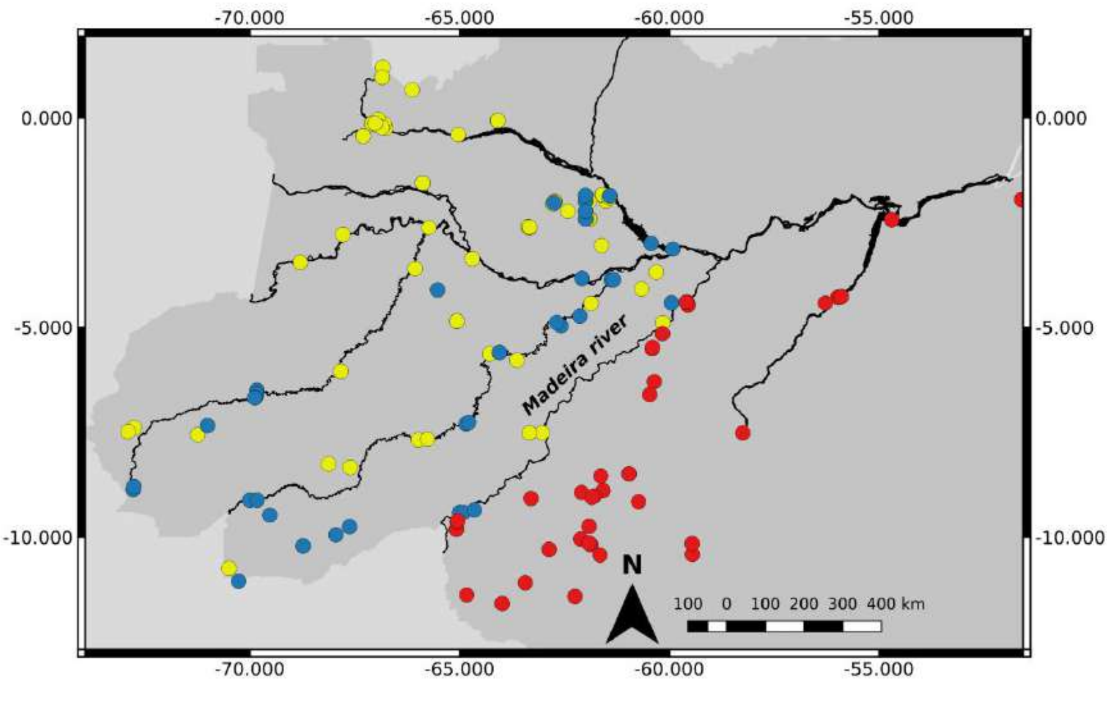

Figure S1 - Species distributions limited by the Madeira River; yellow dots represents current distributions of *Lepidothrix coronata;* blue dots represents current distributions of *Hypocnemis peruviana*; and red dots represents current distributions of *Rhegmatorhina hoffmannsi.* Map generated using QGIS v2.18 (http://www.qgis.org)

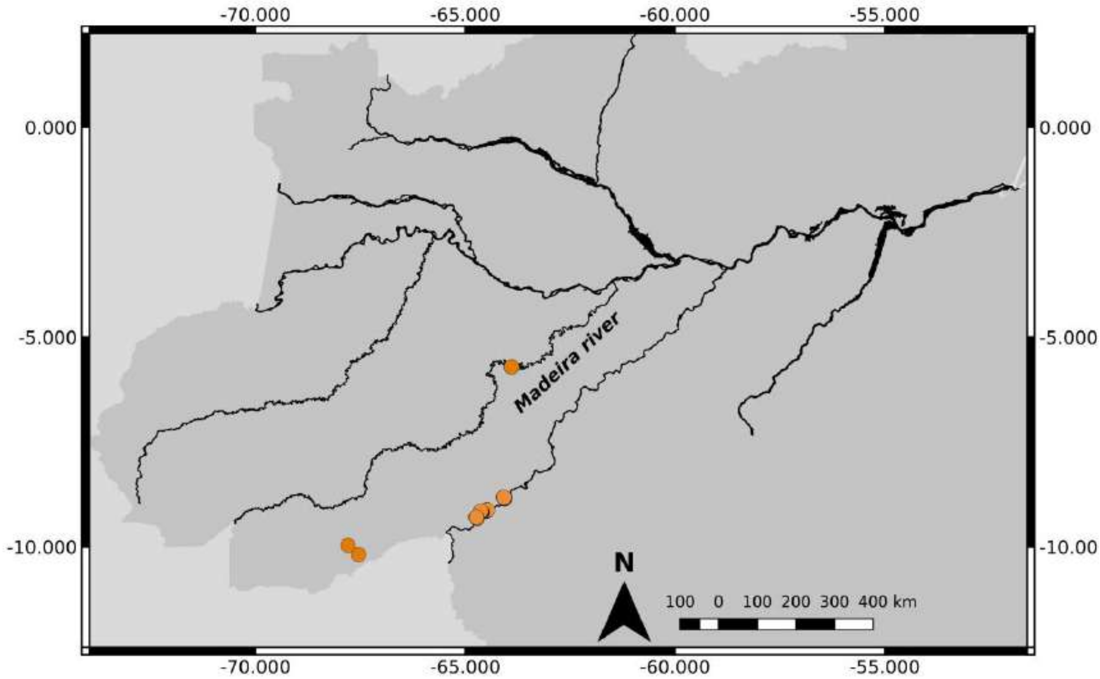

Figure S2 - Distribution of *Saguinus labiatus labiatus* (Orange dots) limited by the Madeira River. Map generated using QGIS v2.18 (http://www.qgis.org)

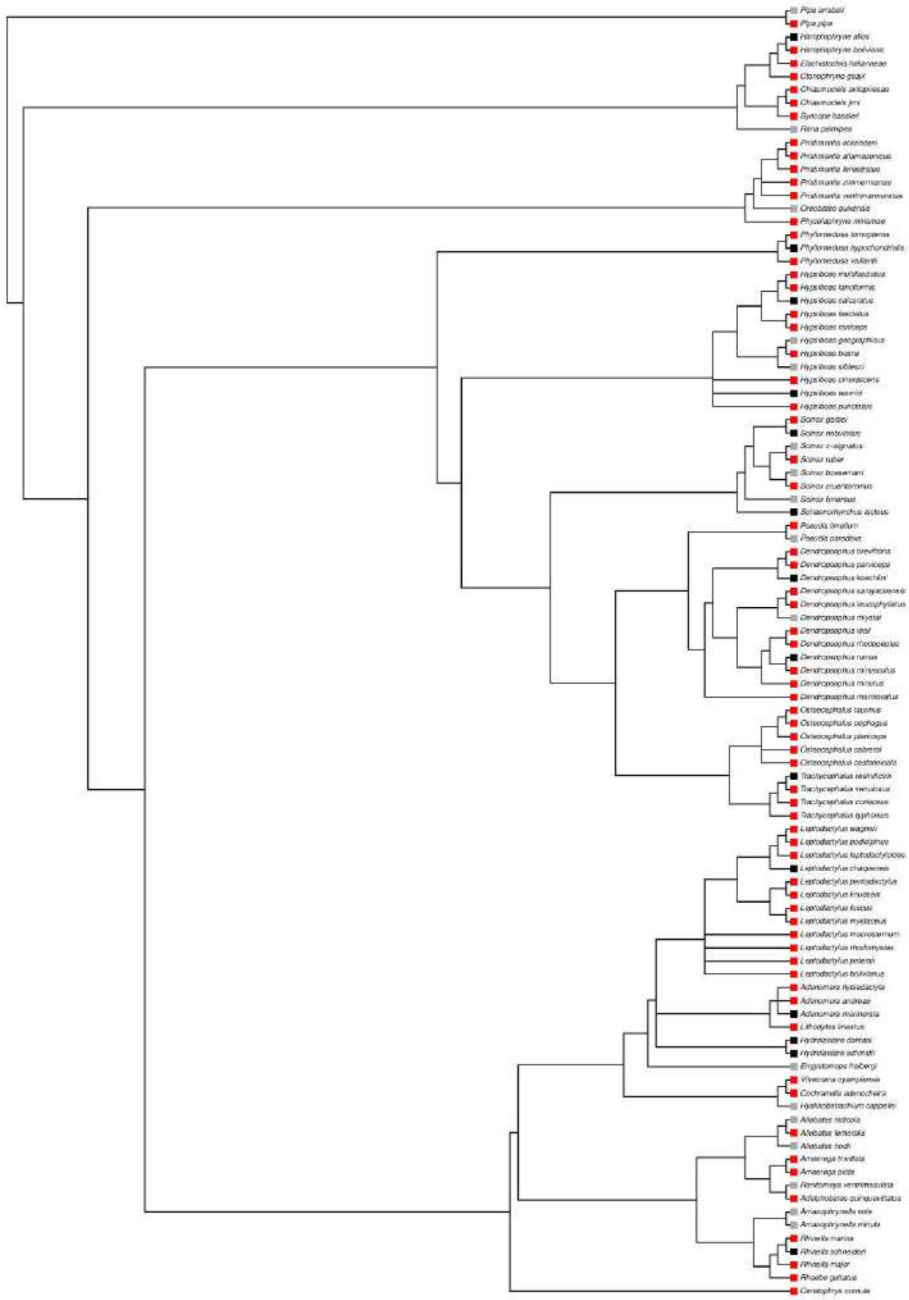

Figure S3 - Phylogenetic hypothesis for anuran species (98) with distributions limited by or crossing the Madeira River; red squares indicate species recorded on both banks of the river; black squares indicate species recorded only on the right bank of the river (Rondonia endemism area); and gray squares indicate species recorded only on the left bank of the river (Inambari endemism area).

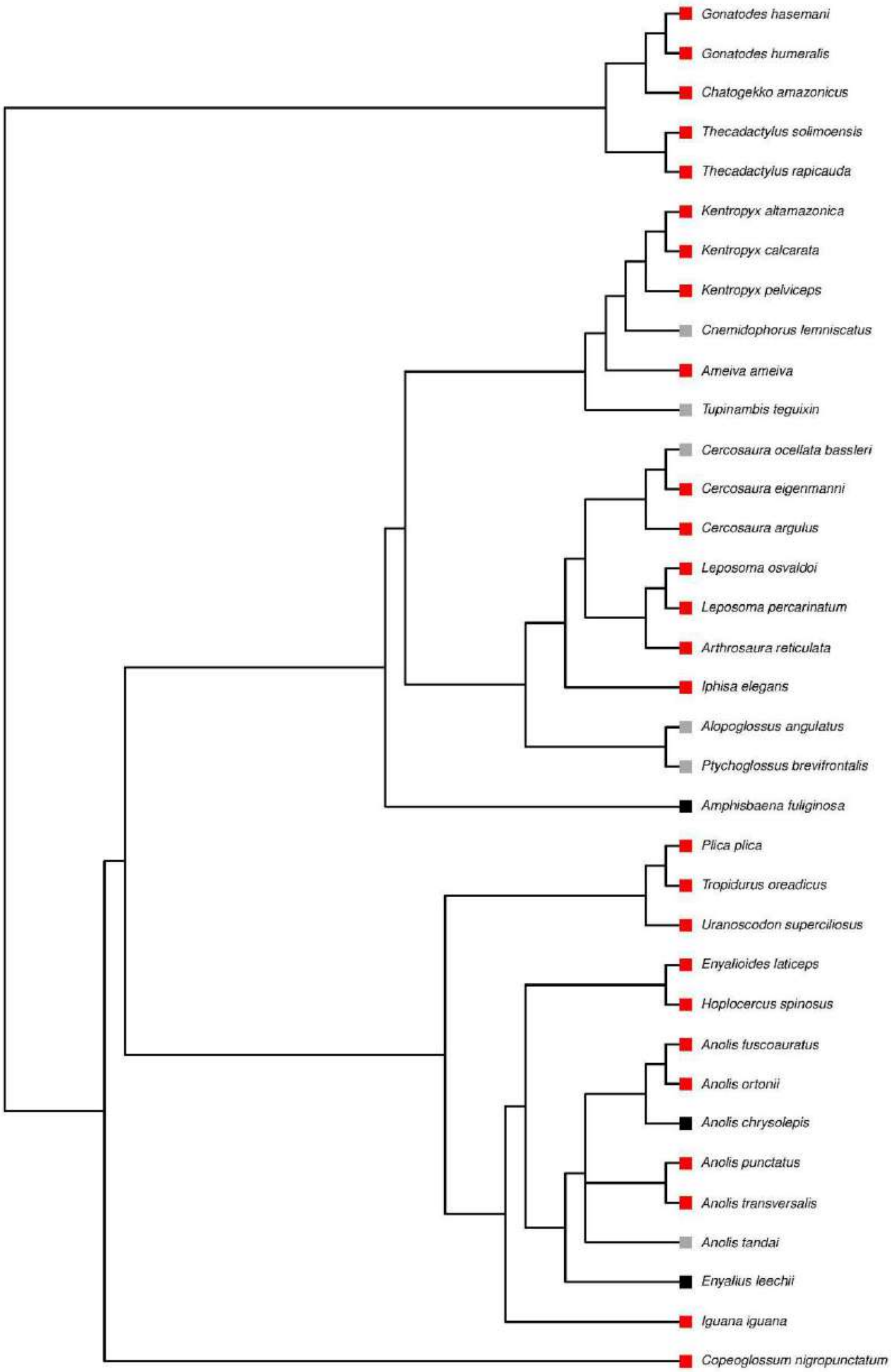

Figure S4 - Phylogenetic hypothesis for lizards (excluding snakes) species (35) with distributions limited by or crossing the Madeira River; red squares indicate species recorded on both banks of the river; black squares indicate species recorded only on the right bank of the river (Rondonia endemism area); and gray squares indicate species recorded only on the left bank of the river (Inambari endemism area).

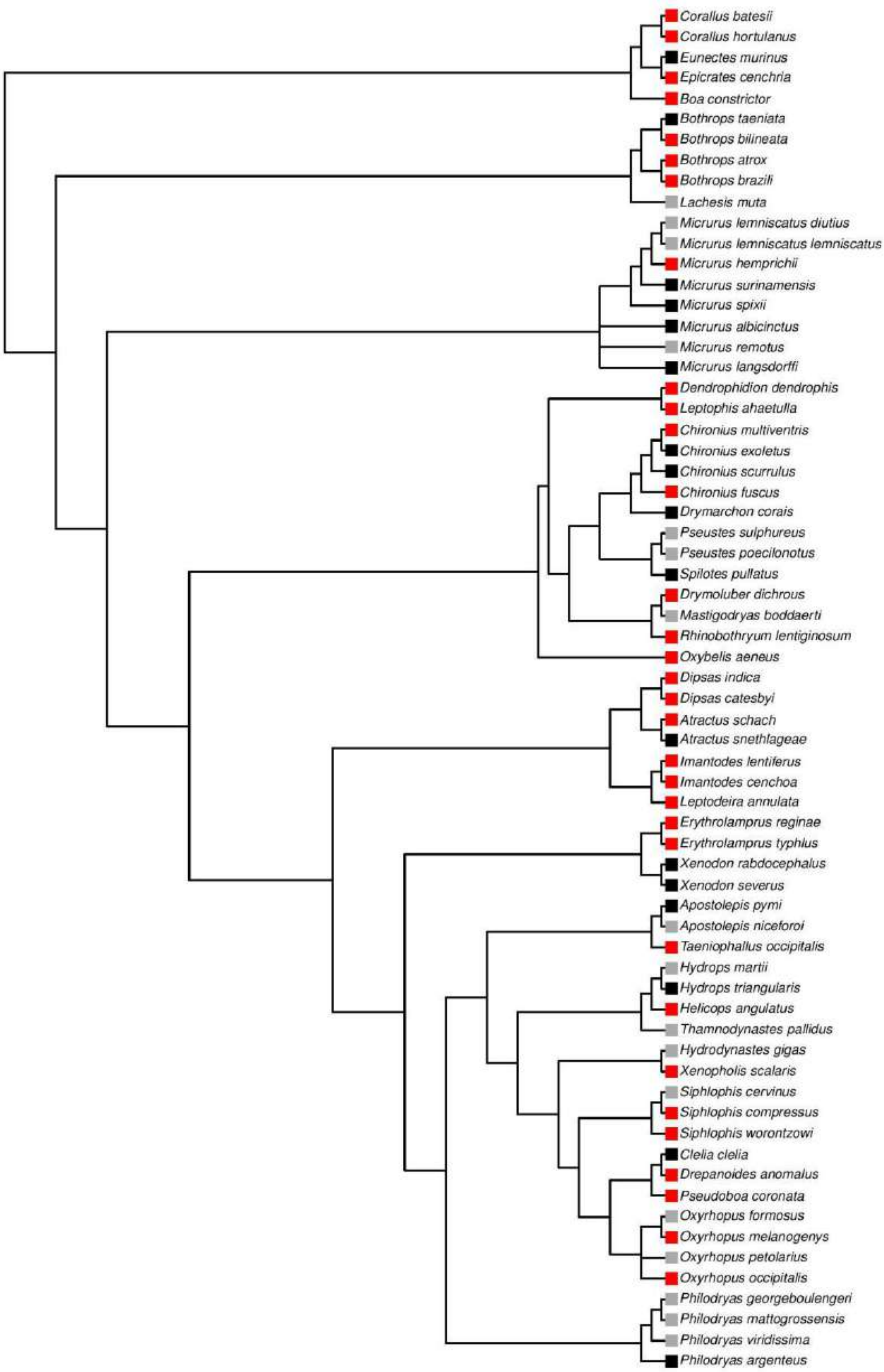

Figure S5 - Phylogenetic hypothesis for snakes species (66) with distributions limited by or crossing the Madeira River; red squares indicate species recorded on both banks of the river; black squares indicate species recorded only on the right bank of the river (Rondonia endemism area); and gray squares indicate species recorded only on the left bank of the river (Inambari endemism area).

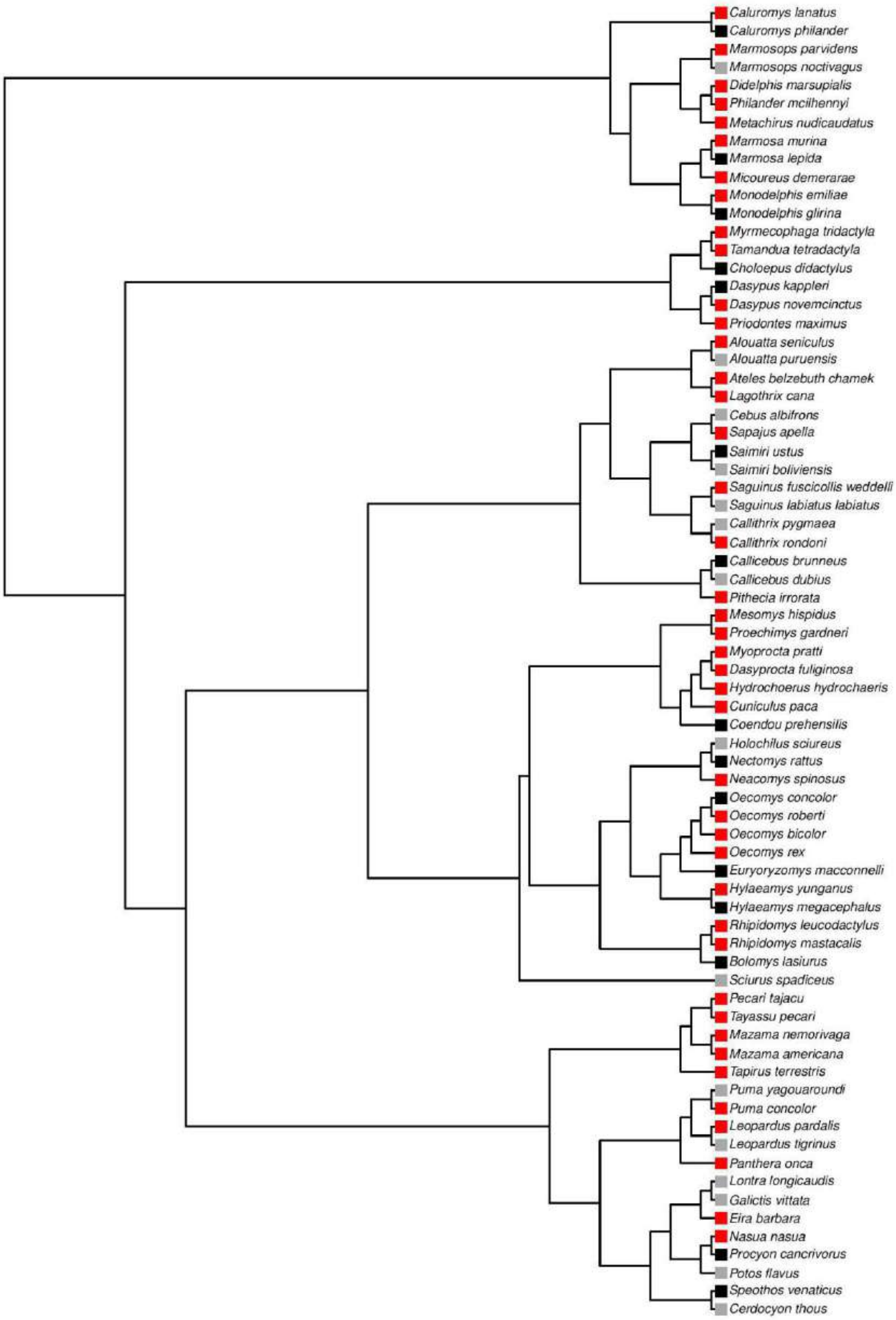

Figure S6 - Phylogenetic hypothesis for small and large non-flying mammals species (72) with distributions limited by or crossing the Madeira River; red squares indicate species recorded on both banks of the river; black squares indicate species recorded only on the right bank of the river (Rondonia endemism area); and gray squares indicate species recorded only on the left bank of the river (Inambari endemism area).

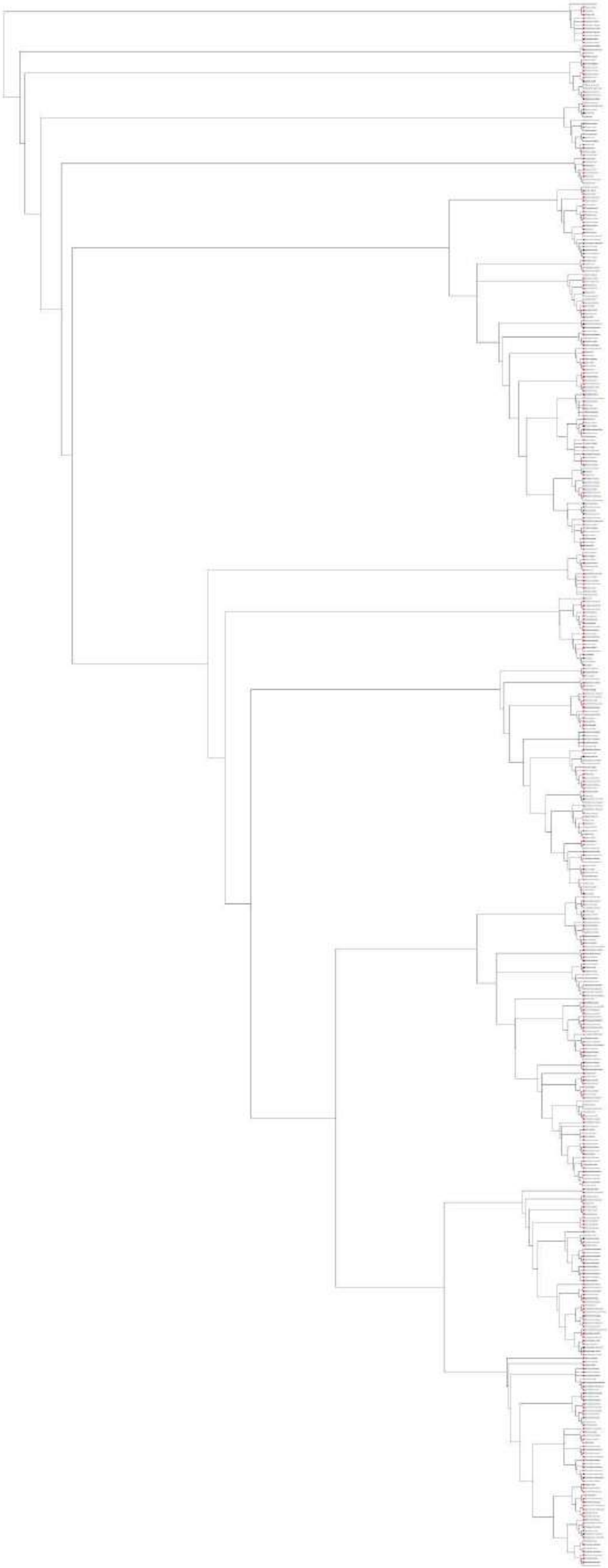

Figure S7 - Phylogenetic hypothesis for Aves species (446 spp) with distributions limited by or crossing the Madeira River; red squares indicate species recorded on both banks of the river; black squares indicate species recorded only on the right bank of the river (Rondonia endemism area); and gray squares indicate species recorded only on the left bank of the river (Inambari endemism area).

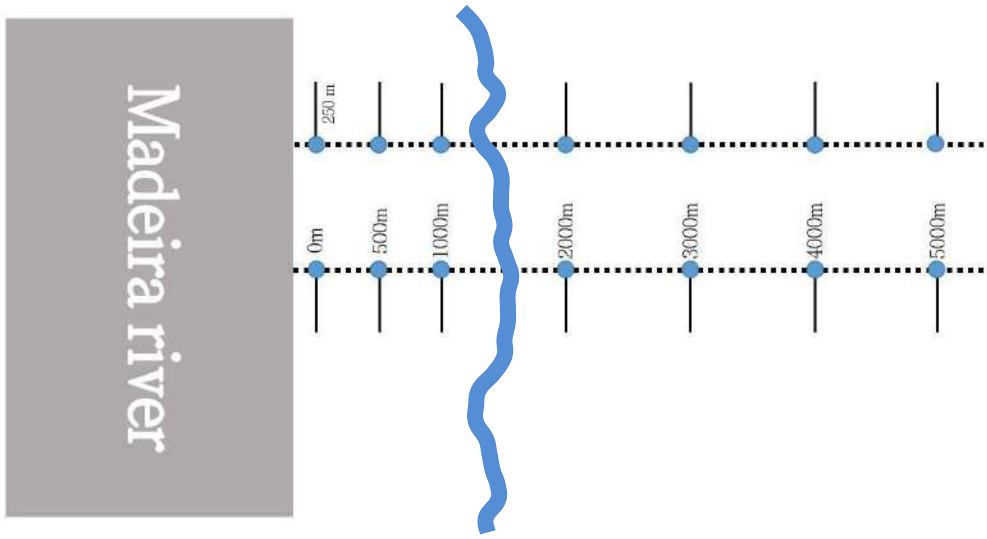

Figure S8 - Sample grid details. Each grid (black dots in Fig.1B) was composed of two parallel 5-km long trails (dashed line) with 14 permanent sampling plots (blue dots) positioned 0, 500, 1000, 2000, 3000, 4000 and 5000 m from the river bank. Blue line indicate the limit of the flooded area in Madeira River.

Table S2 - Number of samples in each endemism area, which correspond to river banks.

Taxonomic group	Rondonia endemism area[1] (Right bank)	Inambari endemism area[1] (Left bank)
Hymenoptera (Apidae)	18	24
Hymenoptera (Formicidae)	24	24
Coleptera (Scarabaeidae, Hidrophylidae*, Ceratocanhidae**)	24	36
Lepidoptera (Nymphalidae)	18	24
Isoptera (Termitidae, Kalotermitidae, Rhinotermitidae)	18	37
Orthoptera (Acrididae, Eumastacidae, Ommexechidae, Proscopiidae, Pyrgomorphidae, Romaleidae, Tetrigidae)	20	20
Snakes	67	62
Lizards	67	62
Anura	67	62
Aves	59	59
Primates	53	49
Large mammals (Rodentia, Pilosa, Ungulados, Carnivora, Artiodactyla, Cingulata)	53	49
Small mammals (Didelphimorphia, Rodentia)	43	40
Chiroptera (Phyllostomidae, Thyropteridae, Mormoopidae, Emballonuridae, Natalidae, Vespertilionidae)	29	28

TableS1 - Species list and species-distribution records (1 = presence and 0 = absence) in each endemism area, which correspond to and river banks. $P_{expected}$ values are shown only for species recorded on only one bank (right or left) of the river.

Taxonomic group	Species	Endemism area[1]			Was the Maderia river a geographic barrier?					
		Inambari (Left bank)	Rondonia (Righ bank)	$P_{expected}$	$P_{expected} \geq 0.50$	$P_{expected} \geq 0.40$	$P_{expected} \geq 0.30$	$P_{expected} \geq 0.20$	$P_{expected} \geq 0.10$	$P_{expected} \geq 0$
Birds	Accipiter bicolor	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Amazilia fimbriata	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Arremon taciturnus	0	1	0,263522255	No	No	No	Yes	Yes	Yes
Birds	Automolus paraensis	0	1	0,111982225	No	No	No	No	Yes	Yes
Birds	Buteo brachyurus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Cacicus sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Campilorhamphus trochilirostris	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Campylorhamphus probatus	0	1	0,096774162	No	No	No	No	No	Yes
Birds	Capito dayi	0	1	0,198084024	No	No	No	No	Yes	Yes
Birds	Caracara plancus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Cathartes sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Chlorostilbon mellisugus	0	1	0,033339612	No	No	No	No	No	Yes
Birds	Clytoctantes atrogularis	0	1	0,096774162	No	No	No	No	No	Yes
Birds	Columbina minuta	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Conopophaga melanogaster	0	1	0,033339612	No	No	No	No	No	Yes
Birds	Contopus sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Cotinga cayana	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Cranioleuca gutturata	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Crotophaga major	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Crypturellus tataupa	0	1	0,033339612	No	No	No	No	No	Yes
Birds	Dacnis lineata	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Dendrocincla turdina	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Dendrocolaptes concolor	0	1	0,033339612	No	No	No	No	No	Yes
Birds	Dendrocolaptes hoffmannsi	0	1	0,17033716	No	No	No	No	Yes	Yes
Birds	dendroplex picus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Euphonia chlorotica	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Forpus modestus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Forpus sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Gymnoderus foetidus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Harpagus sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Hylocharis cyanus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Hylocharis sapphirina	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Hylopezus whittakeri	0	1	0,096774162	No	No	No	No	No	Yes
Birds	Ictinia plumbea	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Leptodon cayanensis	0	1	0,065585914	No	No	No	No	No	Yes
Birds	Leptotila sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Leucopternis sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Lurocalis semitorquatus	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Mionectes sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Myiobius atricaudus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Myiobius sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Myrmelastes rufifacies	0	1	0,111982225	No	No	No	No	Yes	Yes
Birds	Myrmophylax atrothorax	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Myrmornis torquata	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Nonnula ruficapilla	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Periporphyrus erythromelas	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Picumnus aurifrons	0	1	0,033339612	No	No	No	No	No	Yes
Birds	Platyrinchus saturatus	0	1	0,17033716	No	No	No	No	Yes	Yes
Birds	Psophia viridis	0	1	0,065585914	No	No	No	No	No	Yes
Birds	Pulsatrix perspicillata	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Rhegmatorhina hoffmannsi	0	1	0,439599715	No	Yes	Yes	Yes	Yes	Yes
Birds	Schiffornis major	0	1	0,033339612	No	No	No	No	No	Yes

Birds	Selenidera sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Sporophila castaneiventris	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Thamnophilus nigrocinereus	0	1	0,049597197	No	No	No	No	No	Yes
Birds	Thamnophilus stictocephalus	0	1	0,111982225	No	No	No	No	Yes	Yes
Birds	Topaza pella	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Veniliornis passerinus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Veniliornis sp.	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Xipholaena punicea	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Zebrilus undulatus	0	1	0,016808718	No	No	No	No	No	Yes
Birds	Aburria cujubi	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Accipiter poliogaster	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Actitis macularius	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Ammodramus aurifrons	1	0	0,065585914	No	No	No	No	No	Yes
Birds	Anthracothorax nigricollis	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Ara chloropterus	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Aramides cajanea	1	0	0,081310135	No	No	No	No	No	Yes
Birds	Aratinga leucophthalma	1	0	0,065585914	No	No	No	No	No	Yes
Birds	Ardea cocoi	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Attila citrineiventris	1	0	0,126938491	No	No	No	No	Yes	Yes
Birds	Automolus melanopezus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Berlepschia rikeri	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Bucco macrodactylus	1	0	0,065585914	No	No	No	No	No	Yes
Birds	Bucco sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Buteogallus schistaceus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Campylorhamphus gyldenstolpei	1	0	0,065585914	No	No	No	No	No	Yes
Birds	Caryothraustes canadensis	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Cathartes burrovianus	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Cephalopterus ornatus	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Cercomacra manu	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Cercomacra serva	1	0	0,111982225	No	No	No	No	Yes	Yes
Birds	Chaetura sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Claravis pretiosa	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Cnipodectes subbrunneus	1	0	0,156111958	No	No	No	No	Yes	Yes
Birds	Coccyzus euleri	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Coccyzus melacoryphus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Colaptes punctigula	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Contopus virens	1	0	0,096774162	No	No	No	No	No	Yes
Birds	Dacnis albiventer	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dacnis cayana	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Dacnis flaviventer	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dacnis sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dendrocolaptes juruanus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dendrocolaptes sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dendroica striata	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Dixiphia pipra	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Euphonia minuta	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Falco deiroleucus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Falco sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Formicivora rufa	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Galbalcyrhynchus purusianus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Galbula cyanescens	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Galbula sp.	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Griseotyrannus aurantioatrocristatus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Harpagus diodon	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Hemitriccus griseipectus	1	0	0,081310135	No	No	No	No	No	Yes
Birds	Herpsilochmus sp. nov.	1	0	0,049597197	No	No	No	No	No	Yes

Birds	Heterospizias meridionalis	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Hylophilax naevius	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Hylophilax punctulatus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Hylophilus pectoralis	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Hypocnemis peruviana	1	0	0,494340337	No	Yes	Yes	Yes	Yes	Yes
Birds	Hypocnemoides sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Inezia inornata	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Inezia sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Iodopleura isabellae	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Knipolegus poecilocercus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Lanio penicillatus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Lepidothrix coronata	1	0	0,51139152	Yes	Yes	Yes	Yes	Yes	Yes
Birds	Micrastur buckleyi	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Micrastur gilvicollis	1	0	0,39991161	No	Yes	Yes	Yes	Yes	Yes
Birds	Milvago chimachima	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Monasa flavirostris	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Mycteria americana	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Myiozetetes similis	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Myrmeciza fortis	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Myrmotherula multostriata	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Neoctantes niger	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Notharchus ordii	1	0	0,224918144	No	No	No	Yes	Yes	Yes
Birds	Nothura boraquira	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Nyctibius bracteatus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Nystalus striolatus	1	0	0,096774162	No	No	No	No	No	Yes
Birds	Odontophorus stellatus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Opisthocomus hoazin	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Pachyramphus castaneus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Pachyramphus minor	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Pachyramphus sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Pachyramphus surinamus	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Patagioenas cayennensis	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Patagioenas picazuro	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Penelope sp.	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Philydor sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Poecilotriccus senex	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Polioptila laeta	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Porzana albicollis	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Progne chalybea	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Psophia leucoptera	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Pteroglossus beauharnaesii	1	0	0,126938491	No	No	No	No	Yes	Yes
Birds	Pteroglossus mariae	1	0	0,111982225	No	No	No	No	Yes	Yes
Birds	Pyrilia sp.	1	0	0,081310135	No	No	No	No	No	Yes
Birds	Rupornis magnirostris	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Saltator coerulescens	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Schiffornis amazonum	1	0	0,300234616	No	No	Yes	Yes	Yes	Yes
Birds	Schistochlamys melanopis	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Sclerurus sp.	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Selenidera reinwardtii	1	0	0,288201637	No	No	No	Yes	Yes	Yes
Birds	Sporophila caerulescens	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Sporophila schistacea	1	0	0,096774162	No	No	No	No	No	Yes
Birds	Sturnella militaris	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tachycineta albiventer	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tangara nigrocincta	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Tangara schrankii	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tangara varia	1	0	0,016808718	No	No	No	No	No	Yes

Birds	Tangara velia	1	0	0,033339612	No	No	No	No	No	Yes
Birds	Taraba major	1	0	0,081310135	No	No	No	No	No	Yes
Birds	Tersina viridis	1	0	0,049597197	No	No	No	No	No	Yes
Birds	THamnophilus aethiops	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tigrissoma lineatum	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tityra semifasciata	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tityra sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Turdus amaurochalinus	1	0	0,049597197	No	No	No	No	No	Yes
Birds	Tyrannopsis sulphurea	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Tyrannus savana	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Xiphorhynchus sp.	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Xolmis cinereus	1	0	0,016808718	No	No	No	No	No	Yes
Birds	Amazona amazonica	1	1	NA	No	No	No	No	No	No
Birds	Amazona farinosa	1	1	NA	No	No	No	No	No	No
Birds	Amazona kawalli	1	1	NA	No	No	No	No	No	No
Birds	Amazona ochrocephala	1	1	NA	No	No	No	No	No	No
Birds	Amazona sp.	1	1	NA	No	No	No	No	No	No
Birds	Ancistrops strigilatus	1	1	NA	No	No	No	No	No	No
Birds	Ara ararauna	1	1	NA	No	No	No	No	No	No
Birds	Ara macao	1	1	NA	No	No	No	No	No	No
Birds	Ara severus	1	1	NA	No	No	No	No	No	No
Birds	Ara sp.	1	1	NA	No	No	No	No	No	No
Birds	Aratinga weddellii	1	1	NA	No	No	No	No	No	No
Birds	Attila bolivianus	1	1	NA	No	No	No	No	No	No
Birds	Attila cinnamomeus	1	1	NA	No	No	No	No	No	No
Birds	Attila sp.	1	1	NA	No	No	No	No	No	No
Birds	Attila spadiceus	1	1	NA	No	No	No	No	No	No
Birds	Automolus infuscatus	1	1	NA	No	No	No	No	No	No
Birds	Automolus ochrolaemus	1	1	NA	No	No	No	No	No	No
Birds	Automolus rufipileatus	1	1	NA	No	No	No	No	No	No
Birds	Automolus subulatus	1	1	NA	No	No	No	No	No	No
Birds	Baryphthengus martii	1	1	NA	No	No	No	No	No	No
Birds	Brotogeris chrysoptera	1	1	NA	No	No	No	No	No	No
Birds	Brotogeris sanctithomae	1	1	NA	No	No	No	No	No	No
Birds	Brotogeris sp.	1	1	NA	No	No	No	No	No	No
Birds	Brotogeris versicolurus	1	1	NA	No	No	No	No	No	No
Birds	Bucco capensis	1	1	NA	No	No	No	No	No	No
Birds	Bucco tamatia	1	1	NA	No	No	No	No	No	No
Birds	Buteo nitidus	1	1	NA	No	No	No	No	No	No
Birds	Cacicus cela	1	1	NA	No	No	No	No	No	No
Birds	Cacicus haemorrhous	1	1	NA	No	No	No	No	No	No
Birds	Campephilus melanoleucos	1	1	NA	No	No	No	No	No	No
Birds	Campephilus rubricollis	1	1	NA	No	No	No	No	No	No
Birds	Camptostoma obsoletum	1	1	NA	No	No	No	No	No	No
Birds	Campylopterus largipennis	1	1	NA	No	No	No	No	No	No
Birds	Campylorhamphus procurvoides	1	1	NA	No	No	No	No	No	No
Birds	Campylorhynchus turdinus	1	1	NA	No	No	No	No	No	No
Birds	Cantorchilus leucotis	1	1	NA	No	No	No	No	No	No
Birds	Capito auratus	1	1	NA	No	No	No	No	No	No
Birds	Cathartes aura	1	1	NA	No	No	No	No	No	No
Birds	Cathartes melambrotus	1	1	NA	No	No	No	No	No	No
Birds	Catharus fuscescens	1	1	NA	No	No	No	No	No	No
Birds	Celeus elegans	1	1	NA	No	No	No	No	No	No
Birds	Celeus flavus	1	1	NA	No	No	No	No	No	No
Birds	Celeus grammicus	1	1	NA	No	No	No	No	No	No
Birds	Celeus torquatus	1	1	NA	No	No	No	No	No	No

Birds	Ceratopipra rubrocapilla	1	1	NA	No	No	No	No	No	No
Birds	Cercomacra cinerascens	1	1	NA	No	No	No	No	No	No
Birds	Cercomacra nigrescens	1	1	NA	No	No	No	No	No	No
Birds	Certhiasomus stictolaemus	1	1	NA	No	No	No	No	No	No
Birds	Chaetura brachyura	1	1	NA	No	No	No	No	No	No
Birds	Chaetura meridionalis	1	1	NA	No	No	No	No	No	No
Birds	Chamaeza nobilis	1	1	NA	No	No	No	No	No	No
Birds	Chelidoptera tenebrosa	1	1	NA	No	No	No	No	No	No
Birds	Chiroxiphia pareola	1	1	NA	No	No	No	No	No	No
Birds	Chloroceryle aenea	1	1	NA	No	No	No	No	No	No
Birds	Chloroceryle inda	1	1	NA	No	No	No	No	No	No
Birds	Chlorostilbon notatus	1	1	NA	No	No	No	No	No	No
Birds	Cissopis leverianus	1	1	NA	No	No	No	No	No	No
Birds	Cnemotriccus fuscatus	1	1	NA	No	No	No	No	No	No
Birds	Coccycua minuta	1	1	NA	No	No	No	No	No	No
Birds	Columbina talpacoti	1	1	NA	No	No	No	No	No	No
Birds	Conopias parvus	1	1	NA	No	No	No	No	No	No
Birds	Conopophaga aurita	1	1	NA	No	No	No	No	No	No
Birds	Coragyps atratus	1	1	NA	No	No	No	No	No	No
Birds	Corythopis torquatus	1	1	NA	No	No	No	No	No	No
Birds	Crotophaga ani	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus cinereus	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus obsoletus	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus parvirostris	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus soui	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus strigulosus	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus undulatus	1	1	NA	No	No	No	No	No	No
Birds	Crypturellus variegatus	1	1	NA	No	No	No	No	No	No
Birds	Cyanerpes caeruleus	1	1	NA	No	No	No	No	No	No
Birds	Cyanoloxia cyanoides	1	1	NA	No	No	No	No	No	No
Birds	Cyanoloxia rothschildii	1	1	NA	No	No	No	No	No	No
Birds	Cyclarhis gujanensis	1	1	NA	No	No	No	No	No	No
Birds	Cymbilaimus lineatus	1	1	NA	No	No	No	No	No	No
Birds	Cyphorhinus arada	1	1	NA	No	No	No	No	No	No
Birds	Daptrius ater	1	1	NA	No	No	No	No	No	No
Birds	Deconychura longicauda	1	1	NA	No	No	No	No	No	No
Birds	Dendrexetastes rufigula	1	1	NA	No	No	No	No	No	No
Birds	Dendrocincla fuliginosa	1	1	NA	No	No	No	No	No	No
Birds	Dendrocincla merula	1	1	NA	No	No	No	No	No	No
Birds	Dendrocolaptes certhia	1	1	NA	No	No	No	No	No	No
Birds	Dendrocolaptes picumnus	1	1	NA	No	No	No	No	No	No
Birds	Dendroplex picus	1	1	NA	No	No	No	No	No	No
Birds	Deroptyus accipitrinus	1	1	NA	No	No	No	No	No	No
Birds	Dichrozona cincta	1	1	NA	No	No	No	No	No	No
Birds	Drymophila devillei	1	1	NA	No	No	No	No	No	No
Birds	Dryocopus lineatus	1	1	NA	No	No	No	No	No	No
Birds	Elanoides forficatus	1	1	NA	No	No	No	No	No	No
Birds	Electron platyrhynchum	1	1	NA	No	No	No	No	No	No
Birds	Epinecrophylla haematonota	1	1	NA	No	No	No	No	No	No
Birds	Epinecrophylla leucophthalma	1	1	NA	No	No	No	No	No	No
Birds	Epinecrophylla ornata	1	1	NA	No	No	No	No	No	No
Birds	Euphonia chrysopasta	1	1	NA	No	No	No	No	No	No
Birds	Euphonia rufiventris	1	1	NA	No	No	No	No	No	No
Birds	Euphonia xanthogaster	1	1	NA	No	No	No	No	No	No
Birds	Eurypyga helias	1	1	NA	No	No	No	No	No	No
Birds	Falco rufigularis	1	1	NA	No	No	No	No	No	No

Birds	Florisuga mellivora	1	1	NA	No	No	No	No	No	No
Birds	Formicarius analis	1	1	NA	No	No	No	No	No	No
Birds	Formicarius colma	1	1	NA	No	No	No	No	No	No
Birds	Formicivora grisea	1	1	NA	No	No	No	No	No	No
Birds	Frederickena unduligera	1	1	NA	No	No	No	No	No	No
Birds	Galbula cyanicollis	1	1	NA	No	No	No	No	No	No
Birds	Galbula dea	1	1	NA	No	No	No	No	No	No
Birds	Galbula leucogastra	1	1	NA	No	No	No	No	No	No
Birds	Galbula ruficauda	1	1	NA	No	No	No	No	No	No
Birds	Gallus gallus domesticus	1	1	NA	No	No	No	No	No	No
Birds	Geotrygon montana	1	1	NA	No	No	No	No	No	No
Birds	Geotrygon violacea	1	1	NA	No	No	No	No	No	No
Birds	Glaucidium brasilianum	1	1	NA	No	No	No	No	No	No
Birds	Glaucidium hardyi	1	1	NA	No	No	No	No	No	No
Birds	Glaucis hirsutus	1	1	NA	No	No	No	No	No	No
Birds	Glyphorynchus spirurus	1	1	NA	No	No	No	No	No	No
Birds	Grallaria varia	1	1	NA	No	No	No	No	No	No
Birds	Granatellus pelzelni	1	1	NA	No	No	No	No	No	No
Birds	Gymnopithys salvini	1	1	NA	No	No	No	No	No	No
Birds	Habia rubica	1	1	NA	No	No	No	No	No	No
Birds	Haematoderus militaris	1	1	NA	No	No	No	No	No	No
Birds	Hafferia fortis	1	1	NA	No	No	No	No	No	No
Birds	Harpagus bidentatus	1	1	NA	No	No	No	No	No	No
Birds	Heliornis fulica	1	1	NA	No	No	No	No	No	No
Birds	Heliothryx auritus	1	1	NA	No	No	No	No	No	No
Birds	Hemithraupis flavicollis	1	1	NA	No	No	No	No	No	No
Birds	Hemitriccus minimus	1	1	NA	No	No	No	No	No	No
Birds	Hemitriccus minor	1	1	NA	No	No	No	No	No	No
Birds	Hemitriccus sp.	1	1	NA	No	No	No	No	No	No
Birds	Herpetotheres cachinnans	1	1	NA	No	No	No	No	No	No
Birds	Heterocercus linteatus	1	1	NA	No	No	No	No	No	No
Birds	Hydropsalis albicollis	1	1	NA	No	No	No	No	No	No
Birds	Hydropsalis nigrescens	1	1	NA	No	No	No	No	No	No
Birds	Hydropsalis parvula	1	1	NA	No	No	No	No	No	No
Birds	Hylexetastes sp.	1	1	NA	No	No	No	No	No	No
Birds	Hylexetastes stresemanni	1	1	NA	No	No	No	No	No	No
Birds	Hylexetastes uniformis	1	1	NA	No	No	No	No	No	No
Birds	Hyloctistes subulatus	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus hypoxanthus	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus muscicapinus	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus ochraceiceps	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus semicinereus	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus sp.	1	1	NA	No	No	No	No	No	No
Birds	Hylophilus thoracicus	1	1	NA	No	No	No	No	No	No
Birds	Hylophylax naevius	1	1	NA	No	No	No	No	No	No
Birds	Hylophylax punctulatus	1	1	NA	No	No	No	No	No	No
Birds	Hypocnemis ochrogyna	1	1	NA	No	No	No	No	No	No
Birds	Hypocnemoides maculicauda	1	1	NA	No	No	No	No	No	No
Birds	Hypocnemoides melanopogon	1	1	NA	No	No	No	No	No	No
Birds	Ibycter americanus	1	1	NA	No	No	No	No	No	No
Birds	Icterus cayanensis	1	1	NA	No	No	No	No	No	No
Birds	Isleria hauxwelli	1	1	NA	No	No	No	No	No	No
Birds	Jacamerops aureus	1	1	NA	No	No	No	No	No	No
Birds	Lamprospiza melanoleuca	1	1	NA	No	No	No	No	No	No
Birds	Lanio cristatus	1	1	NA	No	No	No	No	No	No
Birds	Lanio luctuosus	1	1	NA	No	No	No	No	No	No

Birds	Lanio surinamus	1	1	NA	No	No	No	No	No	No
Birds	Lanio versicolor	1	1	NA	No	No	No	No	No	No
Birds	Laniocera hypopyrra	1	1	NA	No	No	No	No	No	No
Birds	Laterallus exilis	1	1	NA	No	No	No	No	No	No
Birds	Laterallus viridis	1	1	NA	No	No	No	No	No	No
Birds	Lathrotriccus euleri	1	1	NA	No	No	No	No	No	No
Birds	Legatus leucophaius	1	1	NA	No	No	No	No	No	No
Birds	Lepidocolaptes albolineatus	1	1	NA	No	No	No	No	No	No
Birds	Lepidothrix nattereri	1	1	NA	No	No	No	No	No	No
Birds	Leptopogon amaurocephalus	1	1	NA	No	No	No	No	No	No
Birds	Leptotila rufaxilla	1	1	NA	No	No	No	No	No	No
Birds	Leptotila verreauxi	1	1	NA	No	No	No	No	No	No
Birds	Leucopternis kuhli	1	1	NA	No	No	No	No	No	No
Birds	Liosceles thoracicus	1	1	NA	No	No	No	No	No	No
Birds	Lipaugus vociferans	1	1	NA	No	No	No	No	No	No
Birds	Lophostrix cristata	1	1	NA	No	No	No	No	No	No
Birds	Machaeropterus pyrocephalus	1	1	NA	No	No	No	No	No	No
Birds	Malacoptila rufa	1	1	NA	No	No	No	No	No	No
Birds	Megaceryle torquata	1	1	NA	No	No	No	No	No	No
Birds	Megarynchus pitangua	1	1	NA	No	No	No	No	No	No
Birds	Megascops usta	1	1	NA	No	No	No	No	No	No
Birds	Megastictus margaritatus	1	1	NA	No	No	No	No	No	No
Birds	Melanerpes cruentatus	1	1	NA	No	No	No	No	No	No
Birds	Mesembrinibis cayennensis	1	1	NA	No	No	No	No	No	No
Birds	Micrastur mintoni	1	1	NA	No	No	No	No	No	No
Birds	Micrastur mirandollei	1	1	NA	No	No	No	No	No	No
Birds	Micrastur ruficollis	1	1	NA	No	No	No	No	No	No
Birds	Micrastur semitorquatus	1	1	NA	No	No	No	No	No	No
Birds	Micrastur sp.	1	1	NA	No	No	No	No	No	No
Birds	Microcerculus marginatus	1	1	NA	No	No	No	No	No	No
Birds	Microrhopias quixensis	1	1	NA	No	No	No	No	No	No
Birds	Microxenops milleri	1	1	NA	No	No	No	No	No	No
Birds	Mionectes macconnelli	1	1	NA	No	No	No	No	No	No
Birds	Mionectes oleagineus	1	1	NA	No	No	No	No	No	No
Birds	Momotus momota	1	1	NA	No	No	No	No	No	No
Birds	Monasa morphoeus	1	1	NA	No	No	No	No	No	No
Birds	Monasa nigrifrons	1	1	NA	No	No	No	No	No	No
Birds	Monasa sp.	1	1	NA	No	No	No	No	No	No
Birds	Myiarchus ferox	1	1	NA	No	No	No	No	No	No
Birds	Myiarchus tuberculifer	1	1	NA	No	No	No	No	No	No
Birds	Myiarchus tyrannulus	1	1	NA	No	No	No	No	No	No
Birds	Myiobius barbatus	1	1	NA	No	No	No	No	No	No
Birds	Myiodynastes maculatus	1	1	NA	No	No	No	No	No	No
Birds	Myiopagis caniceps	1	1	NA	No	No	No	No	No	No
Birds	Myiopagis gaimardii	1	1	NA	No	No	No	No	No	No
Birds	Myiornis ecaudatus	1	1	NA	No	No	No	No	No	No
Birds	Myiothlypis fulvicauda	1	1	NA	No	No	No	No	No	No
Birds	Myiozetetes cayanensis	1	1	NA	No	No	No	No	No	No
Birds	Myiozetetes luteiventris	1	1	NA	No	No	No	No	No	No
Birds	Myrmeciza atrothorax	1	1	NA	No	No	No	No	No	No
Birds	Myrmeciza hemimelaena	1	1	NA	No	No	No	No	No	No
Birds	Myrmelastes humaythae	1	1	NA	No	No	No	No	No	No
Birds	Myrmoborus leucophrys	1	1	NA	No	No	No	No	No	No
Birds	Myrmoborus myotherinus	1	1	NA	No	No	No	No	No	No
Birds	Myrmothera campanisona	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula assimilis	1	1	NA	No	No	No	No	No	No

Birds	Myrmotherula axillaris	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula brachyura	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula hauxwelli	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula iheringi	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula longipennis	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula menetriesii	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula sclateri	1	1	NA	No	No	No	No	No	No
Birds	Myrmotherula sp.	1	1	NA	No	No	No	No	No	No
Birds	Nasica longirostris	1	1	NA	No	No	No	No	No	No
Birds	Nonnula rubecula	1	1	NA	No	No	No	No	No	No
Birds	Notharchus hyperrhynchus	1	1	NA	No	No	No	No	No	No
Birds	Notharchus tectus	1	1	NA	No	No	No	No	No	No
Birds	Nyctibius grandis	1	1	NA	No	No	No	No	No	No
Birds	Nyctibius griseus	1	1	NA	No	No	No	No	No	No
Birds	Nyctiphrynus ocellatus	1	1	NA	No	No	No	No	No	No
Birds	Odontophorus gujanensis	1	1	NA	No	No	No	No	No	No
Birds	Odontorchilus cinereus	1	1	NA	No	No	No	No	No	No
Birds	Onychorhynchus coronatus	1	1	NA	No	No	No	No	No	No
Birds	Ornithion inerme	1	1	NA	No	No	No	No	No	No
Birds	Ortalis guttata	1	1	NA	No	No	No	No	No	No
Birds	Orthopsittaca manilatus	1	1	NA	No	No	No	No	No	No
Birds	Pachyramphus marginatus	1	1	NA	No	No	No	No	No	No
Birds	Pachyramphus polychopterus	1	1	NA	No	No	No	No	No	No
Birds	Patagioenas plumbea	1	1	NA	No	No	No	No	No	No
Birds	Patagioenas sp.	1	1	NA	No	No	No	No	No	No
Birds	Patagioenas speciosa	1	1	NA	No	No	No	No	No	No
Birds	Patagioenas subvinacea	1	1	NA	No	No	No	No	No	No
Birds	Pauxi tuberosa	1	1	NA	No	No	No	No	No	No
Birds	Penelope jacquacu	1	1	NA	No	No	No	No	No	No
Birds	Phaeothlypis fulvicauda	1	1	NA	No	No	No	No	No	No
Birds	Phaethornis hispidus	1	1	NA	No	No	No	No	No	No
Birds	Phaethornis malaris	1	1	NA	No	No	No	No	No	No
Birds	Phaethornis philippii	1	1	NA	No	No	No	No	No	No
Birds	Phaethornis ruber	1	1	NA	No	No	No	No	No	No
Birds	Phaethornis sp.	1	1	NA	No	No	No	No	No	No
Birds	Phaetusa simplex	1	1	NA	No	No	No	No	No	No
Birds	Pharomachrus pavoninus	1	1	NA	No	No	No	No	No	No
Birds	Pheugopedius genibarbis	1	1	NA	No	No	No	No	No	No
Birds	Philydor erythrocercum	1	1	NA	No	No	No	No	No	No
Birds	Philydor erythropterum	1	1	NA	No	No	No	No	No	No
Birds	Philydor pyrrhodes	1	1	NA	No	No	No	No	No	No
Birds	Philydor ruficaudatum	1	1	NA	No	No	No	No	No	No
Birds	Phlegopsis erythroptera	1	1	NA	No	No	No	No	No	No
Birds	Phlegopsis nigromaculata	1	1	NA	No	No	No	No	No	No
Birds	Phoenicircus nigricollis	1	1	NA	No	No	No	No	No	No
Birds	Piaya cayana	1	1	NA	No	No	No	No	No	No
Birds	Piaya melanogaster	1	1	NA	No	No	No	No	No	No
Birds	Piaya sp.	1	1	NA	No	No	No	No	No	No
Birds	Piculus chrysochloros	1	1	NA	No	No	No	No	No	No
Birds	Piculus flavigula	1	1	NA	No	No	No	No	No	No
Birds	Piculus laemostictus	1	1	NA	No	No	No	No	No	No
Birds	Pionites leucogaster	1	1	NA	No	No	No	No	No	No
Birds	Pionus menstruus	1	1	NA	No	No	No	No	No	No
Birds	Pipra fasciicauda	1	1	NA	No	No	No	No	No	No
Birds	Pipra rubrocapilla	1	1	NA	No	No	No	No	No	No
Birds	Piprites chloris	1	1	NA	No	No	No	No	No	No

Birds	Pitangus sulphuratus	1	1	NA	No	No	No	No	No	No
Birds	Platyrinchus coronatus	1	1	NA	No	No	No	No	No	No
Birds	Platyrinchus platyrhynchos	1	1	NA	No	No	No	No	No	No
Birds	Progne tapera	1	1	NA	No	No	No	No	No	No
Birds	Psarocolius angustirostris	1	1	NA	No	No	No	No	No	No
Birds	Psarocolius bifasciatus	1	1	NA	No	No	No	No	No	No
Birds	Psarocolius decumanus	1	1	NA	No	No	No	No	No	No
Birds	Psarocolius sp.	1	1	NA	No	No	No	No	No	No
Birds	Psarocolius viridis	1	1	NA	No	No	No	No	No	No
Birds	Psittacara leucophthalmus	1	1	NA	No	No	No	No	No	No
Birds	Pteroglossus bitorquatus	1	1	NA	No	No	No	No	No	No
Birds	Pteroglossus castanotis	1	1	NA	No	No	No	No	No	No
Birds	Pteroglossus sp.	1	1	NA	No	No	No	No	No	No
Birds	Pygiptila stellaris	1	1	NA	No	No	No	No	No	No
Birds	Pyrilia barrabandi	1	1	NA	No	No	No	No	No	No
Birds	Pyrrhura perlata	1	1	NA	No	No	No	No	No	No
Birds	Pyrrhura snethlageae	1	1	NA	No	No	No	No	No	No
Birds	Pyrrhura sp.	1	1	NA	No	No	No	No	No	No
Birds	Querula purpurata	1	1	NA	No	No	No	No	No	No
Birds	Ramphastos tucanus	1	1	NA	No	No	No	No	No	No
Birds	Ramphastos vitellinus	1	1	NA	No	No	No	No	No	No
Birds	Ramphocaenus melanurus	1	1	NA	No	No	No	No	No	No
Birds	Ramphocelus carbo	1	1	NA	No	No	No	No	No	No
Birds	Ramphotrigon ruficauda	1	1	NA	No	No	No	No	No	No
Birds	Rhegmatorhina melanosticta	1	1	NA	No	No	No	No	No	No
Birds	Rhynchocyclus olivaceus	1	1	NA	No	No	No	No	No	No
Birds	Rhytipterna simplex	1	1	NA	No	No	No	No	No	No
Birds	Saltator grossus	1	1	NA	No	No	No	No	No	No
Birds	Saltator maximus	1	1	NA	No	No	No	No	No	No
Birds	Schiffornis turdina	1	1	NA	No	No	No	No	No	No
Birds	Schistocichla humaythae	1	1	NA	No	No	No	No	No	No
Birds	Schistocichla rufifacies	1	1	NA	No	No	No	No	No	No
Birds	Sciaphylax hemimelaena	1	1	NA	No	No	No	No	No	No
Birds	Sclateria naevia	1	1	NA	No	No	No	No	No	No
Birds	Sclerurus albigularis	1	1	NA	No	No	No	No	No	No
Birds	Sclerurus caudacutus	1	1	NA	No	No	No	No	No	No
Birds	Sclerurus macconnelli	1	1	NA	No	No	No	No	No	No
Birds	Sclerurus mexicanus	1	1	NA	No	No	No	No	No	No
Birds	Sclerurus rufigularis	1	1	NA	No	No	No	No	No	No
Birds	Selenidera gouldii	1	1	NA	No	No	No	No	No	No
Birds	Sittasomus griseicapillus	1	1	NA	No	No	No	No	No	No
Birds	Spizaetus ornatus	1	1	NA	No	No	No	No	No	No
Birds	Spizaetus tyrannus	1	1	NA	No	No	No	No	No	No
Birds	Sporophila angolensis	1	1	NA	No	No	No	No	No	No
Birds	Stelgidopteryx ruficollis	1	1	NA	No	No	No	No	No	No
Birds	Strix sp.	1	1	NA	No	No	No	No	No	No
Birds	Synallaxis gujanensis	1	1	NA	No	No	No	No	No	No
Birds	Synallaxis rutilans	1	1	NA	No	No	No	No	No	No
Birds	Tangara chilensis	1	1	NA	No	No	No	No	No	No
Birds	Tangara episcopus	1	1	NA	No	No	No	No	No	No
Birds	Tangara gyrola	1	1	NA	No	No	No	No	No	No
Birds	Tangara mexicana	1	1	NA	No	No	No	No	No	No
Birds	Tangara palmarum	1	1	NA	No	No	No	No	No	No
Birds	Tangara sp.	1	1	NA	No	No	No	No	No	No
Birds	Terenotriccus erythrurus	1	1	NA	No	No	No	No	No	No
Birds	Terenura humeralis	1	1	NA	No	No	No	No	No	No

Birds	Thalurania furcata	1	1	NA	No	No	No	No	No	No
Birds	Thamnomanes caesius	1	1	NA	No	No	No	No	No	No
Birds	Thamnomanes saturninus	1	1	NA	No	No	No	No	No	No
Birds	Thamnomanes schistogynus	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus aethiops	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus amazonicus	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus doliatus	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus murinus	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus schistaceus	1	1	NA	No	No	No	No	No	No
Birds	Thamnophilus sp.	1	1	NA	No	No	No	No	No	No
Birds	Threnetes leucurus	1	1	NA	No	No	No	No	No	No
Birds	Tinamus guttatus	1	1	NA	No	No	No	No	No	No
Birds	Tinamus major	1	1	NA	No	No	No	No	No	No
Birds	Tinamus tao	1	1	NA	No	No	No	No	No	No
Birds	Todirostrum chrysocrotaphum	1	1	NA	No	No	No	No	No	No
Birds	Todirostrum maculatum	1	1	NA	No	No	No	No	No	No
Birds	Tolmomyias assimilis	1	1	NA	No	No	No	No	No	No
Birds	Tolmomyias flaviventris	1	1	NA	No	No	No	No	No	No
Birds	Tolmomyias poliocephalus	1	1	NA	No	No	No	No	No	No
Birds	Tolmomyias sulphurescens	1	1	NA	No	No	No	No	No	No
Birds	Touit huetii	1	1	NA	No	No	No	No	No	No
Birds	Troglodytes musculus	1	1	NA	No	No	No	No	No	No
Birds	Trogon collaris	1	1	NA	No	No	No	No	No	No
Birds	Trogon curucui	1	1	NA	No	No	No	No	No	No
Birds	Trogon melanurus	1	1	NA	No	No	No	No	No	No
Birds	Trogon ramonianus	1	1	NA	No	No	No	No	No	No
Birds	Trogon rufus	1	1	NA	No	No	No	No	No	No
Birds	Trogon sp.	1	1	NA	No	No	No	No	No	No
Birds	Trogon violaceus	1	1	NA	No	No	No	No	No	No
Birds	Trogon viridis	1	1	NA	No	No	No	No	No	No
Birds	Turdus albicollis	1	1	NA	No	No	No	No	No	No
Birds	Turdus fumigatus	1	1	NA	No	No	No	No	No	No
Birds	Turdus hauxwelli	1	1	NA	No	No	No	No	No	No
Birds	Turdus lawrencii	1	1	NA	No	No	No	No	No	No
Birds	Tyranneutes stolzmanni	1	1	NA	No	No	No	No	No	No
Birds	Tyrannulus elatus	1	1	NA	No	No	No	No	No	No
Birds	Tyrannus melancholicus	1	1	NA	No	No	No	No	No	No
Birds	Urubitinga urubitinga	1	1	NA	No	No	No	No	No	No
Birds	Vanellus chilensis	1	1	NA	No	No	No	No	No	No
Birds	Veniliornis affinis	1	1	NA	No	No	No	No	No	No
Birds	Vireo chivi	1	1	NA	No	No	No	No	No	No
Birds	Vireo olivaceus	1	1	NA	No	No	No	No	No	No
Birds	Vireolanius leucotis	1	1	NA	No	No	No	No	No	No
Birds	Volatinia jacarina	1	1	NA	No	No	No	No	No	No
Birds	Willisornis poecilinotus	1	1	NA	No	No	No	No	No	No
Birds	Xenops minutus	1	1	NA	No	No	No	No	No	No
Birds	Xiphocolaptes promeropirhynchus	1	1	NA	No	No	No	No	No	No
Birds	Xiphorhynchus elegans	1	1	NA	No	No	No	No	No	No
Birds	Xiphorhynchus guttatus	1	1	NA	No	No	No	No	No	No
Birds	Xiphorhynchus obsoletus	1	1	NA	No	No	No	No	No	No
Birds	Xiphorhynchus ocellatus	1	1	NA	No	No	No	No	No	No
Birds	Zimmerius gracilipes	1	1	NA	No	No	No	No	No	No
Small mammals	Caluromys philander	0	1	0,323827778	No	No	Yes	Yes	Yes	Yes
Small mammals	Cricetidae sp.1	0	1	0,042366409	No	No	No	No	No	Yes
Small mammals	Didelphis sp.4	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Euryoryzomys macconnelli	0	1	0,102653399	No	No	No	No	Yes	Yes

Small mammals	Holochilus sp.1	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Hylaeamys megacephalus	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Marmosa lepida	0	1	0,062888168	No	No	No	No	No	Yes
Small mammals	Marmosops sp.	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Monodelphis glirina	0	1	0,212330851	No	No	No	Yes	Yes	Yes
Small mammals	Necromys lasiurus	0	1	0,042366409	No	No	No	No	No	Yes
Small mammals	Nectomys rattus	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Oecomys concolor	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Oecomys sp.	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Rhipidomys sp.4	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Riphidomys sp.2	0	1	0,02140672	No	No	No	No	No	Yes
Small mammals	Didelphis sp.3	1	0	0,10204435	No	No	No	No	Yes	Yes
Small mammals	Euryoryzomys sp.1	1	0	0,02652526	No	No	No	No	No	Yes
Small mammals	Euryoryzomys sp.2	1	0	0,052362868	No	No	No	No	No	Yes
Small mammals	Holochilus sciureus	1	0	0,077530237	No	No	No	No	No	Yes
Small mammals	Marmosa sp.2	1	0	0,12592177	No	No	No	No	Yes	Yes
Small mammals	Marmosops noctivagus	1	0	0,02652526	No	No	No	No	No	Yes
Small mammals	Marmosops sp.3	1	0	0,171830742	No	No	No	No	Yes	Yes
Small mammals	Monodelphis sp.1	1	0	0,077530237	No	No	No	No	No	Yes
Small mammals	Nectomys sp.1	1	0	0,02652526	No	No	No	No	No	Yes
Small mammals	Oecomys bicolor	1	0	0,052362868	No	No	No	No	No	Yes
Small mammals	Proechimys sp.3	1	0	0,02652526	No	No	No	No	No	Yes
Small mammals	Urosciurus spadiceus	1	0	0,052362868	No	No	No	No	No	Yes
Small mammals	Caluromys lanatus	1	1	NA	No	No	No	No	No	No
Small mammals	Didelphis marsupialis	1	1	NA	No	No	No	No	No	No
Small mammals	Hylaeamys sp.1	1	1	NA	No	No	No	No	No	No
Small mammals	Hylaeamys sp.2	1	1	NA	No	No	No	No	No	No
Small mammals	Hylaeamys yunganus	1	1	NA	No	No	No	No	No	No
Small mammals	Marmosa murina	1	1	NA	No	No	No	No	No	No
Small mammals	Marmosops parvidens	1	1	NA	No	No	No	No	No	No
Small mammals	Marmosops sp.2	1	1	NA	No	No	No	No	No	No
Small mammals	Mesomys hispidus	1	1	NA	No	No	No	No	No	No
Small mammals	Metachirus nudicaudatus	1	1	NA	No	No	No	No	No	No
Small mammals	Micoureus demerarae	1	1	NA	No	No	No	No	No	No
Small mammals	Micoureus sp.3	1	1	NA	No	No	No	No	No	No
Small mammals	Monodelphis emiliae	1	1	NA	No	No	No	No	No	No
Small mammals	Neacomys spinosus	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys bicolor	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys rex	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys roberti	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys sp.1	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys sp.3	1	1	NA	No	No	No	No	No	No
Small mammals	Oecomys sp.4	1	1	NA	No	No	No	No	No	No
Small mammals	Philander mcilhennyi	1	1	NA	No	No	No	No	No	No
Small mammals	Proechimys gardineri	1	1	NA	No	No	No	No	No	No
Small mammals	Proechimys sp.	1	1	NA	No	No	No	No	No	No
Small mammals	Proechimys sp.2	1	1	NA	No	No	No	No	No	No
Small mammals	Rhipidomys leucodactylus	1	1	NA	No	No	No	No	No	No
Small mammals	Rhipidomys mastacalis	1	1	NA	No	No	No	No	No	No
Small mammals	Rhipidomys sp.2	1	1	NA	No	No	No	No	No	No
Large mammals	Choloepus didactylus	0	1	0,034298295	No	No	No	No	No	Yes
Large mammals	Coendou prehensilis	0	1	0,017295718	No	No	No	No	No	Yes
Large mammals	Dasypus kappleri	0	1	0,017295718	No	No	No	No	No	Yes
Large mammals	Leopardus pardalismitis	0	1	0,017295718	No	No	No	No	No	Yes
Large mammals	Procyon cancrivorus	0	1	0,017295718	No	No	No	No	No	Yes
Large mammals	Spheotos venaticus	0	1	0,034298295	No	No	No	No	No	Yes

Large mammals	Cerdocyon thous	1	0	0,021836783	No	No	No	No	No	Yes
Large mammals	Galictis vittata	1	0	0,064116067	No	No	No	No	No	Yes
Large mammals	Guerlinguetus ingrami	1	0	0,124193916	No	No	No	No	Yes	Yes
Large mammals	Leopardus tigrinus	1	0	0,043205524	No	No	No	No	No	Yes
Large mammals	Lontra longicaudis	1	0	0,021836783	No	No	No	No	No	Yes
Large mammals	Pecari pecari	1	0	0,021836783	No	No	No	No	No	Yes
Large mammals	Potus flavus	1	0	0,043205524	No	No	No	No	No	Yes
Large mammals	Puma yagouaroundi	1	0	0,021836783	No	No	No	No	No	Yes
Large mammals	Sciurus sp.	1	0	0,021836783	No	No	No	No	No	Yes
Large mammals	Sciurus spadiceus	1	0	0,10460092	No	No	No	No	Yes	Yes
Large mammals	Cuniculus paca	1	1	NA	No	No	No	No	No	No
Large mammals	Dasyprocta fuliginosa	1	1	NA	No	No	No	No	No	No
Large mammals	Dasyprocta sp.	1	1	NA	No	No	No	No	No	No
Large mammals	Dasyprocta variegata	1	1	NA	No	No	No	No	No	No
Large mammals	Dasypus maximus	1	1	NA	No	No	No	No	No	No
Large mammals	Dasypus novemcinctus	1	1	NA	No	No	No	No	No	No
Large mammals	Dasypus sp.	1	1	NA	No	No	No	No	No	No
Large mammals	Eira barbara	1	1	NA	No	No	No	No	No	No
Large mammals	Guerlinguetus sp.	1	1	NA	No	No	No	No	No	No
Large mammals	Hydrochaeris hydrochaeris	1	1	NA	No	No	No	No	No	No
Large mammals	Leopardus pardalis	1	1	NA	No	No	No	No	No	No
Large mammals	Mazama americana	1	1	NA	No	No	No	No	No	No
Large mammals	Mazama nemorivaga	1	1	NA	No	No	No	No	No	No
Large mammals	Mazama sp.	1	1	NA	No	No	No	No	No	No
Large mammals	Myoprocta pratti	1	1	NA	No	No	No	No	No	No
Large mammals	Myrmecophaga tridactyla	1	1	NA	No	No	No	No	No	No
Large mammals	Nasua nasua	1	1	NA	No	No	No	No	No	No
Large mammals	Panthera onca	1	1	NA	No	No	No	No	No	No
Large mammals	Pecari tajacu	1	1	NA	No	No	No	No	No	No
Large mammals	Priodontes maximus	1	1	NA	No	No	No	No	No	No
Large mammals	Puma concolor	1	1	NA	No	No	No	No	No	No
Large mammals	Tamandua tetradactyla	1	1	NA	No	No	No	No	No	No
Large mammals	Tapirus terrestris	1	1	NA	No	No	No	No	No	No
Large mammals	Tayassu pecari	1	1	NA	No	No	No	No	No	No
Large mammals	Tayassu tajacu	1	1	NA	No	No	No	No	No	No
Primates	Callicebus brunneus	0	1	0,099473351	No	No	No	No	No	Yes
Primates	Cebus apella	0	1	0,017295718	No	No	No	No	No	Yes
Primates	Saimiri ustus	0	1	0,244141279	No	No	No	Yes	Yes	Yes
Primates	Alouatta puruensis	1	0	0,021836783	No	No	No	No	No	Yes
Primates	Callicebus dubius	1	0	0,266510799	No	No	No	Yes	Yes	Yes
Primates	Cebuella pygmaea	1	0	0,043205524	No	No	No	No	No	Yes
Primates	Cebus albifrons	1	0	0,233218805	No	No	No	Yes	Yes	Yes
Primates	Saguinus labiatus labiatus	1	0	0,589509763	Yes	Yes	Yes	Yes	Yes	Yes
Primates	Saimiri boliviensis	1	0	0,343660343	No	No	Yes	Yes	Yes	Yes
Primates	Alouatta seniculus	1	1	NA	No	No	No	No	No	No
Primates	Ateles chamek	1	1	NA	No	No	No	No	No	No
Primates	Lagothrix cana	1	1	NA	No	No	No	No	No	No
Primates	Mico rondoni	1	1	NA	No	No	No	No	No	No
Primates	Pithecia irrorata	1	1	NA	No	No	No	No	No	No
Primates	Saguinus fuscicollis wedelli	1	1	NA	No	No	No	No	No	No
Primates	Saguinus sp.	1	1	NA	No	No	No	No	No	No
Primates	Saguinus weddelli	1	1	NA	No	No	No	No	No	No
Primates	Sapajus apella	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus anderseni	0	1	0,064493044	No	No	No	No	No	Yes
Chiroptera	Chiroderma villosum	0	1	0,095216568	No	No	No	No	No	Yes
Chiroptera	Glossophaga longirostris	0	1	0,032764724	No	No	No	No	No	Yes

Chiroptera	Mimon bennettii	0	1	0,064493044	No	No	No	No	No	Yes
Chiroptera	Myotis riparius	0	1	0,181660657	No	No	No	No	Yes	Yes
Chiroptera	Peropteryx leucoptera	0	1	0,032764724	No	No	No	No	No	Yes
Chiroptera	Rhynchonycteris naso	0	1	0,032764724	No	No	No	No	No	Yes
Chiroptera	Thyroptera discifera	0	1	0,064493044	No	No	No	No	No	Yes
Chiroptera	Cormura brevirostris	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Eptesicus sp.	1	0	0,071397132	No	No	No	No	No	Yes
Chiroptera	Glyphonycteris daviesi	1	0	0,071397132	No	No	No	No	No	Yes
Chiroptera	Lichonycteris degener	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Lionycteris spurrelli	1	0	0,105224334	No	No	No	No	Yes	Yes
Chiroptera	Micronycteris minuta	1	0	0,071397132	No	No	No	No	No	Yes
Chiroptera	Micronycteris schmidtorum	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Natalus macrourus	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Phyllostomus discolor	1	0	0,105224334	No	No	No	No	Yes	Yes
Chiroptera	Saccopteryx canescens	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Vampyriscus sp.	1	0	0,036336784	No	No	No	No	No	Yes
Chiroptera	Artibeus cinereus	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus concolor	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus glaucus	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus gnomus	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus lituratus	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus obscurus	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus planirostris	1	1	NA	No	No	No	No	No	No
Chiroptera	Artibeus sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Carollia benkeithi	1	1	NA	No	No	No	No	No	No
Chiroptera	Carollia brevicauda	1	1	NA	No	No	No	No	No	No
Chiroptera	Carollia perspicillata	1	1	NA	No	No	No	No	No	No
Chiroptera	Carollia sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Centronycteris maximiliani	1	1	NA	No	No	No	No	No	No
Chiroptera	Choeroniscus minor	1	1	NA	No	No	No	No	No	No
Chiroptera	Chrotopterus auritus	1	1	NA	No	No	No	No	No	No
Chiroptera	Dermanura anderseni	1	1	NA	No	No	No	No	No	No
Chiroptera	Dermanura cinerea	1	1	NA	No	No	No	No	No	No
Chiroptera	Dermanura gnoma	1	1	NA	No	No	No	No	No	No
Chiroptera	Dermanura sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Desmodus rotundus	1	1	NA	No	No	No	No	No	No
Chiroptera	Diphylla ecaudata	1	1	NA	No	No	No	No	No	No
Chiroptera	Glossophaga soricina	1	1	NA	No	No	No	No	No	No
Chiroptera	Glyphonycteris sylvestris	1	1	NA	No	No	No	No	No	No
Chiroptera	Hsunycteris thomasi	1	1	NA	No	No	No	No	No	No
Chiroptera	Lampronycteris brachyotis	1	1	NA	No	No	No	No	No	No
Chiroptera	Lonchophylla thomasi	1	1	NA	No	No	No	No	No	No
Chiroptera	Lophostoma brasiliense	1	1	NA	No	No	No	No	No	No
Chiroptera	Lophostoma silvicolum	1	1	NA	No	No	No	No	No	No
Chiroptera	Mesophylla macconnelli	1	1	NA	No	No	No	No	No	No
Chiroptera	Micronycteris hirsuta	1	1	NA	No	No	No	No	No	No
Chiroptera	Micronycteris megalotis	1	1	NA	No	No	No	No	No	No
Chiroptera	Micronycteris microtis	1	1	NA	No	No	No	No	No	No
Chiroptera	Micronycteris sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Mimon crenulatum	1	1	NA	No	No	No	No	No	No
Chiroptera	Myotis nigricans	1	1	NA	No	No	No	No	No	No
Chiroptera	Myotis sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Phylloderma stenops	1	1	NA	No	No	No	No	No	No
Chiroptera	Phyllostomus elongatus	1	1	NA	No	No	No	No	No	No
Chiroptera	Phyllostomus hastatus	1	1	NA	No	No	No	No	No	No
Chiroptera	Platyrrhinus brachycephalus	1	1	NA	No	No	No	No	No	No

Chiroptera	Platyrrhinus incarum	1	1	NA	No	No	No	No	No	No
Chiroptera	Platyrrhinus sp.	1	1	NA	No	No	No	No	No	No
Chiroptera	Pteronotus parnellii	1	1	NA	No	No	No	No	No	No
Chiroptera	Rhinophylla fischerae	1	1	NA	No	No	No	No	No	No
Chiroptera	Rhinophylla pumilio	1	1	NA	No	No	No	No	No	No
Chiroptera	Saccopteryx bilineata	1	1	NA	No	No	No	No	No	No
Chiroptera	Saccopteryx leptura	1	1	NA	No	No	No	No	No	No
Chiroptera	Sturnira lilium	1	1	NA	No	No	No	No	No	No
Chiroptera	Sturnira tildae	1	1	NA	No	No	No	No	No	No
Chiroptera	Thyroptera tricolor	1	1	NA	No	No	No	No	No	No
Chiroptera	Tonatia saurophila	1	1	NA	No	No	No	No	No	No
Chiroptera	Trachops cirrhosus	1	1	NA	No	No	No	No	No	No
Chiroptera	Trinycteris nicefori	1	1	NA	No	No	No	No	No	No
Chiroptera	Uroderma bilobatum	1	1	NA	No	No	No	No	No	No
Chiroptera	Uroderma magnirostrum	1	1	NA	No	No	No	No	No	No
Chiroptera	Vampyressa thyone	1	1	NA	No	No	No	No	No	No
Chiroptera	Vampyriscus bidens	1	1	NA	No	No	No	No	No	No
Anura	Adenomera marmoratus sp.2	0	1	0,066763087	No	No	No	No	No	Yes
Anura	Altigius alios	0	1	0,027251038	No	No	No	No	No	Yes
Anura	Dendropsophus koechlini	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Dendropsophus nanus	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Dendropsophus sp.15	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Elachistocleis sp.1	0	1	0,027251038	No	No	No	No	No	Yes
Anura	Hydrolaetare dantasi	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Hydrolaetare schmidti	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Hypsiboas calcaratus	0	1	0,066763087	No	No	No	No	No	Yes
Anura	Hypsiboas geographicus sp.1	0	1	0,027251038	No	No	No	No	No	Yes
Anura	Hypsiboas wavrini	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Leptodactylus chaquensis	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Leptodactylus marmoratus	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Leptodactylus marmoratus sp.1	0	1	0,092222736	No	No	No	No	No	Yes
Anura	Phyllomedusa hypochondrialis	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Rhinella margaritifera sp.6	0	1	0,176065053	No	No	No	No	Yes	Yes
Anura	Rhinella schneideri	0	1	0,027251038	No	No	No	No	No	Yes
Anura	Scinax nebulosus	0	1	0,079579517	No	No	No	No	No	Yes
Anura	Scinax sp.11	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Sphaenorhynchus lacteus	0	1	0,013718115	No	No	No	No	No	Yes
Anura	Trachycephalus resinifictrix	0	1	0,040601228	No	No	No	No	No	Yes
Anura	Allobates hodli	1	0	0,099369555	No	No	No	No	No	Yes
Anura	Allobates nidicola	1	0	0,243806644	No	No	No	Yes	Yes	Yes
Anura	Allobates sp.2	1	0	0,160143903	No	No	No	No	Yes	Yes
Anura	Allobates sp.7	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Amazophrynella vote	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Chiasmocleis supercilialbus	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Dendrophryniscus minutus	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Dendropsophus myiatay	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Dendropsophus sp.13	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Dendropsophus sp.16	1	0	0,050965092	No	No	No	No	No	Yes
Anura	Engystomops freibergi	1	0	0,114957444	No	No	No	No	Yes	Yes
Anura	Hyalinobatrachium capellei	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Hypsiboas geographicus	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Hypsiboas geographicus sp.4	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Hypsiboas geographicus sp.5	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Hypsiboas sibleszi	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Leptodeira annulata	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Lithobates palmipes	1	0	0,017280969	No	No	No	No	No	Yes

Anura	Oreobates quixensis	1	0	0,145340189	No	No	No	No	Yes	Yes
Anura	Pipa arrabali	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Pristimantis sp.6	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Pseudis paradoxa	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Ranitomeya ventrimaculata	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Rhinella margaritifera sp.3	1	0	0,083511291	No	No	No	No	No	Yes
Anura	Rhinella margaritifera sp.4	1	0	0,203056028	No	No	No	Yes	Yes	Yes
Anura	Rhinella margaritifera sp.4	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Rhinella margaritifera sp.5	1	0	0,160143903	No	No	No	No	Yes	Yes
Anura	Rhinella margaritifera sp.7	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Scinax boesemani	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Scinax funerea	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Scinax sp.12	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Scinax sp.3	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Scinax sp.4	1	0	0,034267688	No	No	No	No	No	Yes
Anura	Scinax x-signatus	1	0	0,017280969	No	No	No	No	No	Yes
Anura	Adelphobates quinquevittatus	1	1	NA	No	No	No	No	No	No
Anura	Adenomera andreae	1	1	NA	No	No	No	No	No	No
Anura	Adenomera hylaedactyla	1	1	NA	No	No	No	No	No	No
Anura	Allobates femoralis	1	1	NA	No	No	No	No	No	No
Anura	Allobates sp.1	1	1	NA	No	No	No	No	No	No
Anura	Allobates sp.3	1	1	NA	No	No	No	No	No	No
Anura	Allobates sp.4	1	1	NA	No	No	No	No	No	No
Anura	Allobates sp.5	1	1	NA	No	No	No	No	No	No
Anura	Allobates sp.6	1	1	NA	No	No	No	No	No	No
Anura	Ameerega picta	1	1	NA	No	No	No	No	No	No
Anura	Ameerega trivittata	1	1	NA	No	No	No	No	No	No
Anura	Ceratophrys cornuta	1	1	NA	No	No	No	No	No	No
Anura	Chiasmocleis avilapiresae	1	1	NA	No	No	No	No	No	No
Anura	Chiasmocleis bassleri	1	1	NA	No	No	No	No	No	No
Anura	Chiasmocleis jimi	1	1	NA	No	No	No	No	No	No
Anura	Cochranella adenocheira	1	1	NA	No	No	No	No	No	No
Anura	Ctenophryne geayi	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus brevifrons	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus leali	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus leucophyllatus	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus marmoratus	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus minusculus	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus minutus	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus parviceps	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus rhodopeplus	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus sarayacuensis	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus sp.12	1	1	NA	No	No	No	No	No	No
Anura	Dendropsophus sp.14	1	1	NA	No	No	No	No	No	No
Anura	Elachistocleis helianneae	1	1	NA	No	No	No	No	No	No
Anura	Hamptophryne bolivianus	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas boans	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas cinerascens	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas fasciatus	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas geographicus sp.3	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas geographycus sp.2	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas lanciformis	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas multifasciatus	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas punctatus	1	1	NA	No	No	No	No	No	No
Anura	Hypsiboas raniceps	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus andreae	1	1	NA	No	No	No	No	No	No

Anura	Leptodactylus bolivianus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus fuscus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus hylaedactylus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus knudseni	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus leptodactyloides	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus lineatus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus macrosternum	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus mystaceus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus pentadactylus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus petersii	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus podicipinus	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus rhodomystax	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus wagneri	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus wagneri sp.1	1	1	NA	No	No	No	No	No	No
Anura	Leptodactylus wagneri sp.2	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus cabrerai	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus castaneicola	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus leprieurii sp.1	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus oophagus	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus planiceps	1	1	NA	No	No	No	No	No	No
Anura	Osteocephalus taurinus	1	1	NA	No	No	No	No	No	No
Anura	Phyllomedusa tomopterna	1	1	NA	No	No	No	No	No	No
Anura	Phyllomedusa vaillantii	1	1	NA	No	No	No	No	No	No
Anura	Phyzelaphryne miriamae	1	1	NA	No	No	No	No	No	No
Anura	Pipa pipa	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis altamazonicus	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis fenestratus	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis ockendeni	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis sp.1	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis sp.2	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis sp.4	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis sp.5	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis ventrimarmoratus	1	1	NA	No	No	No	No	No	No
Anura	Pristimantis zimmermanae	1	1	NA	No	No	No	No	No	No
Anura	Pseudis limellum	1	1	NA	No	No	No	No	No	No
Anura	Rhaebo guttatus	1	1	NA	No	No	No	No	No	No
Anura	Rhinella major	1	1	NA	No	No	No	No	No	No
Anura	Rhinella margaritifera sp.1	1	1	NA	No	No	No	No	No	No
Anura	Rhinella margaritifera sp.2	1	1	NA	No	No	No	No	No	No
Anura	Rhinella margaritifera sp.7	1	1	NA	No	No	No	No	No	No
Anura	Rhinella marina	1	1	NA	No	No	No	No	No	No
Anura	Scinax cruentommus	1	1	NA	No	No	No	No	No	No
Anura	Scinax garbei	1	1	NA	No	No	No	No	No	No
Anura	Scinax ruber	1	1	NA	No	No	No	No	No	No
Anura	Scinax sp.1	1	1	NA	No	No	No	No	No	No
Anura	Scinax sp.13	1	1	NA	No	No	No	No	No	No
Anura	Scinax sp.2	1	1	NA	No	No	No	No	No	No
Anura	Trachycephalus coriaceus	1	1	NA	No	No	No	No	No	No
Anura	Trachycephalus typhonius	1	1	NA	No	No	No	No	No	No
Anura	Trachycephalus venulosus	1	1	NA	No	No	No	No	No	No
Anura	Vitreorana oyampiensis	1	1	NA	No	No	No	No	No	No
Lizards	Amphisbaena fuliginosa	0	1	0,013718115	No	No	No	No	No	Yes
Lizards	Anolis nitens	0	1	0,013718115	No	No	No	No	No	Yes
Lizards	Enyalius leechii	0	1	0,027251038	No	No	No	No	No	Yes
Lizards	Norops ortonii	0	1	0,040601228	No	No	No	No	No	Yes
Lizards	Alopoglossus angulatus	1	0	0,017280969	No	No	No	No	No	Yes

Lizards	Anolis nitens nitens	1	0	0,034267688	No	No	No	No	No	Yes
Lizards	Anolis transversalis	1	0	0,114957444	No	No	No	No	Yes	Yes
Lizards	Cercosaura ocellata	1	0	0,160143903	No	No	No	No	Yes	Yes
Lizards	Cercosaura ocellata bassleri	1	0	0,017280969	No	No	No	No	No	Yes
Lizards	Cnemidophorus lemniscatus	1	0	0,034267688	No	No	No	No	No	Yes
Lizards	Leposoma sp.1	1	0	0,017280969	No	No	No	No	No	Yes
Lizards	Leposoma sp.2	1	0	0,034267688	No	No	No	No	No	Yes
Lizards	Norops tandai	1	0	0,067378035	No	No	No	No	No	Yes
Lizards	Ptychoglossus brevifrontalis	1	0	0,017280969	No	No	No	No	No	Yes
Lizards	Tupinambis teguixin	1	0	0,017280969	No	No	No	No	No	Yes
Lizards	Ameiva ameiva	1	1	NA	No	No	No	No	No	No
Lizards	Anolis fuscoauratus	1	1	NA	No	No	No	No	No	No
Lizards	Anolis ortonii	1	1	NA	No	No	No	No	No	No
Lizards	Anolis punctatus	1	1	NA	No	No	No	No	No	No
Lizards	Arthrosaura reticulata	1	1	NA	No	No	No	No	No	No
Lizards	Cercosaura argulus	1	1	NA	No	No	No	No	No	No
Lizards	Cercosaura eigenmanni	1	1	NA	No	No	No	No	No	No
Lizards	Chatogekko amazonicus	1	1	NA	No	No	No	No	No	No
Lizards	Coleodactylus amazonicus	1	1	NA	No	No	No	No	No	No
Lizards	Copeoglossum nigropunctatum	1	1	NA	No	No	No	No	No	No
Lizards	Dactyloa punctata	1	1	NA	No	No	No	No	No	No
Lizards	Dactyloa transversalis	1	1	NA	No	No	No	No	No	No
Lizards	Enyalioides laticeps	1	1	NA	No	No	No	No	No	No
Lizards	Gonatodes hasemani	1	1	NA	No	No	No	No	No	No
Lizards	Gonatodes humeralis	1	1	NA	No	No	No	No	No	No
Lizards	Hoplocercus spinosus	1	1	NA	No	No	No	No	No	No
Lizards	Iguana iguana	1	1	NA	No	No	No	No	No	No
Lizards	Iphisa elegans	1	1	NA	No	No	No	No	No	No
Lizards	Kentropyx altamazonica	1	1	NA	No	No	No	No	No	No
Lizards	Kentropyx calcarata	1	1	NA	No	No	No	No	No	No
Lizards	Kentropyx pelviceps	1	1	NA	No	No	No	No	No	No
Lizards	Leposoma osvaldoi	1	1	NA	No	No	No	No	No	No
Lizards	Leposoma percarinatum	1	1	NA	No	No	No	No	No	No
Lizards	Mabuya nigropunctata	1	1	NA	No	No	No	No	No	No
Lizards	Norops fuscoauratus	1	1	NA	No	No	No	No	No	No
Lizards	Plica plica	1	1	NA	No	No	No	No	No	No
Lizards	Plica umbra ochrocollaris	1	1	NA	No	No	No	No	No	No
Lizards	Thecadactylus rapicauda	1	1	NA	No	No	No	No	No	No
Lizards	Thecadactylus solimoensis	1	1	NA	No	No	No	No	No	No
Lizards	Tropidurus oreadicus	1	1	NA	No	No	No	No	No	No
Lizards	Uranoscodon superciliosus	1	1	NA	No	No	No	No	No	No
Snakes	Apostolepis nigrolineata	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Apostolepis sp.	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Atractus snethlageae	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Bothrops taeniatus	0	1	0,027251038	No	No	No	No	No	Yes
Snakes	Chironius exoletus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Clelia clelia	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Erythrolamprus reginae	0	1	0,040601228	No	No	No	No	No	Yes
Snakes	Eunectes murinus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Hydrops triangularis	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Micrurus spixii	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Micrurus albicinctus	0	1	0,027251038	No	No	No	No	No	Yes
Snakes	Micrurus langsdorffi	0	1	0,027251038	No	No	No	No	No	Yes
Snakes	Micrurus surinamensis	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Philodryas argentea	0	1	0,129136003	No	No	No	No	Yes	Yes
Snakes	Phylodryas argentea	0	1	0,053771112	No	No	No	No	No	Yes

Snakes	Pseudoboa martinsii	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Pseudoboa sp.1	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Spilotes pullatus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Xenodon rabdocephalus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Xenodon severus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Xenoxybelis argenteus	0	1	0,013718115	No	No	No	No	No	Yes
Snakes	Apostolepis niceforoi	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Atractus sp.	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Bothriopsis bilineata	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Epictia sp.	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Hydrops martii	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Lachesis muta	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Mastigodryas boddaerti	1	0	0,050965092	No	No	No	No	No	Yes
Snakes	Micrurus lemniscatus diutus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Micrurus lemniscatus lemniscatus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Micrurus remotus	1	0	0,067378035	No	No	No	No	No	Yes
Snakes	Oxyrhopus formosus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Oxyrhopus petola	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Oxyrhopus petolarius	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Philodryas boulengeri	1	0	0,050965092	No	No	No	No	No	Yes
Snakes	Philodryas georgeboulengeri	1	0	0,145340189	No	No	No	No	Yes	Yes
Snakes	Philodryas viridissima	1	0	0,034267688	No	No	No	No	No	Yes
Snakes	Phylodryas boulengeri	1	0	0,099369555	No	No	No	No	No	Yes
Snakes	Pseustes poecilonotus	1	0	0,050965092	No	No	No	No	No	Yes
Snakes	Pseustes sulphureus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Siphlophis cervinus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Thamnodynastes pallidus	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Xenoxybelis boulengeri	1	0	0,017280969	No	No	No	No	No	Yes
Snakes	Atractus schach	1	1	NA	No	No	No	No	No	No
Snakes	Boa constrictor	1	1	NA	No	No	No	No	No	No
Snakes	Bothrops atrox	1	1	NA	No	No	No	No	No	No
Snakes	Bothrops bilineatus	1	1	NA	No	No	No	No	No	No
Snakes	Bothrops brazili	1	1	NA	No	No	No	No	No	No
Snakes	Chironius fuscus	1	1	NA	No	No	No	No	No	No
Snakes	Chironius multiventris	1	1	NA	No	No	No	No	No	No
Snakes	Corallus batesii	1	1	NA	No	No	No	No	No	No
Snakes	Corallus hortulanus	1	1	NA	No	No	No	No	No	No
Snakes	Dendrophidion dendrophis	1	1	NA	No	No	No	No	No	No
Snakes	Dipsas catesbyi	1	1	NA	No	No	No	No	No	No
Snakes	Dipsas indica	1	1	NA	No	No	No	No	No	No
Snakes	Drepanoides anomalus	1	1	NA	No	No	No	No	No	No
Snakes	Drymoluber dichrous	1	1	NA	No	No	No	No	No	No
Snakes	Epicrates cenchria	1	1	NA	No	No	No	No	No	No
Snakes	Helicops angulatus	1	1	NA	No	No	No	No	No	No
Snakes	Imantodes cenchoa	1	1	NA	No	No	No	No	No	No
Snakes	Imantodes lentiferus	1	1	NA	No	No	No	No	No	No
Snakes	Leptodeira annulata	1	1	NA	No	No	No	No	No	No
Snakes	Leptophis ahaetulla	1	1	NA	No	No	No	No	No	No
Snakes	Liophis reginae	1	1	NA	No	No	No	No	No	No
Snakes	Liophis typhlus	1	1	NA	No	No	No	No	No	No
Snakes	Micrurus hemprichii	1	1	NA	No	No	No	No	No	No
Snakes	Micrurus lemniscatus	1	1	NA	No	No	No	No	No	No
Snakes	Oxybelis aeneus	1	1	NA	No	No	No	No	No	No
Snakes	Oxyrhopus melanogenys	1	1	NA	No	No	No	No	No	No
Snakes	Oxyrhopus occipitalis	1	1	NA	No	No	No	No	No	No
Snakes	Pseudoboa coronata	1	1	NA	No	No	No	No	No	No

Snakes	Rhinobothryum lentiginosum	1	1	NA	No	No	No	No	No	No
Snakes	Siphlophis compressus	1	1	NA	No	No	No	No	No	No
Snakes	Siphlophis worontzowi	1	1	NA	No	No	No	No	No	No
Snakes	Taeniophallus occipitalis	1	1	NA	No	No	No	No	No	No
Snakes	Xenopholis scalaris	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa amazonica	0	1	0,200091093	No	No	No	Yes	Yes	Yes
Hymenoptera (Apidae)	Eufriesea auripes	1	0	0,060689101	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eufriesea fallax	1	0	0,060689101	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eufriesea flaviventris	1	0	0,060689101	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eufriesea pulchra	1	0	0,089712679	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eufriesea sp.2	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eufriesea surinamensis	1	0	0,060689101	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa chlorina	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa hugonis	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa rugilabris	1	0	0,246834604	No	No	No	Yes	Yes	Yes
Hymenoptera (Apidae)	Euglossa securigera	1	0	0,145237921	No	No	No	No	Yes	Yes
Hymenoptera (Apidae)	Euglossa sp.1	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa sp.2	1	0	0,060689101	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa sp.3	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Euglossa sp.5	1	0	0,030793088	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Eulaema polyzona	1	0	0,089712679	No	No	No	No	No	Yes
Hymenoptera (Apidae)	Aglae caerulea	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eufriesea fragocora	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eufriesea superba	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa analis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa augaspis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa avicula	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa bidentata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa chalybeata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa cognata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa crassipunctata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa despecta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa gaianii	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa ignita	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa imperialis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa intersecta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa iopyrrha	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa irisa	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa laevincta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa magnipes	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa modestior	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa mourei	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa orellana	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa parvula	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa pleosticta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Euglossa prasina	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema bombiformis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema cingulata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema meriana	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema mocsaryi	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema nigrita	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Eulaema pseudocingulata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Exaerete frontalis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Exaerete lepeletieri	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Exaerete smaragdina	1	1	NA	No	No	No	No	No	No
Hymenoptera (Apidae)	Exaerete trochanterica	1	1	NA	No	No	No	No	No	No

Hymenoptera (Formicidae)	Atta cephalotes	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Brachymyrmex sp.4	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Brachymyrmex sp.6	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Camponotus sp.6	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Carebara lignata	0	1	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Cephalotes minutus	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cephalotes sp.1	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Crematogaster carinata	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Crematogaster nigropilosa	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cyphomyrmex salvini	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cyphomyrmex sp.13	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cyphomyrmex sp.3	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Dolichoderus bidens	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Dolichoderus longicollis	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Dolichoderus septemspinosus	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys sp.11	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Lachnomyrmex sp.1	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Leptogenys unistimulosa	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Megalomyrmex drifti	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Monomorium pharaonis	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Neivamyrmex adnepos	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Neivamyrmex sp.3	0	1	0,154010274	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Neoponera laevigata	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Odontomachus caelatus	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pachycondyla sp.2	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole fracticeps	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.5	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.54	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.55	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pseudomyrmex simplex	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pseudomyrmex sp.2	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Rhopalothrix sp.2	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Simopelta jeckylli	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Solenopsis molesta	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Solenopsis sp.5	0	1	0,154010274	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Strumigenys deinomastax	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys sp.14	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys sp.15	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys trinidadensis	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Trachymyrmex farinosus	0	1	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Tranopelta gilva	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Wasmannia rochai	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Wasmannia scrobifera	0	1	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Acromyrmex subterraneus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Acropyga sp.1	1	0	0,222219709	No	No	No	Yes	Yes	Yes
Hymenoptera (Formicidae)	Allomerus octoarticulatus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Anochetus sp.2	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Apterostigma sp.1	1	0	0,254316057	No	No	No	Yes	Yes	Yes
Hymenoptera (Formicidae)	Azteca chartiffex	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Azteca sp.2	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Azteca sp.3	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Azteca sp.4	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Brachymyrmex sp.5	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Camponotus atriceps	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Camponotus cameranoi	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Camponotus novogranadensis	1	0	0,117791323	No	No	No	No	Yes	Yes

Hymenoptera (Formicidae)	Camponotus rapax	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Camponotus sericeiventris	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Camponotus sp.5	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Carebara sp.5	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cephalotes atratus	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cephalotes pellans	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cephalotes pusillus	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Cephalotes sp.2	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cephalotes sp.3	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cerapachys augustae	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Cheliomyrmex megalonyx	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Crematogaster curvispinosa	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Cyphomyrmex strigatus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Dinoponera gigantea	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Discothyrea sexarticulata	1	0	0,154010274	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Dolichoderus debilis	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Dolichoderus sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Ectatomma horni	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Eurhopalotrhrix pilulifera	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gigantiops destructor	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Gnamptogenys acuminata	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys caelata	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys ericae	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys kempfi	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys sp.3	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Gnamptogenys striatula	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Hylomyrma sp.2	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Hypoponera sp.10	1	0	0,154010274	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Hypoponera sp.16	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Labidus praedator	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Linepithema sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Megalomyrmex sp.5	1	0	0,188801767	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Mycocepurus goeldii	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Mycocepurus sp.2	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Neivamyrmex angustinodis	1	0	0,188801767	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Neoponera commutata	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Neoponera venusta	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Nesomyrmex pleuriticus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Octostruma sp.1	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Odontomachus bauri	1	0	0,188801767	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Odontomachus emarginatus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Odontomachus hastatus	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Odontomachus sp.3	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pachycondyla crassinoda	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pachycondyla sp.3	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.11	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.14	1	0	0,188801767	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Pheidole sp.43	1	0	0,314742478	No	No	Yes	Yes	Yes	Yes
Hymenoptera (Formicidae)	Pheidole sp.8	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole sp.9	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pheidole vorax	1	0	0,254316057	No	No	No	Yes	Yes	Yes
Hymenoptera (Formicidae)	Prionopelta sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pseudomyrmex ita	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Pseudomyrmex sp.3	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Rhopalothrix sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Rogeria belti	1	0	0,117791323	No	No	No	No	Yes	Yes

Hymenoptera (Formicidae)	Rogeria blanda	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Rogeria sp.1	1	0	0,254316057	No	No	No	Yes	Yes	Yes
Hymenoptera (Formicidae)	Simopelta anomma	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Stigmatomma degeneratum	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys appretiata	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys infidelis	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Strumigenys sp.1	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Strumigenys sp.2	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Tapinoma sp.1	1	0	0,117791323	No	No	No	No	Yes	Yes
Hymenoptera (Formicidae)	Tranopelta sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Typhlomyrmex sp.1	1	0	0,040845275	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Wasmannia sp.1	1	0	0,080088993	No	No	No	No	No	Yes
Hymenoptera (Formicidae)	Anochetus diegensis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Anochetus horridus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Anochetus sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Apterostigma auriculatum	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Apterostigma pilosum	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Apterostigma sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Apterostigma sp.4	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Atta sexdens	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Azteca sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Azteca sp.5	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Basiceros militaris	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Blepharidatta brasiliensis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Brachymyrmex sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Brachymyrmex sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Brachymyrmex sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Camponotus blandus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Camponotus crassus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Camponotus fastigatus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Camponotus femoratus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Camponotus rectangularis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Carebara sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Carebara sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Carebara urichi	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cerapachys splendens	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster acuta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster brasiliensis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster flavosensitiva	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster limata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster longispina	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster sotobosque	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster stollii	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Crematogaster tenuicula	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex laevigatus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex lectus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex minutus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex peltatus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex rimosus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex sp.12	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Cyphomyrmex sp.4	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Discothyrea denticulata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Discothyrea humilis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Dolichoderus bispinosus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Dolichoderus cogitans	1	1	NA	No	No	No	No	No	No

Hymenoptera (Formicidae)	Dolichoderus decollatus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Dolichoderus imitator	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Eciton burchellii	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Ectatomma brunneum	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Ectatomma edentatum	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Ectatomma lugens	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys haenschi	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys horni	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys moelleri	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys pleurodon	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys relicta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys sp.5	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Gnamptogenys tortuolosa	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma dentiloba	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma dolochops	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma immanis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma longiscapa	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma reitteri	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hylomyrma sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.11	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.12	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.13	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.14	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.4	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.5	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.6	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.7	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.8	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Hypoponera sp.9	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Labidus spininodis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Mayaponera constricta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex balzani	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex cuatiara	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex goeldii	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex leoninus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex sp.8	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Megalomyrmex wallacei	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Mycetarotes sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Mycocepurus sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Mycocepurus sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Myrmicocrypta sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Myrmicocrypta sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Neoponera apicalis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Neoponera cavinodis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Neoponera crenata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Neoponera unidentata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Neoponera verenae	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Nylanderia caeciliae	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Nylanderia fulva	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Nylanderia guatemalensis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Nylanderia sp.3	1	1	NA	No	No	No	No	No	No

Hymenoptera (Formicidae)	Nylanderia sp.5	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Nylanderia sp.6	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Ochetomyrmex semipolitus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Octostruma balzani	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Octostruma iheringi	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Octostruma sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Octostruma sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Odontomachus chelifer	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Odontomachus haematodus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Odontomachus meinerti	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Odontomachus sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Odontomachus sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Oxyepoecus ephippiatus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pachycondyla ferruginea	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pachycondyla harpax	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pachycondyla impressa	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pachycondyla sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pachycondyla striata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole biconstricta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole flavens	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.10	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.12	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.15	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.16	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.17	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.18	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.19	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.20	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.21	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.22	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.23	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.24	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.26	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.27	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.28	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.29	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.30	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.32	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.40	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.41	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.42	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.44	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.45	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.46	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.47	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.48	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.49	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.50	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.51	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.52	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.53	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pheidole sp.7	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pseudomyrmex tenuis	1	1	NA	No	No	No	No	No	No

Hymenoptera (Formicidae)	Pseudomyrmex termitarius	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Pseudoponera stigma	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rasopone arhuaca	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rogeria alzatei	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rogeria cornuta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rogeria cuneola	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rogeria leptonana	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Rogeria sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Sericomyrmex sp.1	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Sericomyrmex sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis brevicornis	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis castor	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis clytemnestra	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis geminata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis loretana	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis saevissima	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis sp.7	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis sp.9	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Solenopsis substituta	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Stegomyrmex olindae	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys beebei	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys denticulata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys elongata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys inusitata	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys perparva	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys smithii	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.10	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.13	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.4	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.5	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.6	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.7	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.8	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys sp.9	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys trudifera	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Strumigenys zeteki	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Tapinoma melanocephalum	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Tatuidris tatusia	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Tetramorium sp.2	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Thaumatomyrmex atrox	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex bugnioni	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex cornetzi	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex diversus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex mandibulares	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex opulentus	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex ruthae	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex sp.10	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex sp.3	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex sp.7	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex sp.8	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Trachymyrmex sp.9	1	1	NA	No	No	No	No	No	No
Hymenoptera (Formicidae)	Wasmannia auropunctata	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.09	0	1	0,269381788	No	No	No	Yes	Yes	Yes
Coleoptera	Canthidium sp.09	0	1	0,171376993	No	No	No	No	Yes	Yes

Coleoptera	Canthidium sp.13	0	1	0,117695035	No	No	No	No	Yes	Yes
Coleoptera	Canthon sp.01	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Canthon sp.03	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Canthon sp.05	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Dichotomius sp.07	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Eurysternus hirtellus	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Hidrophylidae sp.01	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Onthophagus sp.05	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Scybalocanthon sp.02	0	1	0,060637961	No	No	No	No	No	Yes
Coleoptera	Aphodiinae sp.	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Ateuchus sp.06	1	0	0,154010274	No	No	No	No	Yes	Yes
Coleoptera	Ateuchus sp.08	1	0	0,054101449	No	No	No	No	No	Yes
Coleoptera	Ateuchus sp.10	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Canthidium sp.04	1	0	0,036387123	No	No	No	No	No	Yes
Coleoptera	Canthidium sp.12	1	0	0,071503457	No	No	No	No	No	Yes
Coleoptera	Canthon luteicolle	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Canthon sp.06	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Canthon sp.07	1	0	0,071503457	No	No	No	No	No	Yes
Coleoptera	Canthon sp.08	1	0	0,088598419	No	No	No	No	No	Yes
Coleoptera	Canthon sp.10	1	0	0,036387123	No	No	No	No	No	Yes
Coleoptera	Canthon sp.12	1	0	0,036387123	No	No	No	No	No	Yes
Coleoptera	Canthon sp.13	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Ceratocanthidae sp.01	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Cetoniinae sp.	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Delthochilum valgum	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Dendropaemon sp.01	1	0	0,036387123	No	No	No	No	No	Yes
Coleoptera	Dichotomius conicollis	1	0	0,10539152	No	No	No	No	Yes	Yes
Coleoptera	Dichotomius sp.05	1	0	0,185004845	No	No	No	No	Yes	Yes
Coleoptera	Eurysternus cyanescens	1	0	0,088598419	No	No	No	No	No	Yes
Coleoptera	Oxysternon conspiscillatum	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Oxysternon spiniferum	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Pseudocanthon sp.01	1	0	0,054101449	No	No	No	No	No	Yes
Coleoptera	Scatimus sp.04	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Scatimus sp.05	1	0	0,018355121	No	No	No	No	No	Yes
Coleoptera	Scybalocanthon sp.01	1	0	0,036387123	No	No	No	No	No	Yes
Coleoptera	Scybalocanthon sp.03	1	0	0,071503457	No	No	No	No	No	Yes
Coleoptera	Scybalocanthon sp.05	1	0	0,054101449	No	No	No	No	No	Yes
Coleoptera	Ateuchus candezei	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.01	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.02	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.03	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.05	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.07	1	1	NA	No	No	No	No	No	No
Coleoptera	Ateuchus sp.11	1	1	NA	No	No	No	No	No	No
Coleoptera	Besourenga horacioi	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.01	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.03	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.05	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.08	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.10	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.14	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthidium sp.15	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthon aequinoctiale	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthon sp.02	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthon sp.04	1	1	NA	No	No	No	No	No	No
Coleoptera	Canthon sp.09	1	1	NA	No	No	No	No	No	No

Coleoptera	Canthon sp.11	1	1	NA	No	No	No	No	No	No
Coleoptera	Coprophanaeus lancifer	1	1	NA	No	No	No	No	No	No
Coleoptera	Coprophanaeus telamon	1	1	NA	No	No	No	No	No	No
Coleoptera	Cryptocanthon sp.01	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum amazonicum	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum carinatum	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum granulosum	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum howdeni	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum laetiusculum	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum orbiculare	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum sp.02	1	1	NA	No	No	No	No	No	No
Coleoptera	Deltochilum sp.06	1	1	NA	No	No	No	No	No	No
Coleoptera	Dichotomius globulus	1	1	NA	No	No	No	No	No	No
Coleoptera	Dichotomius lucasi	1	1	NA	No	No	No	No	No	No
Coleoptera	Dichotomius prietoi	1	1	NA	No	No	No	No	No	No
Coleoptera	Dichotomius sp.04	1	1	NA	No	No	No	No	No	No
Coleoptera	Dichotomius sp.06	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus caribaeus	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus hypocrita	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus sp.01	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus sp.03	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus squamosus	1	1	NA	No	No	No	No	No	No
Coleoptera	Eurysternus wittmerorum	1	1	NA	No	No	No	No	No	No
Coleoptera	Hansreia affinis	1	1	NA	No	No	No	No	No	No
Coleoptera	Onthophagus sp.01	1	1	NA	No	No	No	No	No	No
Coleoptera	Onthophagus sp.02	1	1	NA	No	No	No	No	No	No
Coleoptera	Onthophagus sp.03	1	1	NA	No	No	No	No	No	No
Coleoptera	Onthophagus sp.04	1	1	NA	No	No	No	No	No	No
Coleoptera	Oxysternon silenus	1	1	NA	No	No	No	No	No	No
Coleoptera	Phanaeus chalcomelas	1	1	NA	No	No	No	No	No	No
Coleoptera	Scybalocanthon sp.06	1	1	NA	No	No	No	No	No	No
Coleoptera	Scybalocanthon sp.07	1	1	NA	No	No	No	No	No	No
Coleoptera	Scybalocanthon sp.08	1	1	NA	No	No	No	No	No	No
Lepidoptera	Adelpha attica attica	0	1	0,36148569	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Adelpha cocala cocala	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Adelpha heraclea heraclea	0	1	0,311512359	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Adelpha melona leucocoma	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Adelpha thesprotia	0	1	0,311512359	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Archaeoprepona meander meander	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Caeruleuptychia caerulea	0	1	0,138092468	No	No	No	No	Yes	Yes
Lepidoptera	Caligo eurilochus livius	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Catoblepia xanthus	0	1	0,257802931	No	No	No	Yes	Yes	Yes
Lepidoptera	Catonephele antinoe	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Consul fabius	0	1	0,138092468	No	No	No	No	Yes	Yes
Lepidoptera	Eresia sp.1	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Eryphanis gerhardi	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Eunica malvina malvina	0	1	0,138092468	No	No	No	No	Yes	Yes
Lepidoptera	Eunica marsolia marsolia	0	1	0,311512359	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Eunica sophosniba agele	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Eunica sydonia caresa	0	1	0,257802931	No	No	No	Yes	Yes	Yes
Lepidoptera	Harjesia oreba	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Magneuptychia gera nobilis	0	1	0,138092468	No	No	No	No	Yes	Yes
Lepidoptera	Marpesia crethon	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Marpesia egina	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Memphis phantes vicinia	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Memphis philumena philumena	0	1	0,071503457	No	No	No	No	No	Yes

Lepidoptera	Memphis polycarmes	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Pareuptychia sp.2	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Prepona eugenes	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Prepona pylene	0	1	0,36148569	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Pseudodebis sp.1	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Selenophanes cassiope	0	1	0,257802931	No	No	No	Yes	Yes	Yes
Lepidoptera	Splendeuptychia aurigera	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Taygetomorpha celia	0	1	0,071503457	No	No	No	No	No	Yes
Lepidoptera	Vila emilia sinefascia	0	1	0,138092468	No	No	No	No	Yes	Yes
Lepidoptera	Zaretis isidora	0	1	0,257802931	No	No	No	Yes	Yes	Yes
Lepidoptera	Adelpha plesaure phliassa	1	0	0,089712679	No	No	No	No	No	Yes
Lepidoptera	Amphidecta pignerator pignerator	1	0	0,060689101	No	No	No	No	No	Yes
Lepidoptera	Antirrhea philoctetes avernus	1	0	0,197553488	No	No	No	No	Yes	Yes
Lepidoptera	Callicore excelsior michaeli	1	0	0,171785746	No	No	No	No	Yes	Yes
Lepidoptera	Chloreuptychia arnaca	1	0	0,117887824	No	No	No	No	Yes	Yes
Lepidoptera	Cissia penelope	1	0	0,31542794	No	No	Yes	Yes	Yes	Yes
Lepidoptera	Cissia sp.1	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Cissia sp.2	1	0	0,060689101	No	No	No	No	No	Yes
Lepidoptera	Cissia sp.4	1	0	0,060689101	No	No	No	No	No	Yes
Lepidoptera	Diaethria clymena clymena	1	0	0,089712679	No	No	No	No	No	Yes
Lepidoptera	Ectima thecla lirina	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Erichthodes sp.1	1	0	0,117887824	No	No	No	No	Yes	Yes
Lepidoptera	Eunica monima	1	0	0,246834604	No	No	No	Yes	Yes	Yes
Lepidoptera	Eunica viola	1	0	0,222562758	No	No	No	Yes	Yes	Yes
Lepidoptera	Euptychia mollina	1	0	0,117887824	No	No	No	No	Yes	Yes
Lepidoptera	Hamadryas glauconome glauconome	1	0	0,171785746	No	No	No	No	Yes	Yes
Lepidoptera	Magneuptychia fugitiva	1	0	0,145237921	No	No	No	No	Yes	Yes
Lepidoptera	Magneuptychia newtoni	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Magneuptychia sp.2	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Marpesia themistocles norica	1	0	0,060689101	No	No	No	No	No	Yes
Lepidoptera	Opoptera aorsa hilaris	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Pareuptychia sp.1	1	0	0,060689101	No	No	No	No	No	Yes
Lepidoptera	Pareuptychia sp.3	1	0	0,030793088	No	No	No	No	No	Yes
Lepidoptera	Pierella amalia	1	0	0,089712679	No	No	No	No	No	Yes
Lepidoptera	Pierella hortona albofasciata	1	0	0,270389526	No	No	No	Yes	Yes	Yes
Lepidoptera	Taygetis angulosa	1	0	0,171785746	No	No	No	No	Yes	Yes
Lepidoptera	Taygetis uncinata	1	0	0,117887824	No	No	No	No	Yes	Yes
Lepidoptera	Temenis pulchra pallidior	1	0	0,089712679	No	No	No	No	No	Yes
Lepidoptera	Adelpha capucinus capucinus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Adelpha iphicleora gortyna	1	1	NA	No	No	No	No	No	No
Lepidoptera	Adelpha malea aethalia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Adelpha mesentina	1	1	NA	No	No	No	No	No	No
Lepidoptera	Agrias claudina sardanapalus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Amphidecta calliomma	1	1	NA	No	No	No	No	No	No
Lepidoptera	Archaeoprepona amphimachus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Archaeoprepona demophon demophon	1	1	NA	No	No	No	No	No	No
Lepidoptera	Archaeoprepona licomedes licomedes	1	1	NA	No	No	No	No	No	No
Lepidoptera	Batesia hypochlora hypoxantha	1	1	NA	No	No	No	No	No	No
Lepidoptera	Bia actorion	1	1	NA	No	No	No	No	No	No
Lepidoptera	Caerois chorinaeus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Caeruleuptychia brixius	1	1	NA	No	No	No	No	No	No
Lepidoptera	Caligo idomeneus idomeneus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Caligo illioneus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Caligo teucer teucer	1	1	NA	No	No	No	No	No	No
Lepidoptera	Callicore cynosura cynosura	1	1	NA	No	No	No	No	No	No
Lepidoptera	Catoblepia berecynthia	1	1	NA	No	No	No	No	No	No

Lepidoptera	Catoblepia soranus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Catonephele acontius acontius	1	1	NA	No	No	No	No	No	No
Lepidoptera	Catonephele numilia numilia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Catonephele salacia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Chloreuptychia agatha	1	1	NA	No	No	No	No	No	No
Lepidoptera	Chloreuptychia chlorimene	1	1	NA	No	No	No	No	No	No
Lepidoptera	Chloreuptychia herseis	1	1	NA	No	No	No	No	No	No
Lepidoptera	Chloreuptychia hewitsonii	1	1	NA	No	No	No	No	No	No
Lepidoptera	Choreuptychia sp.1	1	1	NA	No	No	No	No	No	No
Lepidoptera	Cissia proba	1	1	NA	No	No	No	No	No	No
Lepidoptera	Cissia sp.3	1	1	NA	No	No	No	No	No	No
Lepidoptera	Cithaerias phantoma	1	1	NA	No	No	No	No	No	No
Lepidoptera	Colobura annulata	1	1	NA	No	No	No	No	No	No
Lepidoptera	Colobura dirce dirce	1	1	NA	No	No	No	No	No	No
Lepidoptera	Doxocopa agathina agathina	1	1	NA	No	No	No	No	No	No
Lepidoptera	Dynamine erchia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Eryphanis automedon automedon	1	1	NA	No	No	No	No	No	No
Lepidoptera	Eunica eurota eurota	1	1	NA	No	No	No	No	No	No
Lepidoptera	Eunica orphise	1	1	NA	No	No	No	No	No	No
Lepidoptera	Fountainea ryphea ryphea	1	1	NA	No	No	No	No	No	No
Lepidoptera	Haetera piera negra	1	1	NA	No	No	No	No	No	No
Lepidoptera	Hamadryas arinome arinome	1	1	NA	No	No	No	No	No	No
Lepidoptera	Hamadryas feronia farinulenta	1	1	NA	No	No	No	No	No	No
Lepidoptera	Hamadryas laodamia laodamia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Harjesia griseola	1	1	NA	No	No	No	No	No	No
Lepidoptera	Hermeuptychia hermes	1	1	NA	No	No	No	No	No	No
Lepidoptera	Historis acheronta acheronta	1	1	NA	No	No	No	No	No	No
Lepidoptera	Historis odius	1	1	NA	No	No	No	No	No	No
Lepidoptera	Hypna clytemnestra clytemnestra	1	1	NA	No	No	No	No	No	No
Lepidoptera	Magneuptychia libye	1	1	NA	No	No	No	No	No	No
Lepidoptera	Magneuptychia sp.1	1	1	NA	No	No	No	No	No	No
Lepidoptera	Magneuptychia tricolor tricolor	1	1	NA	No	No	No	No	No	No
Lepidoptera	Marpesia chiron marius	1	1	NA	No	No	No	No	No	No
Lepidoptera	Marpesia orsilochus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Megeuptychia antonoe	1	1	NA	No	No	No	No	No	No
Lepidoptera	Memphis acidalia acidalia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Memphis glauce	1	1	NA	No	No	No	No	No	No
Lepidoptera	Memphis leonida leonida	1	1	NA	No	No	No	No	No	No
Lepidoptera	Memphis oenomais	1	1	NA	No	No	No	No	No	No
Lepidoptera	Morpho achilles achilles	1	1	NA	No	No	No	No	No	No
Lepidoptera	Morpho deidamia neoptolemus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Morpho menelaus terrestris	1	1	NA	No	No	No	No	No	No
Lepidoptera	Nessaea hewitsonii	1	1	NA	No	No	No	No	No	No
Lepidoptera	Nessaea obrinus lesoudieri	1	1	NA	No	No	No	No	No	No
Lepidoptera	Opsiphanes cassiae	1	1	NA	No	No	No	No	No	No
Lepidoptera	Opsiphanes invirae	1	1	NA	No	No	No	No	No	No
Lepidoptera	Opsiphanes quiteria	1	1	NA	No	No	No	No	No	No
Lepidoptera	Paraeuptychia ocirrhoe ocirrhoe	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pierella astyoche	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pierella hyalinus extincta	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pierella lamia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pierella lena brasiliensis	1	1	NA	No	No	No	No	No	No
Lepidoptera	Posttaygetis penelea	1	1	NA	No	No	No	No	No	No
Lepidoptera	Prepona dexamenus dexamenus	1	1	NA	No	No	No	No	No	No
Lepidoptera	Prepona laertes demodice	1	1	NA	No	No	No	No	No	No
Lepidoptera	Prepona pheridamas	1	1	NA	No	No	No	No	No	No

Lepidoptera	Pseudodebis marpessa	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pseudodebis valentina	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pyrrhogyra amphiro amphiro	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pyrrhogyra crameri nautaca	1	1	NA	No	No	No	No	No	No
Lepidoptera	Pyrrhogyra edocla cuparina	1	1	NA	No	No	No	No	No	No
Lepidoptera	Splendeuptychia purusana	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis cleopatra	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis echo echo	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis kerea	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis laches laches	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis leuctra	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis mermeria	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis rufomarginata	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis sosis	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis sp.1	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis sp.2	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis thamyra	1	1	NA	No	No	No	No	No	No
Lepidoptera	Taygetis virgilia	1	1	NA	No	No	No	No	No	No
Lepidoptera	Temenis laothoe laothoe	1	1	NA	No	No	No	No	No	No
Lepidoptera	Tigridia acesta tapajona	1	1	NA	No	No	No	No	No	No
Lepidoptera	Yphthimoides sp.1	1	1	NA	No	No	No	No	No	No
Lepidoptera	Zaretis itys itys	1	1	NA	No	No	No	No	No	No
Isoptera	Agnatotermes sp.2	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Anoplotermes sp.10	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Aparatermes sp.13	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Aparatermes sp.8	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Calcaritermes rioensis	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Calcaritermes sp.3	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Cavitermes rozeni	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Cornitermes sp.4	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Dentispicotermes sp.5	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Dihoploermes sp.1	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Embiratermes sp.3	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Ereymatermes sp.2	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Grigiotermes sp.10	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Grigiotermes sp.6	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Labiotermes leptothrix	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Labiotermes sp.1	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Mapinguaritermes peruanus	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Nasutitermes sp.19	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Nasutitermes sp.27	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Nasutitermes surinamensis	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Neocapritermes sp.8	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Orthognathotermes humilis	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Orthognathotermes sp.1	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Paraconvexitermes acangapua	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Rhynchoermes sp.1	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Ruptitermes sp.14	0	1	0,368484782	No	No	Yes	Yes	Yes	Yes
Isoptera	Ruptitermes sp.15	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Silvestritermes holmgreni	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Silvestritermes sp.2	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Spinitermes sp.1	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Subulitermes sp.2	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Syntermes parallelus	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Syntermes sp.1	0	1	0,108075798	No	No	No	No	Yes	Yes
Isoptera	Syntermes sp.2	0	1	0,108075798	No	No	No	No	Yes	Yes

Isoptera	Tetimatermes sp.2	0	1	0,204753301	No	No	No	Yes	Yes	Yes
Isoptera	Acangaobitermes krishinai	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Agnathotermes glaber	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Angularitermes coninasus	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Anhangatermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Anoplotermes sp.7	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Armiermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Atlantitermes sp.8	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Atlantitermes sp.9	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Caetetermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Calcaritermes sp.2	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Cavitermes tuberosus	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Coendutermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Corniermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Cornitermes bolivianus	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Dentispicotermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Dentispicotermes sp.2	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Embiratermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Embiratermes spissus	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Glyptotermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Grigiotermes sp.4	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Grigiotermes sp.5	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Grigiotermes sp.9	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Labioermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Labiotermes guasu	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Nasutitermes macrocephalus	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Nasutitermes peruanus	1	0	0,051307082	No	No	No	No	No	Yes
Isoptera	Nasutitermes robustus	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Nasutitermes sp.10	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Nasutitermes sp.15	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Nasutitermes sp.4	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Neocapritermes sp.4	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Neocapritermes sp.5	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Neocapritermes sp.7	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Neocapritermes sp.9	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Neocapritermes talpoides	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Paracurviermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Paracurvitermes manni	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Rhinotermes hispidus	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Roundiermes sp.1	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Rugiermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Rugiermes sp.2	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Rugitermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Ruptitermes sp.4	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Syntermes longiceps	1	0	0,025972551	No	No	No	No	No	Yes
Isoptera	Syntermes sp.4	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Syntermes sp.5	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Uncitermes sp.1	1	0	0,013066964	No	No	No	No	No	Yes
Isoptera	Velocitermes sp.1	1	0	0,038718638	No	No	No	No	No	Yes
Isoptera	Alaniermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Angularitermes nasutissimus	1	1	NA	No	No	No	No	No	No
Isoptera	Anoplotermes sp.5	1	1	NA	No	No	No	No	No	No
Isoptera	Anoplotermes sp.6	1	1	NA	No	No	No	No	No	No
Isoptera	Anoplotermes sp.8	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.11	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.12	1	1	NA	No	No	No	No	No	No

Isoptera	Aparatermes sp.14	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.5	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.6	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.7	1	1	NA	No	No	No	No	No	No
Isoptera	Aparatermes sp.9	1	1	NA	No	No	No	No	No	No
Isoptera	Armitermes euamignathus	1	1	NA	No	No	No	No	No	No
Isoptera	Armitermes holmgreni	1	1	NA	No	No	No	No	No	No
Isoptera	Armitermes minutus	1	1	NA	No	No	No	No	No	No
Isoptera	Armitermes peruanus	1	1	NA	No	No	No	No	No	No
Isoptera	Atlantitermes oculatissimus	1	1	NA	No	No	No	No	No	No
Isoptera	Atlantitermes snyderi	1	1	NA	No	No	No	No	No	No
Isoptera	Atlantitermes sp.5	1	1	NA	No	No	No	No	No	No
Isoptera	Atlantitermes sp.6	1	1	NA	No	No	No	No	No	No
Isoptera	Atlantitermes sp.7	1	1	NA	No	No	No	No	No	No
Isoptera	Caetetermes taquarussu	1	1	NA	No	No	No	No	No	No
Isoptera	Coatitermes clevelandi	1	1	NA	No	No	No	No	No	No
Isoptera	Coatitermes kartaboensis	1	1	NA	No	No	No	No	No	No
Isoptera	Coatitermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Coatitermes sp.3	1	1	NA	No	No	No	No	No	No
Isoptera	Constrictotermes cavifrons	1	1	NA	No	No	No	No	No	No
Isoptera	Convexitermes convexifrons	1	1	NA	No	No	No	No	No	No
Isoptera	Coptotermes testaceus	1	1	NA	No	No	No	No	No	No
Isoptera	Cornicapritermes mucronatus	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes ovatus	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes pilosus	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes pugnax	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes sp.3	1	1	NA	No	No	No	No	No	No
Isoptera	Cornitermes weberi	1	1	NA	No	No	No	No	No	No
Isoptera	Crepititermes verruculosus	1	1	NA	No	No	No	No	No	No
Isoptera	Curvitermes odontognathus	1	1	NA	No	No	No	No	No	No
Isoptera	Cylindrotermes flangiatus	1	1	NA	No	No	No	No	No	No
Isoptera	Cylindrotermes parvignathus	1	1	NA	No	No	No	No	No	No
Isoptera	Cyranotermes karipuna	1	1	NA	No	No	No	No	No	No
Isoptera	Cyrilliotermes angulariceps	1	1	NA	No	No	No	No	No	No
Isoptera	Dihoplotermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Dolichorhinotermes latilabrum	1	1	NA	No	No	No	No	No	No
Isoptera	Dolichorhinotermes longilabius	1	1	NA	No	No	No	No	No	No
Isoptera	Dolichorhinotermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Embiratermes ignotus	1	1	NA	No	No	No	No	No	No
Isoptera	Embiratermes latidens	1	1	NA	No	No	No	No	No	No
Isoptera	Embiratermes neotenicus	1	1	NA	No	No	No	No	No	No
Isoptera	Embiratermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Ereymatermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Genuotermes spinifer	1	1	NA	No	No	No	No	No	No
Isoptera	Heterotermes tenuis	1	1	NA	No	No	No	No	No	No
Isoptera	Labiotermes labralis	1	1	NA	No	No	No	No	No	No
Isoptera	Labiotermes pelliceus	1	1	NA	No	No	No	No	No	No
Isoptera	Microcerotermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Nasuiermes sp.7	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes acangussu	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes banksi	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes bivalens	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes callimorphus	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes corniger	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes ephratae	1	1	NA	No	No	No	No	No	No

Isoptera	Nasutitermes gaigei	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes globiceps	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes guayanae	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.13	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.18	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.21	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.3	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.6	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes sp.9	1	1	NA	No	No	No	No	No	No
Isoptera	Nasutitermes wheeleri	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes longinotus	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes opacus	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes pumilis	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes sp.3	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes talpa	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes taracua	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes unicornis	1	1	NA	No	No	No	No	No	No
Isoptera	Neocapritermes utiariti	1	1	NA	No	No	No	No	No	No
Isoptera	Neoermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Planicapritermes longilabrum	1	1	NA	No	No	No	No	No	No
Isoptera	Planicapritermes planiceps	1	1	NA	No	No	No	No	No	No
Isoptera	Rhinotermes marginalis	1	1	NA	No	No	No	No	No	No
Isoptera	Rhinotermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Rhynchotermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Rotunditermes bragantinus	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes arboreus	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.10	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.11	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.13	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.5	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.6	1	1	NA	No	No	No	No	No	No
Isoptera	Ruptitermes sp.8	1	1	NA	No	No	No	No	No	No
Isoptera	Silvestritermes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Spinitermes longiceps	1	1	NA	No	No	No	No	No	No
Isoptera	Subulitermes baileyi	1	1	NA	No	No	No	No	No	No
Isoptera	Subulitermes microsoma	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes aculeosus	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes molestus	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes peruanus	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes sp.3	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes spinosus	1	1	NA	No	No	No	No	No	No
Isoptera	Syntermes tanygnathus	1	1	NA	No	No	No	No	No	No
Isoptera	Termes sp.1	1	1	NA	No	No	No	No	No	No
Isoptera	Triangularitermes triangulariceps	1	1	NA	No	No	No	No	No	No
Isoptera	Uncitermes teevani	1	1	NA	No	No	No	No	No	No
Isoptera	Velocitermes sp.2	1	1	NA	No	No	No	No	No	No
Isoptera	Velocitermes sp.3	1	1	NA	No	No	No	No	No	No
Orthoptera	Abila bolivari	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Amblytropidia australis	0	1	0,09538952	No	No	No	No	No	Yes
Orthoptera	Amblytropidia minor	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Chloropseustes rondoniae	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Coscineuta sp.	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Euplectrotettix costistriga	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Haroldgrantia lignosa	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Helolampis mellipes	0	1	0,048830125	No	No	No	No	No	Yes

Orthoptera	Notopomala glaucipes	0	1	0,09538952	No	No	No	No	No	Yes
Orthoptera	Ommalotettix obliquus	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Oxybleptella sagitta	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Procolpia cyanoptera	0	1	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Rhopsotettix consummates	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Ronderosia bergii	0	1	0,09538952	No	No	No	No	No	Yes
Orthoptera	Trybliophorus peruvianus	0	1	0,182093062	No	No	No	No	Yes	Yes
Orthoptera	Xiphiola cyanoptera	0	1	0,048830125	No	No	No	No	No	Yes
Orthoptera	Adrolampis contumax	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Agriacris auripennis	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Amblytropidia corrugate	1	0	0,222425364	No	No	No	Yes	Yes	Yes
Orthoptera	Amblytropidia sola	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Baecris punctulatus	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Chariacris violacea	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Chloropseustes leucotylus	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Cornops aquaticum	1	0	0,09538952	No	No	No	No	No	Yes
Orthoptera	Coryacris angustipennis	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Cylindrotettix obscurus	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Cylindrotettix uniformis	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Descampsacris serrulatum	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Eurostacris sp.	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Liebermannacris dorsualis	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Marellia remipes	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Ommatolampis perspicillata	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Ommexecha virens	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Ophthalmolampis indomita	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Parapellopedon uniformis	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Parasitalces sexnotata	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Paropaon laevifrons	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Pellopedon brunneum	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Pseudonautia latebrosa	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Pseudoscopas sp.2	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Rhammatocerus pictus	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Salvadoracris nigritus	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Schistocerca flavofasciata	1	0	0,182093062	No	No	No	No	Yes	Yes
Orthoptera	Spathalium audouini	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Stenopola bohlsii	1	0	0,09538952	No	No	No	No	No	Yes
Orthoptera	Stenopola sp.	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Stenopola tigris	1	0	0,139778469	No	No	No	No	Yes	Yes
Orthoptera	Tucayaca gracilis	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Xyleus modestus	1	0	0,048830125	No	No	No	No	No	Yes
Orthoptera	Zygoclistron thachystictum	1	0	0,182093062	No	No	No	No	Yes	Yes
Orthoptera	Abracris dilecta	1	1	NA	No	No	No	No	No	No
Orthoptera	Abracris flavolineata	1	1	NA	No	No	No	No	No	No
Orthoptera	Adrolampis maculicrus	1	1	NA	No	No	No	No	No	No
Orthoptera	Allotruxalis gracilis	1	1	NA	No	No	No	No	No	No
Orthoptera	Amblytropidia robusta	1	1	NA	No	No	No	No	No	No
Orthoptera	Anablysis longicerca	1	1	NA	No	No	No	No	No	No
Orthoptera	Clematodina eckardtiana	1	1	NA	No	No	No	No	No	No
Orthoptera	Colpolopha biloba	1	1	NA	No	No	No	No	No	No
Orthoptera	Colpolopha latipennis	1	1	NA	No	No	No	No	No	No
Orthoptera	Colpolopha waehneri	1	1	NA	No	No	No	No	No	No
Orthoptera	Copiocera prasina	1	1	NA	No	No	No	No	No	No
Orthoptera	Cornops frenatum	1	1	NA	No	No	No	No	No	No
Orthoptera	Cylindrotettix chacoensis	1	1	NA	No	No	No	No	No	No
Orthoptera	Cylindrotettix orientalis	1	1	NA	No	No	No	No	No	No

Orthoptera	Cylindrotettix santarosae	1	1	NA	No	No	No	No	No	No
Orthoptera	Dichroplus misionensis	1	1	NA	No	No	No	No	No	No
Orthoptera	Dichroplus sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Episomacris collaris	1	1	NA	No	No	No	No	No	No
Orthoptera	Episomacris tarsata	1	1	NA	No	No	No	No	No	No
Orthoptera	Eumastacops nemorivaga	1	1	NA	No	No	No	No	No	No
Orthoptera	Eusitalces vittatus	1	1	NA	No	No	No	No	No	No
Orthoptera	Eutryxalis filata	1	1	NA	No	No	No	No	No	No
Orthoptera	Leptysmina amazonica	1	1	NA	No	No	No	No	No	No
Orthoptera	Locheuma brunneri	1	1	NA	No	No	No	No	No	No
Orthoptera	Lysacris festae	1	1	NA	No	No	No	No	No	No
Orthoptera	Maculiparia annulicornis	1	1	NA	No	No	No	No	No	No
Orthoptera	Metaleptea brevicornis	1	1	NA	No	No	No	No	No	No
Orthoptera	Nautia sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Omura congrua	1	1	NA	No	No	No	No	No	No
Orthoptera	Ophthalmolampis colibri	1	1	NA	No	No	No	No	No	No
Orthoptera	Ophthalmolampis occultata	1	1	NA	No	No	No	No	No	No
Orthoptera	Ophthalmolampis putida	1	1	NA	No	No	No	No	No	No
Orthoptera	Orphula annectens	1	1	NA	No	No	No	No	No	No
Orthoptera	Orphulella concinnula	1	1	NA	No	No	No	No	No	No
Orthoptera	Orphulella punctata	1	1	NA	No	No	No	No	No	No
Orthoptera	Orphulina pulchella	1	1	NA	No	No	No	No	No	No
Orthoptera	Orthoscapheus coryaceus	1	1	NA	No	No	No	No	No	No
Orthoptera	Parascopas sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Paulinia acuminata	1	1	NA	No	No	No	No	No	No
Orthoptera	Peruvia nigromarginata	1	1	NA	No	No	No	No	No	No
Orthoptera	Phaeoparia lineaalba	1	1	NA	No	No	No	No	No	No
Orthoptera	Phaeoparia rondoni	1	1	NA	No	No	No	No	No	No
Orthoptera	Phaeoparia tingomariae	1	1	NA	No	No	No	No	No	No
Orthoptera	Poecilocloeus amazonicus	1	1	NA	No	No	No	No	No	No
Orthoptera	Prionolopha serrata	1	1	NA	No	No	No	No	No	No
Orthoptera	Procolpia minor	1	1	NA	No	No	No	No	No	No
Orthoptera	Propedies bilobus	1	1	NA	No	No	No	No	No	No
Orthoptera	Proscopia bivittata	1	1	NA	No	No	No	No	No	No
Orthoptera	Pseudonautia geniculata	1	1	NA	No	No	No	No	No	No
Orthoptera	Pseudonautia remota	1	1	NA	No	No	No	No	No	No
Orthoptera	Pseudoscopas sp.1	1	1	NA	No	No	No	No	No	No
Orthoptera	Psiloscirtus flavipes	1	1	NA	No	No	No	No	No	No
Orthoptera	Psiloscirtus olivaceus	1	1	NA	No	No	No	No	No	No
Orthoptera	Rhytidochrota sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Schistocerca cancellata	1	1	NA	No	No	No	No	No	No
Orthoptera	Scotussa sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Sitalces volxemi	1	1	NA	No	No	No	No	No	No
Orthoptera	Syntomacris sp.	1	1	NA	No	No	No	No	No	No
Orthoptera	Syntomacris viridipes	1	1	NA	No	No	No	No	No	No
Orthoptera	Tetrataenia surinama	1	1	NA	No	No	No	No	No	No
Orthoptera	Tetrix subulata	1	1	NA	No	No	No	No	No	No
Orthoptera	Tropidacris collaris	1	1	NA	No	No	No	No	No	No
Orthoptera	Trybliophorus elegans	1	1	NA	No	No	No	No	No	No
Orthoptera	Vilerna aeneooculata	1	1	NA	No	No	No	No	No	No
Orthoptera	Vilerna rugulosa	1	1	NA	No	No	No	No	No	No
Orthoptera	Xyleus attenuatus	1	1	NA	No	No	No	No	No	No
Orthoptera	Xyleus discoideus	1	1	NA	No	No	No	No	No	No

Capítulo 2

Sergio Santorelli Jr., William E. Magnusson, Claudia P. Deus, Timothy Keitt. 2019. Neutral processes and reduced dispersal across Amazonian rivers explains how large rivers limit similar species when they rivers are not vicariance barriers. **Ressubmetido após revisão** a *Journal of Biogeography*

Main text file

Title: Neutral processes and reduced dispersal across Amazonian rivers explains how large rivers limit similar species when they rivers are not vicariance barriers

A short running title of less than 40 characters: Neutral theory and dispersal across rivers

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Abstract and keywords

Aim: To show that under neutral-theory dynamics, two competitively-identical species may remain allopatrically distributed for hundreds of generations when Amazonian Rivers only reduce the chance of a species crossing the river.

Location: Amazonia

Time period: 500 generations

Major taxa studied: Two competitively-identical species

Methods: We developed a two-dimensional cellular automata for two allopatrically-distributed species under neutral-theory dynamics. In our model, the river was represented by a condition imposed in the middle of the grid that reduced the chance of either species crossing. Individuals could only colonize empty cells on the grid after mortality of other individuals, and the probability of an individual of a particular species colonizing an empty cell depended on the density of individuals of this species around the site. For each cellular-automata model, we recorded the time required for the first extinction of a species and the frequency with which it occurred.

Results: Reducing the chance of species crossing the river, it was possible to maintain large numbers of allopatrically-distributed individuals for hundreds of generations. Some individuals crossed the river but could not spread to the point of eliminating the species that occupied the opposite bank. In contrast, in the absence of the river, the landscape was generally dominated by a single species and the frequency of occurrence of this scenario was almost 10 times greater than when the river reduced the chance of one species crossing to another bank.

Main conclusions: Neutral processes associated with reduced dispersal across rivers can maintain competitively identical species allopatrically distributed. This process provides a potential mechanism for the maintenance of Amazonian biodiversity, potentially facilitating other processes, such as genetic drift and local adaptation that can result in definitive reproductive isolation.

Keywords: Allopatrically-distributed species, Amazon biodiversity, large rivers, Neutral theory, reduced dispersal, vicariance barrier

Main text

Introduction

The main determinants of the limits of species distributions is a recurrent issue in biogeography. Allopatric distributions constitute one of the most common patterns found for many species (e.g. Barraclough & Vogler, 2000; Chesser & Zink, 1994), and it is often assumed that present-day distributions were caused because a geographical barrier subdivided a population to the point of preventing gene flow among individuals, which consequently promoted speciation (Wiley, 1988). However, extrapolation of this process based only on present-day species distributions should be done with caution. There is evidence that many distributions in the past were different from those currently observed (e.g. Coope & Wilkins, 1994; Elias, 1991, 1992; Graham et al., 1996; Kaustuv, Jablonski, & Valentine, 2001), and even sympatric species or lineages could have speciated in allopatry and expanded their ranges into sympatry (Losos & Glor, 2003). More importantly, sympatric speciation followed by dispersal, could result in present-day allopatric distributions (e.g. Graham & Lundelius, 1984), overestimating the importance of allopatric speciation for many taxonomic groups.

Amazonian endemism areas and the main mechanisms promoting speciation for several phylogenetic lineages have been attributed to allopatric speciation caused by large rivers for many taxonomic groups [e.g. primates (Boubli et al., 2015), lizards (Avila-pires, 1995), anurans (Ron, 2000), butterflies (Hall & Harvey, 2002), birds (Cracraft, 1985; Haffer, 1985; Ribas, Aleixo, Nogueira, Miyaki, & Cracraft, 2012)]. Under this view, sister species or phylogenetic lineages on opposite banks of large rivers and the boundaries of the distribution of species coinciding with large rivers are evidence that the river subdivided a population to the point of preventing gene flow among individuals and promoting allopatric speciation (Ribas et al., 2012). As a consequence, it is expected that (i) species or lineages on opposite banks will be sister taxa; (ii) the time of divergence for all taxa separated by the same river will be similar; (iii) the similarity in species composition between riverbanks will decrease as river width increases; (iv) the similarity of species composition will be greater in localities on the same bank (adjacent cells) than cells on opposite banks separated by the same distance; and (v) the boundaries of species distributions will coincide with large rivers (e.g. Ayres & Clutton-Brock, 1992; Boubli et al., 2015; Dias-Terceiro et al., 2015; Pomara, Ruokolainen, & Young, 2014). However, these conclusions have been questioned.

The hypothesis that large rivers explain the spatial-distribution limits of species and indicate endemism areas for several phylogenetic lineages was inappropriate for >99% of animal species (Santorelli, Magnusson, & Deus, 2018), in a river which has been postulated as a barrier to dispersal for species of various taxa. In addition, there is evidence that several pairs of taxa separated by large rivers had different divergence times, and that the rivers would not have been primary barriers causing vicariance (Naka & Brumfield, 2018). In these cases, the river could have been a physical barrier that limited the expansion of species that diverged elsewhere, such as has been suggested for the robust capuchin monkeys *Sapajus spp.* (Boubli et al., 2015). Rare dispersal through the landscape has also been suggested as a mechanism of speciation in the Amazon (Burney & Brumfield, 2009; Dexter et al., 2017; Fernandes, Wink, Sardelli, & Aleixo, 2014; Smith et al., 2014) and as an explanation for the distribution of sister taxa in species-endemism areas delimited by large rivers (e.g. Byrne et al., 2018; Lynch Alfaro et al., 2015). These cases show that rivers acting as limits to species distributions is not always evidence for allopatric speciation. We propose an alternative hypotheses to explain species distributions being limited by river that which can be extended to any scenario of occurrence of allopatrically-distributed species.

Under the neutral theory of biodiversity (Hubbell, 2001), low dispersal rates can result in some species becoming more abundant by ecological drift and locally dominant due to the low rate of species substitution that is caused by decreased dispersal of individuals. Under neutral theory, the probability of an individual being replaced is given by the relative abundance of the individuals of species, and this simple process can make a species competitively superior despite the entry of ecologically identical colonizers from places with low dispersal rates. This can result in long-term maintenance of species that are competitively similar. Thus, a large river only reducing the dispersal of a species across the river and not eliminating dispersal (assumption of the hypothesis that rivers worked as a vicariance barrier), could maintain these species allopatrically distributed over many generations, since extinction probability of a species is predicted to be a function of population size, resulting in recent colonizers being weaker competitors and more prone to extinction.

To illustrate this process, we developed a two-dimensional cellular automata for two allopatrically-distributed species (the expected distribution pattern when the river is a geographical barrier for species dispersal) under neutral-theory dynamics (Hubbell, 2001) and we show that two competitively-identical species may remain allopatrically distributed for hundreds of generations when the river only reduces the chance of a species crossing a large river. In our simulations, individuals crossed the river but did not spread to the point of eliminating the species that occupies the opposite bank in patterns similar to what has been described for species in the nature. This illustrates how the rivers can maintain species boundaries, even when the process that generated the species was not vicariance and the dispersal rates across the river are higher than necessary to avoid genetic homogenization when the density effect on competition is not taken in consideration.

Material and Methods

The model

To evaluate whether the reduction in dispersal caused by a river is sufficient to maintain the species allopatrically distributed when the river is not a vicariance barrier, we developed a cellular automata model for two equally competitive species (Hubbell, 2001) in a two-dimensional grid. To represent the allopatric distribution expected in studies that accept the river-barrier hypothesis (e.g. Ribas et al., 2012), the grid was separated into left and right sides with each side on the grid representing a bank of the river, and each side was occupied by only one species (Fig. 1a). The river was represented by a constant imposed in the middle of the grid that reduced the chance of either species crossing (Fig. 1a). We call this constant the degree of river permeability (DRP).

The model dynamics was set in three sequential steps: (1) extinction; (2) pre-colonization, as the time between a cell becoming empty due to mortality of an individual and it being colonized or not; and (3) colonization. Each cell on the grid was updated simultaneously based on the extinction and colonization probabilities and the sum of individuals of both species in its neighborhood. The neighborhood was composed of a central cell and the cells around it at the preceding time step, according to a set of local rules. The steps and local rules were as follows:

Step 1: Extinction

Rule 1: Individuals of both species died with probability equal to 0.05 (Fig. 1b).

Step 2: Pre-colonization
Rule 2: Individuals could only colonize an empty cell on the grid after an individual dies (e.g. Fig. 1b).
Rule 3: Individuals of both species had the same chances of colonizing a new cell in the grid ($P_c = 0.95$). If by chance ($1 - P_c$), an empty cell remains empty, this cell will be available to be colonized in the next time step.

Step 3: Colonization
Rule 4: The probability of an individual of a particular species colonizing an empty cell was estimated in two steps (e.g. Fig. 1c). First, according to the following formula:

$$C_{specieX} = \left[\left(\frac{N_{indXoppside}}{S_{neighb}}\right) \times DRP\right] + \left(\frac{N_{indXsamside}}{S_{neighb}}\right)$$

Where: $C_{specieX}$ is the contribution of individuals of a particular species in colonizing an empty cell, $N_{indXoppside}$ is the sum of individuals of this species in its neighborhood that were on the opposite side of the grid (i.e. individuals in the left or right side of the river), $N_{indXsamside}$ is the sum of individuals of this species in its neighborhood (individuals who were in the same side of the grid), DRP is the degree of river permeability, and S_{neighb} is the number of cells in the neighborhood. In the second step, the probability of a given species colonizing the empty cell was proportional to the contribution of individuals of a particular species in colonizing an empty cell ($C_{specieX}$) divided by the sum of the contributions of all species (Fig. 1c).

As we expected that in nature the chance of a species colonizing an empty cell decreases with distance and with the ability of a species to disperse, we increased the size of the neighborhood to represent different colonizing ability (Fig. 2a), assuming that the sum of individuals of both species in its neighborhood is weighted by the distance between these individuals to the empty grid cell (Fig. 2a). The distance was defined by the number of squares on the grid between the empty cell and individuals, and the weight was inversely proportional to the square of this distance (inverse square law; Fig.2b).

Data analysis
In order to show how two competitively-identical species remain allopatrically distributed when the river reduces the chance of either species crossing, we need a better understanding of how ecological interactions are ruled by neutral theory of biodiversity (Hubbell, 2001). Under a neutral model, a new individual can only establish if another dies and makes space; in that sense individuals are competing

for open sites (with advantage being for more abundant species). Thus, a river only reducing the chance of a species crossing a large river, makes a species competitively superior despite the entry of new colonizers. As a result of this process, would be expected that (1) the number of generations until a species goes extinct on the banks of the river will be higher, and (2) the rate of extinction will be lower compared to scenarios in which the river is absent.

We investigated 14 different degrees of river permeability (DsRP = 0.01, 0.05, 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 0.95, 0.99, 1) in two spatial scales (local scale, 32x32; and regional scale, 128x128) and five neighborhood sizes (Fig. 2a). Each cellular-automata model was replicated 101 times for 500 generations (10.000 mortality and colonization cycles with $P_e = 0.05$) and we recorded the time required for the first extinction of a species and the rate with which it occurred (measured by the number of simulations that resulted in the extinction of one species at the end of the 500 generations). The effects of the magnitude of river permeability on these values, was established through cross products property of proportions, comparing their values to those expected with the absence of the river (DRP equal to 1). Each magnitude value represents in percentage how much higher or lower the value is when the river reduces the chance of a species crossing the bank of a large river compared to the absence of the river.

To test our expectations, we used a one sample *t*-test and *Wilcoxon* test to compare the numbers of generations to achieve the first extinction, and the magnitude of extinction rates against the values observed in the absence of the river (DRP equal to 1). The significance of relationships between the number of generations a species remains on the grid before extinction and the magnitude of extinction rates when the river reduces the chance of either species crossing was evaluated using linear models. Statistical analyses were used only for the local scale (32x32), since no extinction occurred at the regional scale (128x128) within 500 generations.

Results

Magnitude of generations to achieve the first extinction

Reducing the chance of species crossing the river, the number of generations for the landscape to be generally dominated by a single species was higher than in the absence of the river. This pattern was observed especially for species with very low (Dispersal 1), low (Dispersal 2), and very high (Dispersal 5) dispersal abilities (Fig. 3a). Although this increase was not observed for species with medium (Dispersal 3) and high (Dispersal 4) abilities (Fig. 3a), the interaction between the number of generations to achieve the first extinction and the effect of the river as a geographical barrier that reduces the chance of either species crossing is still apparent. As degree of river permeability increased (up to about DRP = 0.50), the number of generations to achieve the first extinction decreased in most simulations (Fig. 3b-f).

Magnitude of extinction rates

Reducing the chance of species crossing the river lowered the probability of extinction, especially for species with very low (Dispersal 1), medium (Dispersal 3), and high (Dispersal 4) dispersal abilities (Fig. 4a). The absence of evidence in other simulations (Dispersal 2 and 5) was not enough to exclude the effects of the river reducing the chance of either species crossing on the magnitude of extinction. The relationship expected between degree of river permeability and extinction magnitude was observed in all permeability reductions, as occurred for the time to first extinction.

Spatial patterns

When the chance of a species crossing the bank of a large river was reduced to 1%, it was possible to maintain large numbers of allopatrically-distributed individuals for up to 500 generations (Fig. 5a). The individuals crossed the river but could not spread to the point of eliminating the species that occupied the opposite bank (e.g. first column in Fig. 6). The resident species were competitively superior despite the entry of new colonizers. As a result of this process, the number of generations for a species to go extinct on the banks of the river was high (Fig. 3), and the rate with which it occurred was low (Fig. 4). In contrast, as degree of river permeability increased (e.g. see 50th generation in Fig. 5b-f), the individuals crossed the river and gradually spread (e.g. second to sixth column in Fig. 6), making a species competitively inferior in relation to new colonizers, increasing the chance of a species becoming extinct and the landscape to be dominated by a single species (more abundant species are stronger competitors in neutral theory). Consequently, the number of generations for a species to go extinct on the banks of the river was low (e.g. Fig. 3), and the rate with which it occurred was high (e.g. Fig. 4). This effect was greater for some degrees of dispersal (e.g. see Dispersal 1 to 5 in Fig. 5f).

The strongest evidence for two competitively-identical species remaining allopatrically distributed when the river reduces the chance of either species crossing, independent of combinations of degrees of river permeability and species dispersal abilities, was observed at the regional scale (128x128; Fig. 7); no extinction occurred within 500 generations. However, similar to the patterns observed at the local scale (32x32; Fig. 5 and Fig. 6), as degree of river permeability increased, and depending on the ability of a species to disperse (Fig. 7 and Fig. 8), the chance of a species going extinct and the landscape to be dominated by a single species increased. Hence, results qualitatively similar to those observed in Fig. 3 and Fig. 4 could be expected for the regional scale in simulations with more generations.

The discrepancy between the local and regional-scale results highlights the effect of density on competition and how it can maintain two competitively-identical species allopatrically distributed for hundreds of generations when rivers are not vicariance barriers. The general pattern was similar to what has been described for species in the nature, with dominance of one species on each bank, but with frequent colonization of small areas on the opposite bank and subsequent extinction on that bank.

We have only shown the spatial patterns for some degrees of river permeability and generation times, but Appendix S1 - S13 in Supporting Information presents detailed results for other degrees of river permeability and generation times.

Discussion

Several studies have found examples of similar species, sister species or not, which are separated by large rivers, but the evidence indicates that many of these species were not formed by the process of vicariance resulting from the division of a species by the formation of a river (e.g. Boubli et al., 2015; Byrne et al., 2018; Lynch Alfaro et al., 2015; Naka & Brumfield, 2018). The present-day ecological conditions around the river (e.g. non-flooded and flooded areas) has also been suggested to act as a strong distribution barrier for many forest species (Hayes & Sewlal, 2004; Moraes, Pavan, Barros, & Ribas, 2016), maintaining large numbers of allopatrically-distributed individuals. For patterns matching to these, simple processes expected under neutral theory (Hubbell, 2001) can result in a large river maintaining two species allopatrically-distributed even though it is not an absolute barrier to dispersal.

In a neutral model (Hubbell, 2001), the probability of an individual being replaced is given by the relative abundance of individuals of a particular species, and this simple process makes a species competitively stronger relative to new colonizers simply by the effect of density on competition. Thus, the inclusion of a large river that only reduced the chance of individuals crossing from one bank to another (reducing the entry of new colonizers) was sufficient to maintain two allopatrically distributed species for hundreds of generations. The process described in our simulation also provides a potential mechanisms for the maintenance of Amazonian biodiversity, as it allows competitively-similar species to coexist for many generations even though one species would eventually eliminate the other in the absence of the river; Hubbell, 2001).

Support for our inferences is found in nature. There are empirical indicators that individuals of similar species crossing rivers has not resulted in the competitive exclusion of one of the species; most of the individuals of these species are kept allopatrically distributed even though the river is not an absolute physical barrier. As in ours simulations, small populations of a species often occur on the opposite bank from where the species is most common (e.g. Hayes & Sewlal, 2004; Moraes et al., 2016; Moraes, Ribeiro-Júnior, & Pavan, 2017; Moraes, Werneck, & Pavan, 2019), indicating that dispersal across the river is a frequent event, but apparently is limited a few individuals and followed by local extinction of the species on that bank. For example, a species of squirrel monkey, *Saimiri sciureus*, is widely distributed only on the north bank of the Amazon River, but one individual was recorded on the south bank (Mercês, Lynch Alfaro, Ferreira, Harada, & Silva Júnior, 2015). Another squirrel monkey species, *Saimiri Collinsi*, is widely distributed only on the south bank of the Amazon River, but two individuals were recorded on the northern margin (Mercês et al*.,* 2015). Similarly, the lizard *Norops trachyderma* is abundant and normally restricted to the right bank of the Tapajós River, but an individual was recorded on the left bank of the river; where the congeneric species, *Norops tandai*, is abundant and restricted (Moraes et al*.,* 2016).

There are several other species in which river capture processes (e.g. Ruokolainen, Moulatlet, Zuquim, Hoorm, & Tuomisto, 2018) have resulted in species with small populations on the side of the river occupied by a congeneric species (Hershkovitz, 1988; Peres, Patton, & da Silva, 1996; Vermeer & Tello-Alvarado, 2015). It is likely that there are many more individuals crossing rivers than has been registered in the literature since species detectability (MacKenzie et al., 2002) and the chances of species to successfully colonize a local (Hubbell, 2001) decreases as abundance decreases. Particularly for species close to a watercourse, the detection probabilities can be remarkably low for most animal species (Santorelli et al., 2018).

From these results, we argue that occurrence of allopatrically-distributed species need not always be explained by simple stationary process (Case, Holt, Mcpeek, & Keitt, 2005; Holt & Keitt, 2000; Holt, Keitt, Lewis, Maurer, & Taper, 2005) that assume that species are allopatrically-distributed because (i) habitat is not available (e.g. non-flooded flooded areas), and/or (ii) the habitat available is lower-quality (reduced niche limits), and/or (iii) the habitat available is separated by physical or biotic factors influencing that weaken colonization rates. The last is the most frequently proposed mechanism for the river-barrier hypothesis.

The alternative explanation is that the species are be experiencing demographic Allee effects (Allee, 1931) triggered by the density of competitively identical species and dispersal reduction (in the sense of Neutral theory). Under an Allee model perspective (Case et al., 2005; Holt et al., 2005; Keitt, Lewis, & Holt, 2001) in the absence of adaptive evolution (e.g. see Andrade-Restrepo, Champagnat, & Ferrière, 2019; Kanarek & Webb, 2010; Williams, Hufbauer, & Miller, 2019), when the river reduces the chance of either species crossing, the inability of the individuals that crossed the river to persist below a critical threshold density makes the immigrant population more vulnerable to extinction and could reduce invasion speeds or even reverse invasions, generating a stable range limit and resulting in large numbers of allopatrically-distributed individuals. Many mechanisms have been proposed for such patterns (see Courchamp, Berec, & Gascoigne, 2008) but our analyses cannot distinguish between them.

Sister species or phylogenetic lineages may have originated on opposite banks of large rivers without vicariance, then spread rapidly by chance (Hubbell, 2001), either due to the absence of a competitor (Case et al., 2005; Kubisch, Holt, Poethke, & Fronhofer, 2014; Waters, 2011) or predator-prey interactions (Kubisch et al., 2014) within an area of interfluvium (often called endemism centers) until they meet somewhere near the river. When they meet, both species would remain allopatrically distributed because is difficult for a new immigrants to establish themselves (e.g. Gascoigne & Lipcius, 2004; Li et al., 2019) and to reproduce (e.g. Gascoigne, Berec, Gregory, & Courchamp, 2009; Tregenza & Wedell, 1998) within the interfluvium occupied by another species. This mechanism does not assume that the species have accumulated sufficient divergence to explore different niches. The absence of divergence makes the species ecologically similar, but they remain allopatrically distributed for long periods because of competitive exclusion and dispersal limitation (e.g. Gutiérrez, Boria, & Anderson, 2014; Pigot & Tobias, 2013, 2015; Weir & Price, 2011). The effect of neutral processes associated with reduced dispersal across rivers, could maintain competitively identical species allopatrically distributed for hundreds of generations, giving opportunity for genetic drift or adaptation to different environments resulting in evolutionary differences that prevent fertile crosses between species (Luzuriaga-Aveiga & Weir, 2019; Nosil, 2012; Rundle & Nosil, 2005).

To our knowledge, the present study is the first to formally demonstrate an alternative hypothesis to explain the spatial-distribution limits of species caused by large rivers in the Amazon without vicariance. We show evidence that several phylogenetic lineages alopatrically-distributed and endemism areas delimited by rivers in the Amazon need not always be explained by the presumption that the present-day species distributions correlates with the geographical distribution at the time of speciation. Neutral processes and reduced dispersal go beyond just describing patterns and processes in the Amazon. The river-barrier hypothesis has been widely used to propose endemism areas that are being used as surrogates in conservation planning (Caro & O'Doherty, 1999; Da Silva, Rylands, & Da Fonseca, 2005; Fernandes, 2013) even though this hypothesis is insufficient to explain the spatial-distribution limits of species and to indicate endemism areas for most phylogenetic lineages (Santorelli et al., 2018). More comprehensive models are needed before supposed endemism areas can be routinely included in conservation decisions.

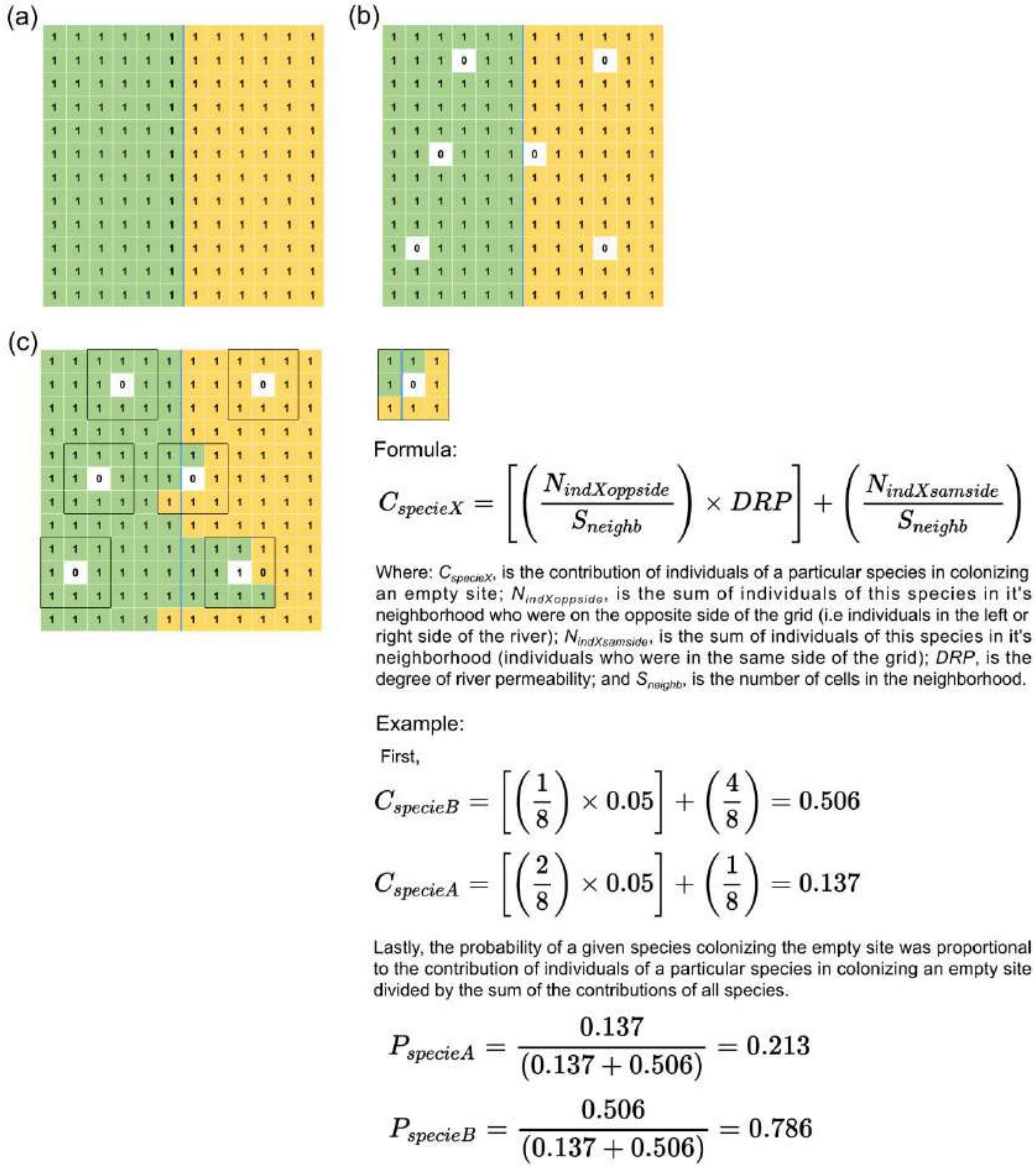


Figure 1. Hypothetical example of model dynamics. The colors green and yellow represent the two species; *species A* and *species B*, respectively. The solid blue line in the middle of the grid represents the river (i.e. indicates where the degree of river permeability reducing the chance of either species crossing). Letters represent how the species were arranged on the grid before starting the simulation, and the local rules that were applied simultaneously in each time step in the model. (a) Each side on the grid was completely occupied by only one species; (b) individuals of both species went extinct locally with probability equal to 0.05 (white squares on the grid represent where the individuals died); and (c) if a empty site should be colonized after mortality of an individual, the probability of an individual of a particular species colonizing an empty site depended on four factors: (i) the sum of individuals of this species in its neighborhood (the neighborhood is indicated by black outline); (ii) the sum of individuals of this species in its neighborhood that were on the opposite side of the grid (i.e individuals in the left or

right side of the river); (iii) the degree of river permeability (DRP); and (iv) the size of the neighborhood. In the example, the empty site has a 78% chance of being colonized by *species B.*

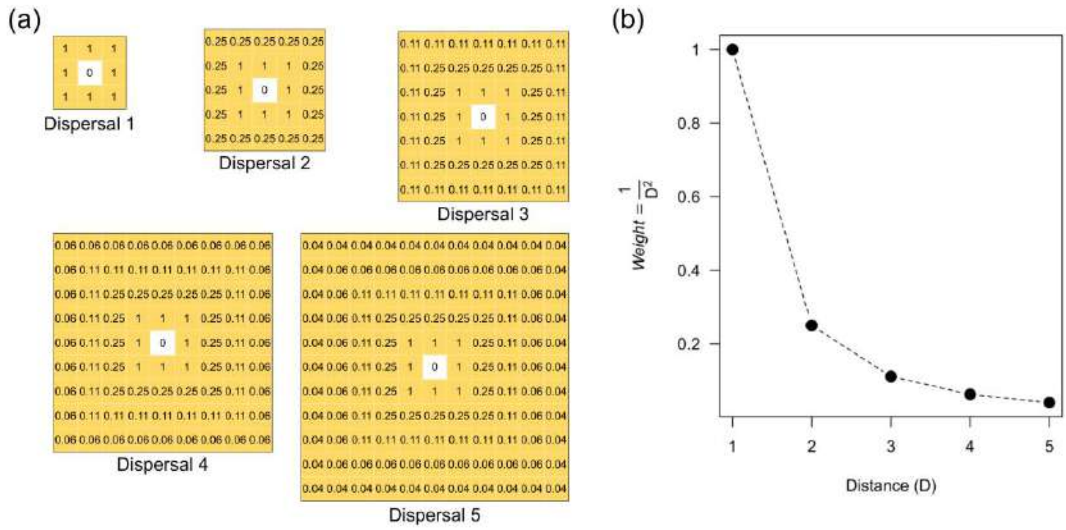
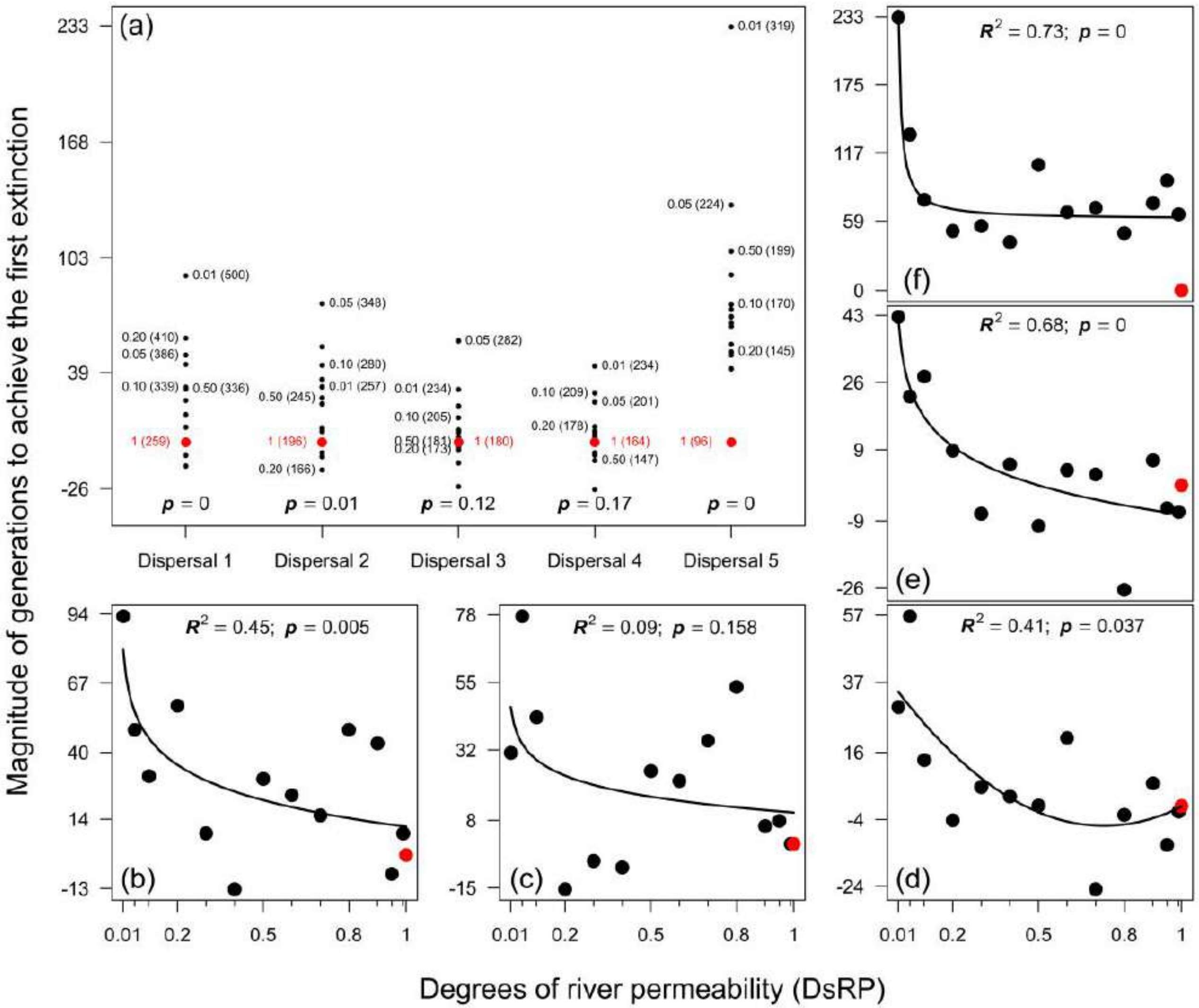


Figure 2. Matrix representations of the neighborhood sizes and weights assigned for each individual depending on the distance from the empty site. (a) Relative abilities of species to disperse in our simulations were as follows: Dispersal 1, very low dispersal ability; Dispersal 2, low; Dispersal 3, medium; Dispersal 4, high; and Dispersal 5, very high. (b) Neighborhood weights in relation to distance from the empty site that were used in simulations.



1

2 **Figure 3.** Magnitude of generations before a species goes extinct on both banks of the river when the river reduces the chance

of either species crossing. (a) Comparison of the magnitude of generations before extinction with river-barrier (solid black circles) and in the absence of the river (solid red circle). Numbers within parentheses are the number of generations and numbers outside parentheses are the degrees of river permeability. The letters p are the *p-values* of one sample *t*-test and *Wilcoxon* test; $p = 0$ indicates $p < 0.0001$. (b) to (f) are the relationships between number of generations before a species goes extinct and degrees of river permeability. In sequence, each letter represents the abilities of a species to disperse (Dispersal 1 to 5).

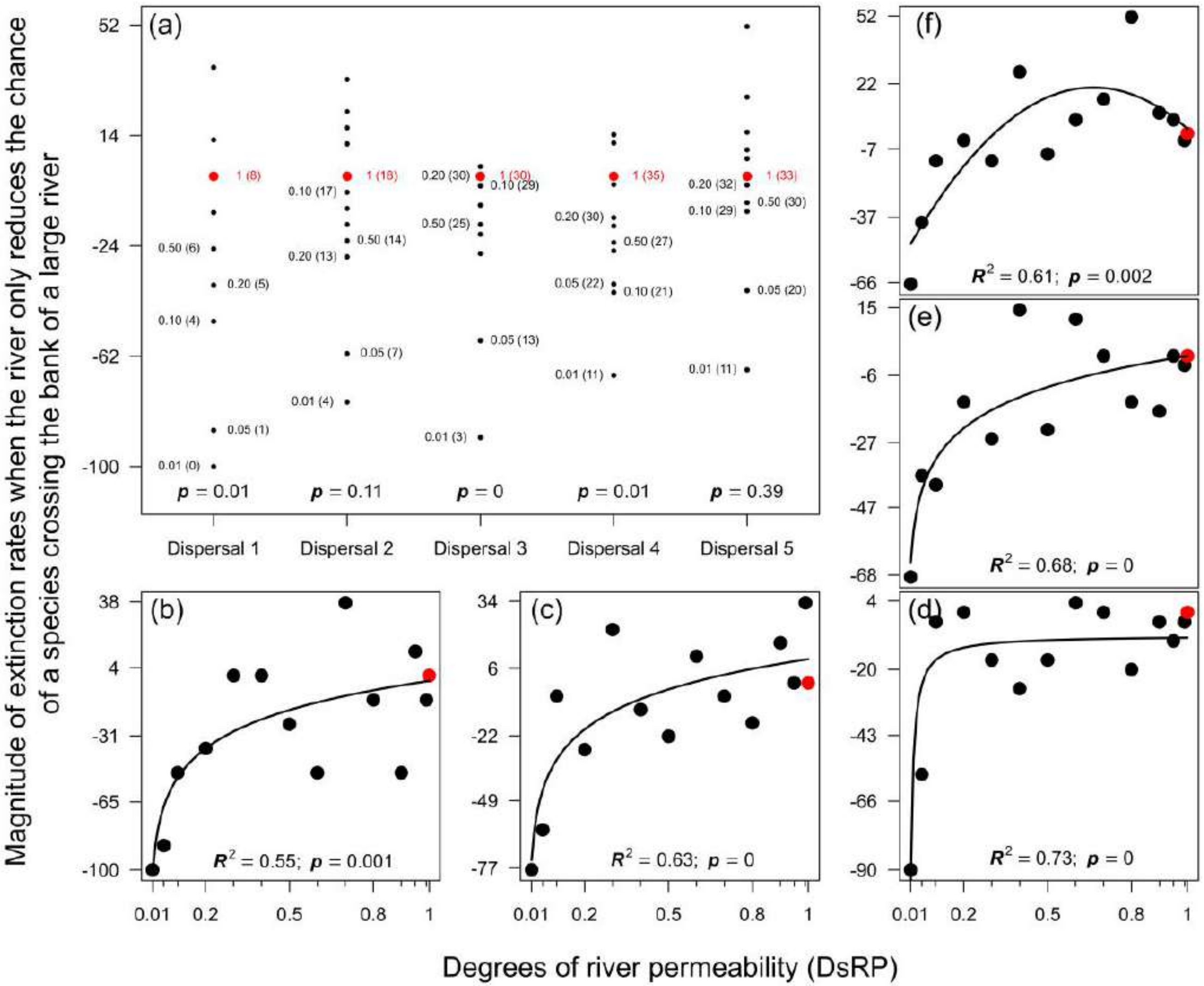


Figure 4. Magnitude of extinction rates when the river reduces the chance of either species crossing. (a) Comparison of the

magnitude of extinction rates with river-barrier (solid black circles) and in the absence of the river (solid red circle). Numbers within parentheses are the number of simulations that resulted in the extinction of one species at the end of the 500 generations and numbers outside parentheses are the degrees of river permeability. The letters *p* are the *p-values* of one sample *t*-test and *Wilcoxon* test; $p = 0$ indicates $p < 0.0001$. (b) to (f) are the relationships between number of generations before a species goes extinct and degrees of river permeability. In sequence, each letter represents the abilities of a species to disperse (Dispersal 1 to 5).

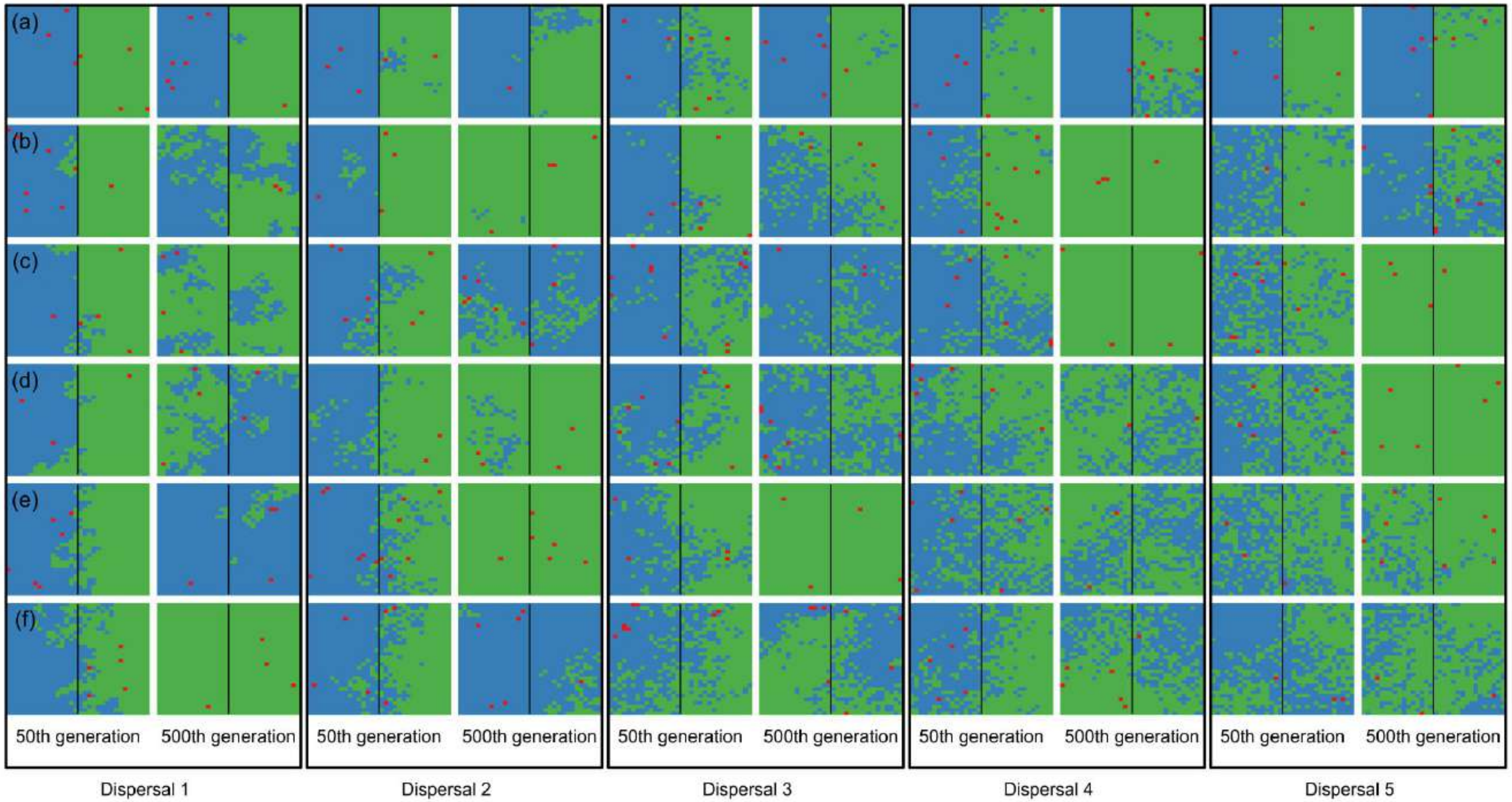


Figure 5. Spatial patterns in simulations at local scale. The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line on the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.50; e (f) 1.

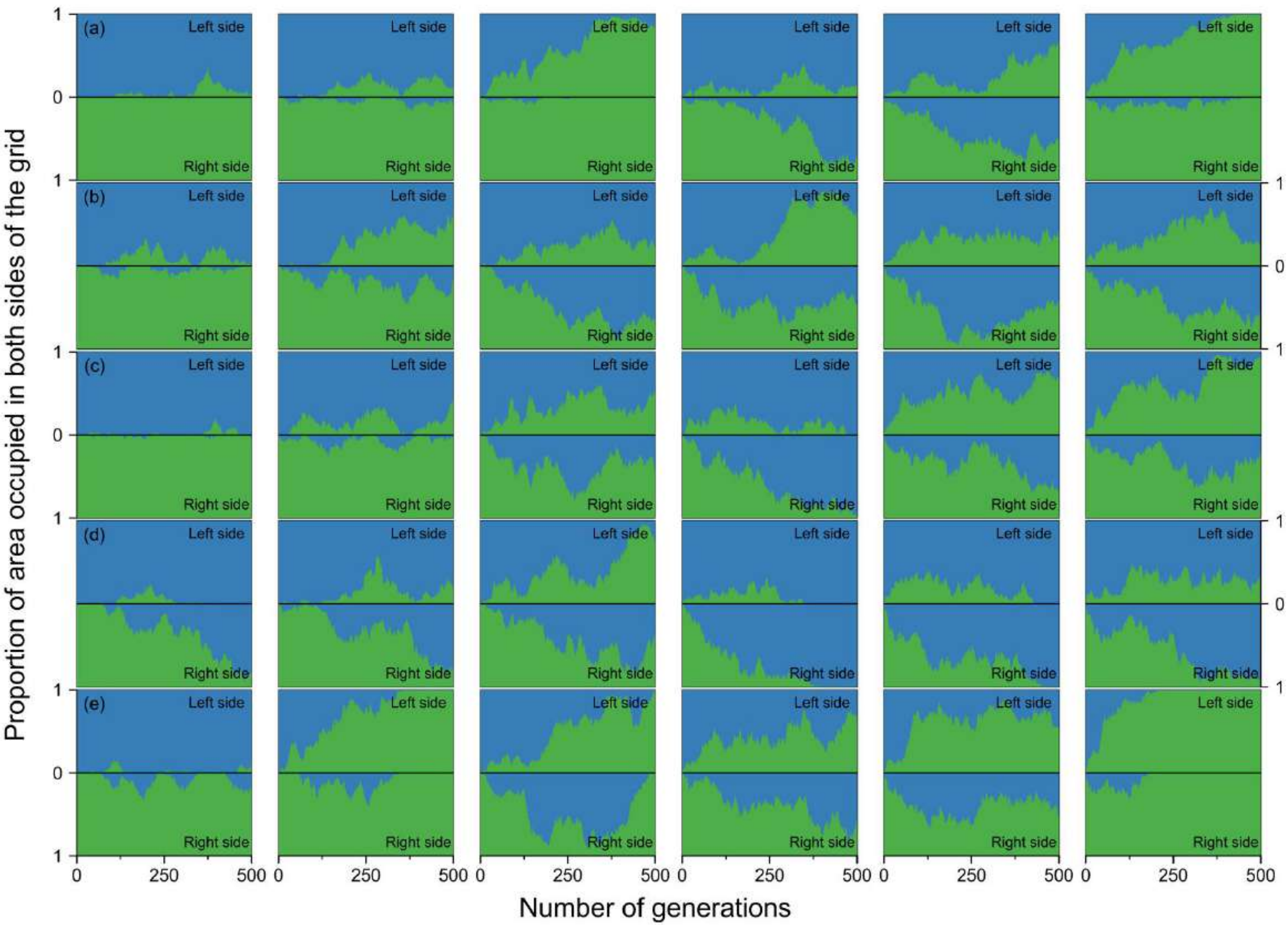


Figure 6. Estimates of the proportion of area occupied on opposite sides of the grid by individuals that crossed the river (right to left side and vice-versa) over generations at local scale. Green area represents individuals that started the simulation on the

right side of the grid and blue area the individuals that started the simulation on the left side. Letters represent the abilities of a species to disperse. (a) Dispersal 1, very low; (b) Dispersal 2, low; (c) Dispersal 3, medium; (d) Dispersal 4, high; and (e) Dispersal 5, very high. The columns represent the degrees of river permeability: 0.01, 0.05, 0.10, 0.20, 0.50, e 1; respectively.

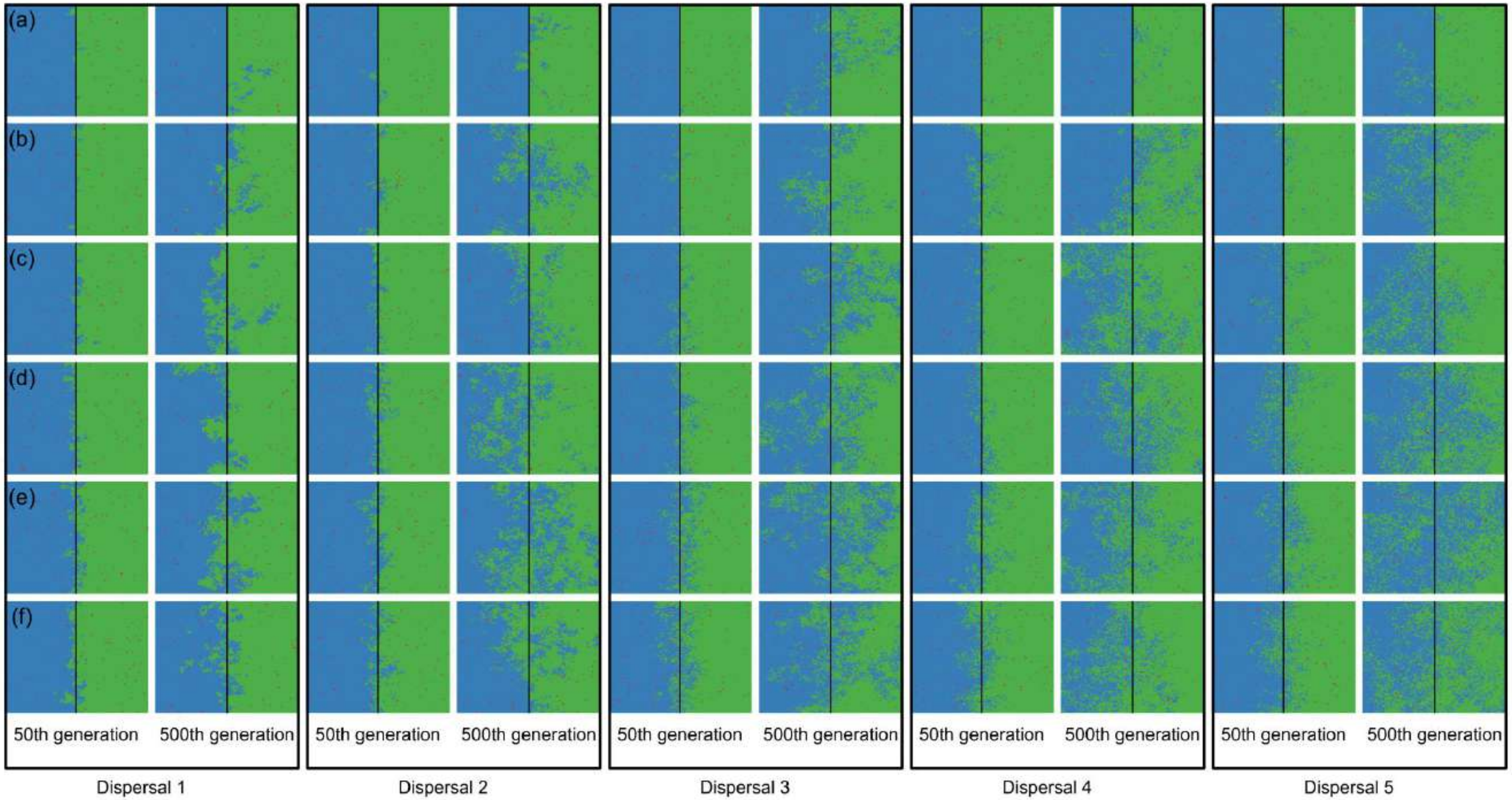


Figure 7. Spatial patterns in simulations at regional scale. The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line on the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river

31 permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.50; e (f) 1.

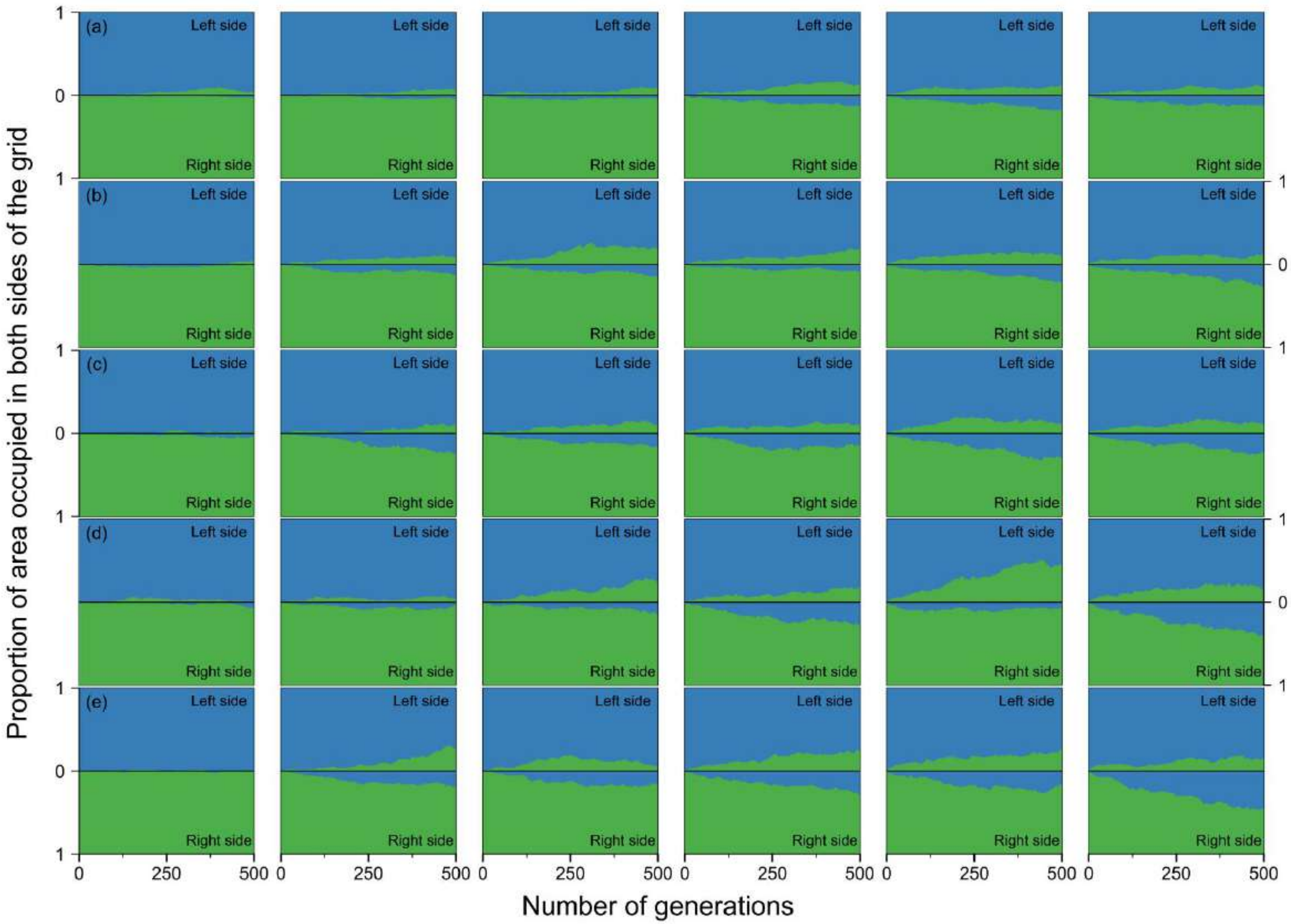


Figure 8. Estimates of the proportion of area occupied on opposite sides of the grid by individuals that crossed the river (right to left side and vice-versa) over generations at regional scale. Green area represents individuals that started the simulation on

the right side of the grid and blue area the individuals that started the simulation on the left side. Letters represent the abilities of a species to disperse. (a) Dispersal 1, very low; (b) Dispersal 2, low; (c) Dispersal 3, medium; (d) Dispersal 4, high; and (e) Dispersal 5, very high. The columns represent the degrees of river permeability: 0.01, 0.05, 0.10, 0.20, 0.50, e 1; respectively.

Data Availability Statement: They are available from the corresponding author on request

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Biosketch: Sergio Santorelli Junior is a postgraduate student in Biological Science at the National Institute of Amazonian Research (INPA), and this study represents a component of his PhD work. His research interests include biogeography, macroecology and ecology in the Amazon. In particular, he works studying of relationships between organisms and their environment at large spatial scales to characterize and explain statistical patterns of abundance, distribution and diversity.

Supporting information

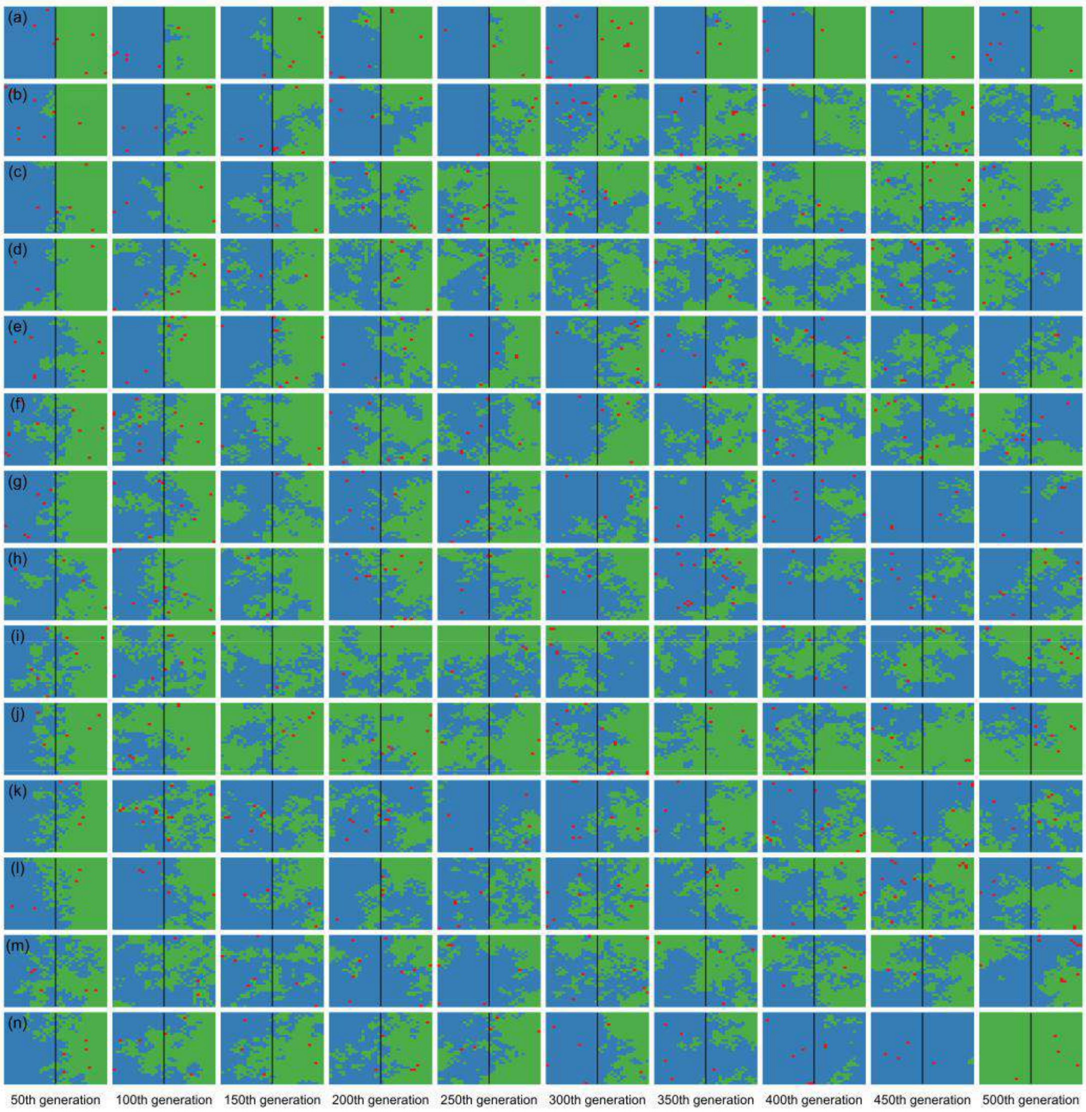

Fig. S1.1. Spatial patterns in simulations at local scale (Dispersal 1). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

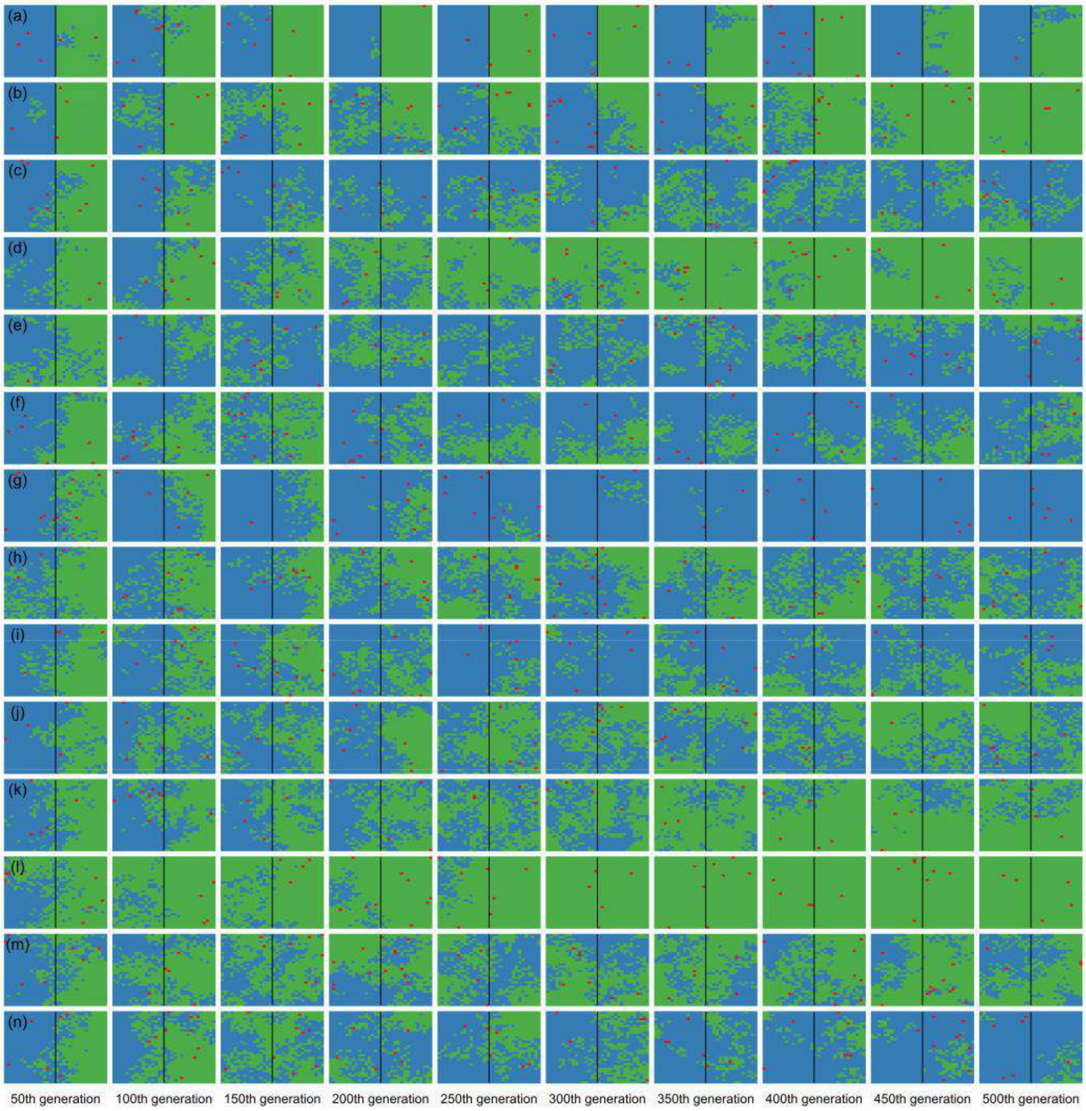

Fig. S2.2. Spatial patterns in simulations at local scale (Dispersal 2). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

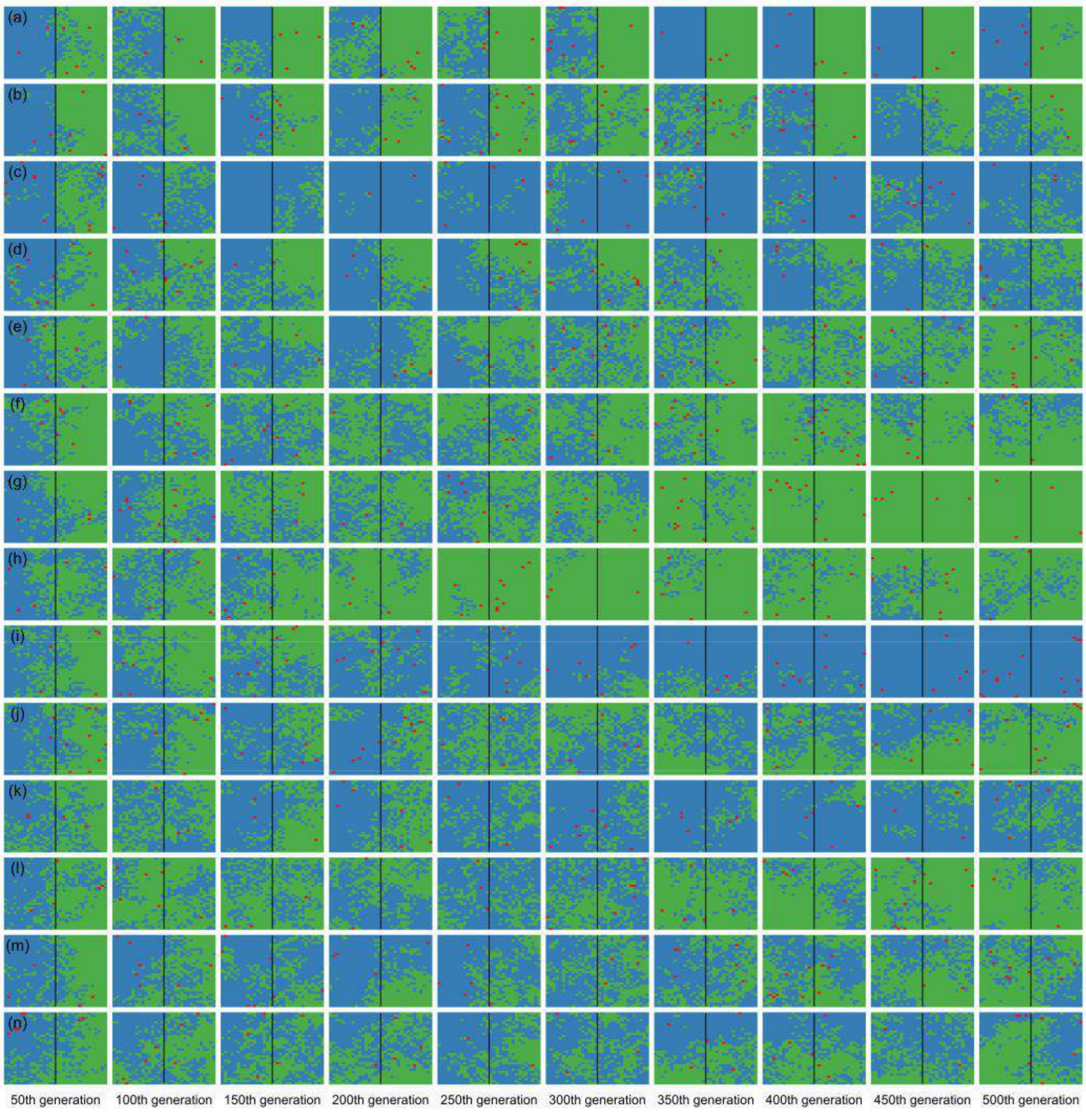

Fig. S3.3. Spatial patterns in simulations at local scale (Dispersal 3). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

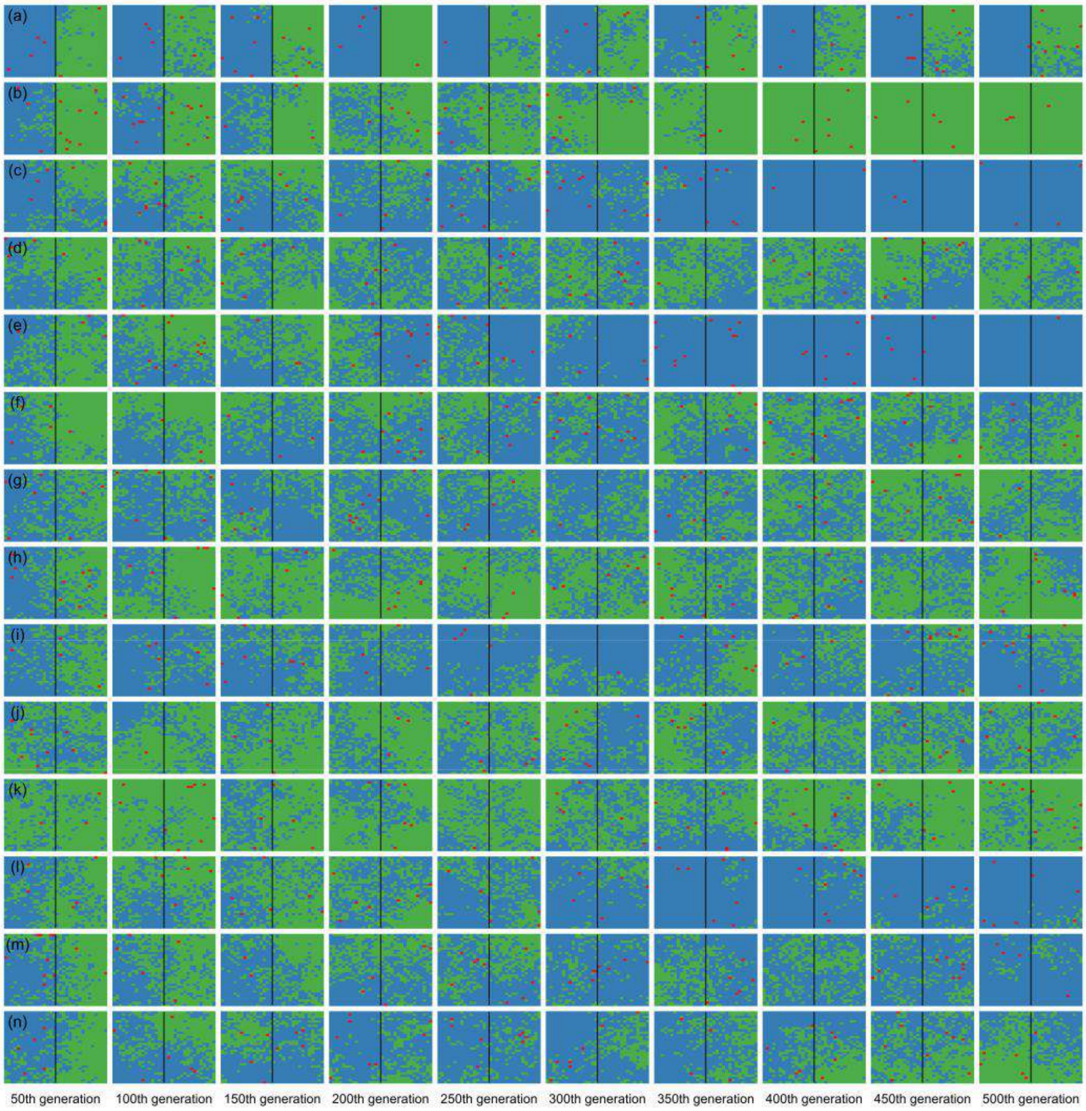

Fig. S4.4. Spatial patterns in simulations at local scale (Dispersal 4). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

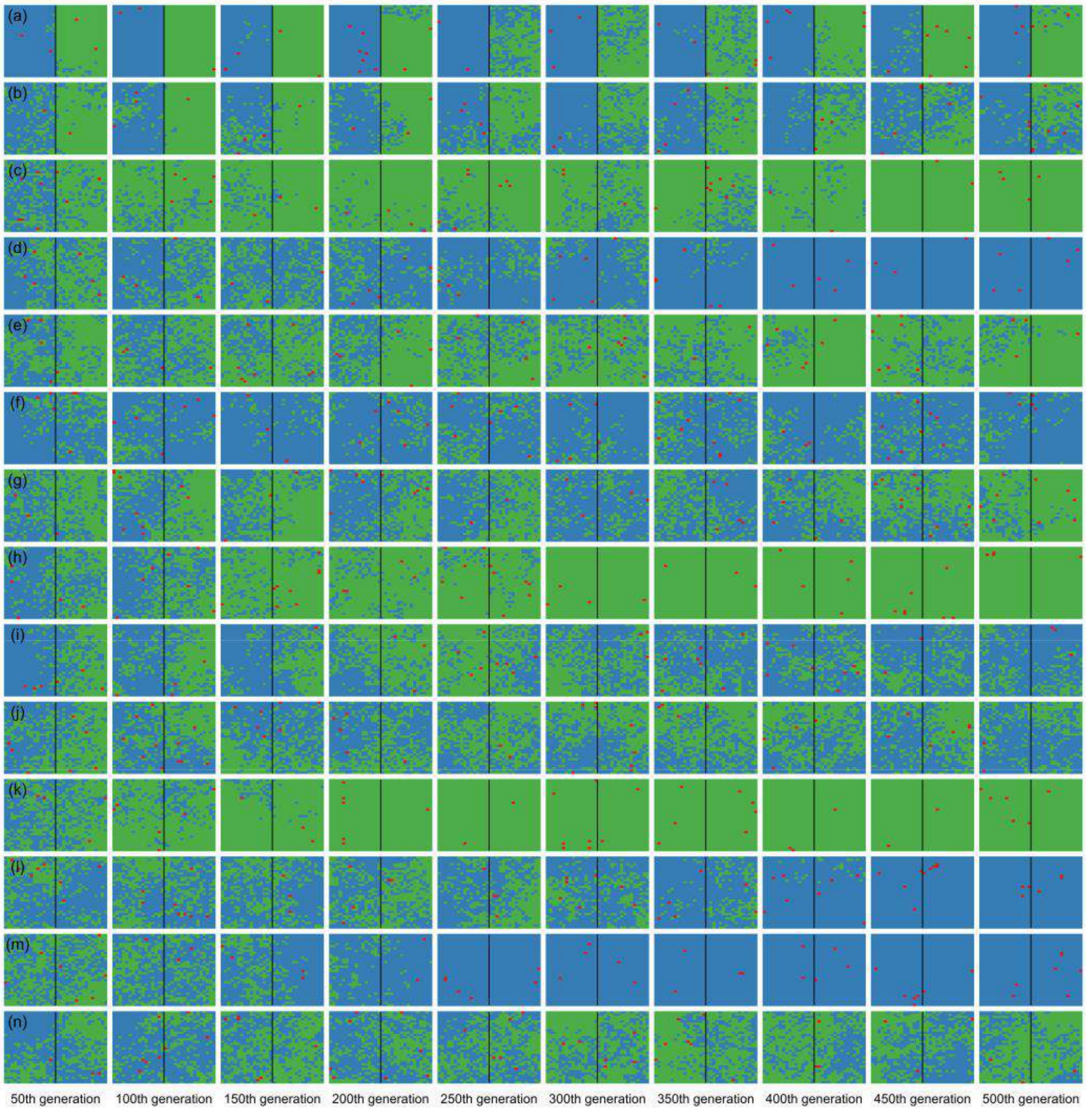

Fig. S5.5. Spatial patterns in simulations at local scale (Dispersal 5). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

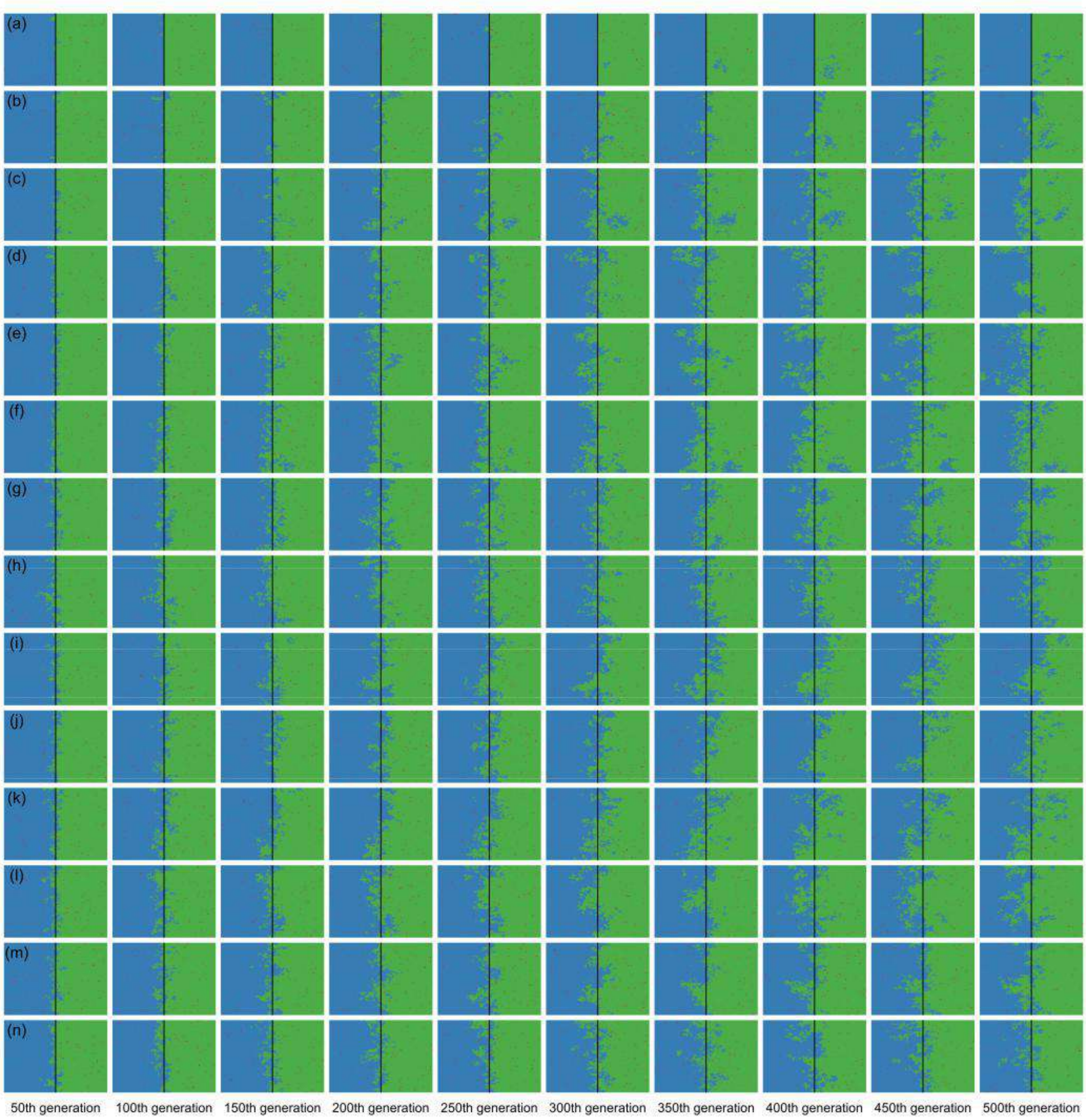

Fig. S7.7. Spatial patterns in simulations at regional scale (Dispersal 1). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

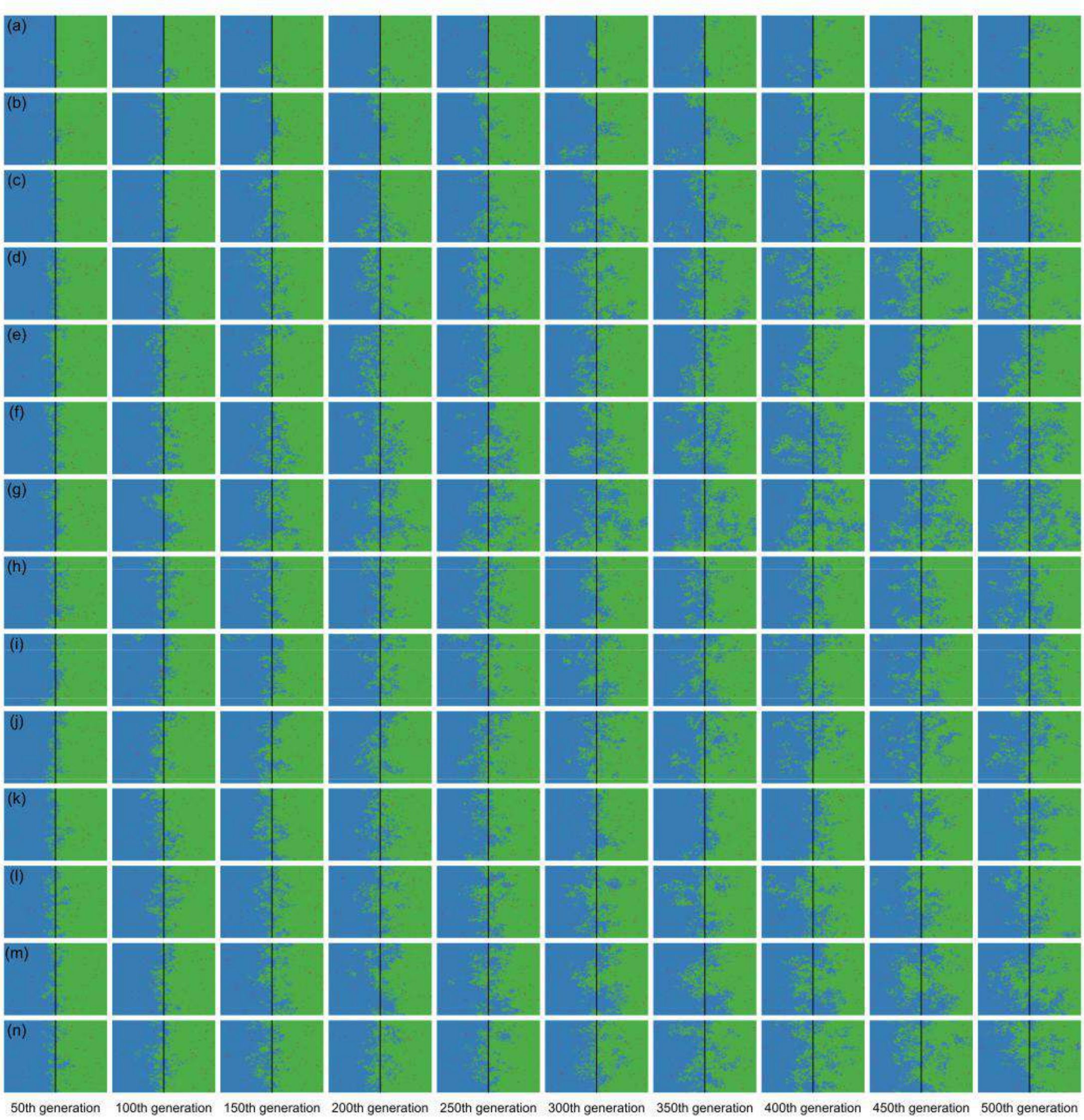

Fig. S8.8. Spatial patterns in simulations at regional scale (Dispersal 2). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

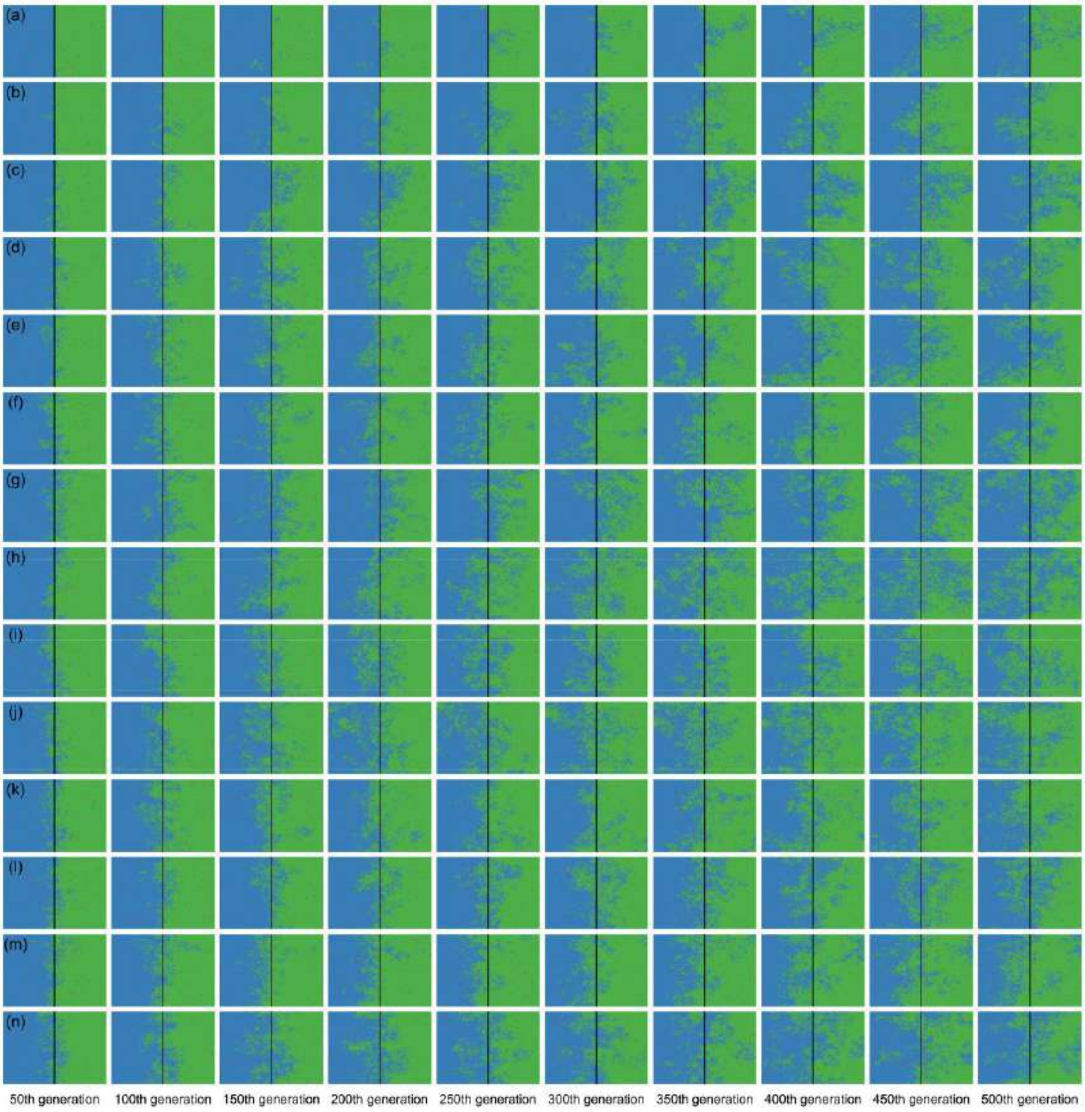

Fig. S9.9. Spatial patterns in simulations at regional scale (Dispersal 3). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

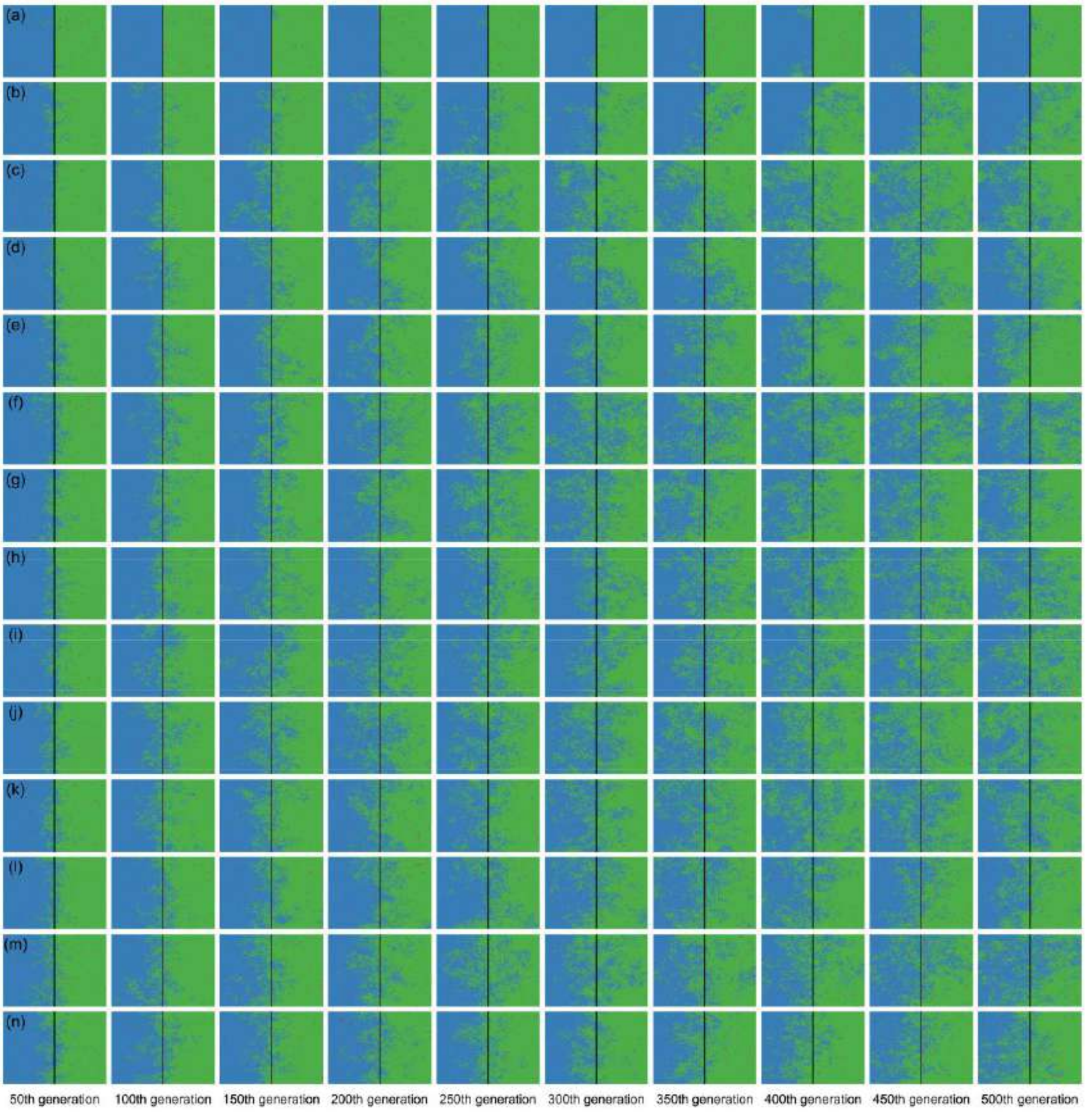

Fig. S10.10. Spatial patterns in simulations at regional scale (Dispersal 4). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

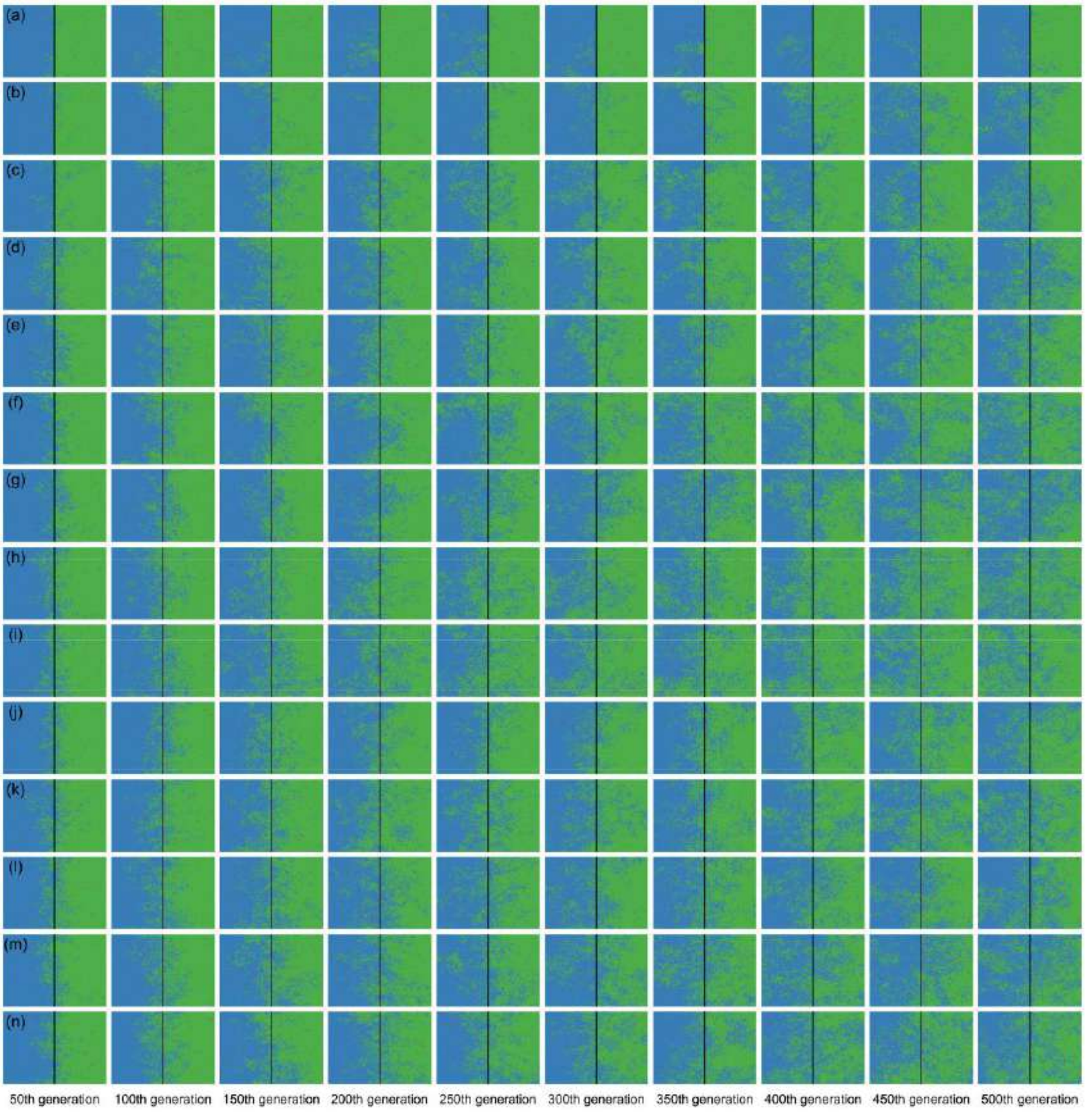

Fig. S11.11. Spatial patterns in simulations at regional scale (Dispersal 5). The blue and green colors represent the two species and red squares represent empty sites on the grid created after individual mortality. The solid line in the middle of the grid indicates where the condition (degree of river permeability) reduced the chance of either species crossing. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1.

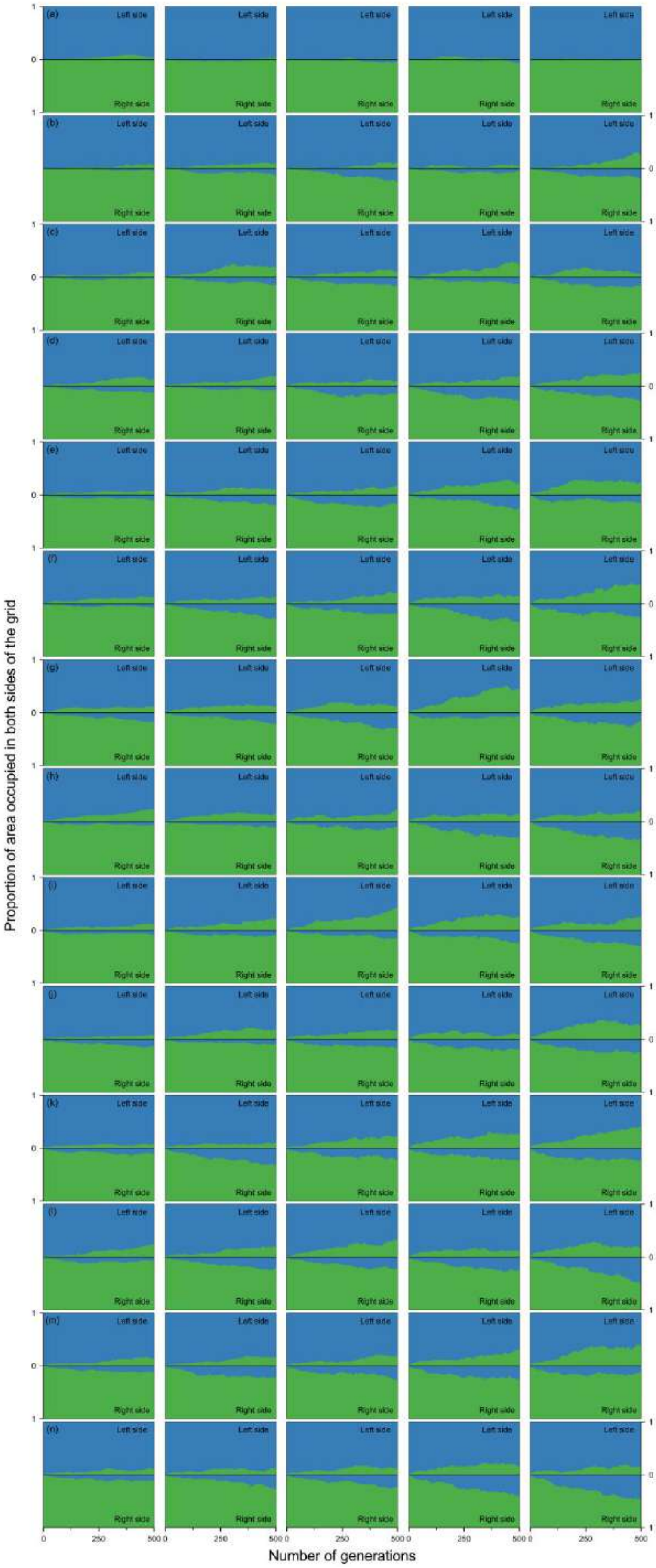

Fig. S12.12. Estimates of the proportion of area occupied on opposite sides of the grid by individuals that crossed the river (right to left side and vice-versa) over generations at regional scale. Green area represents individuals that started the simulation on the right side of the grid and blue area the individuals that started the simulation on the left side. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1. In sequence, the columns represent the abilities of a species to disperse(Dispersal 1 to 5).

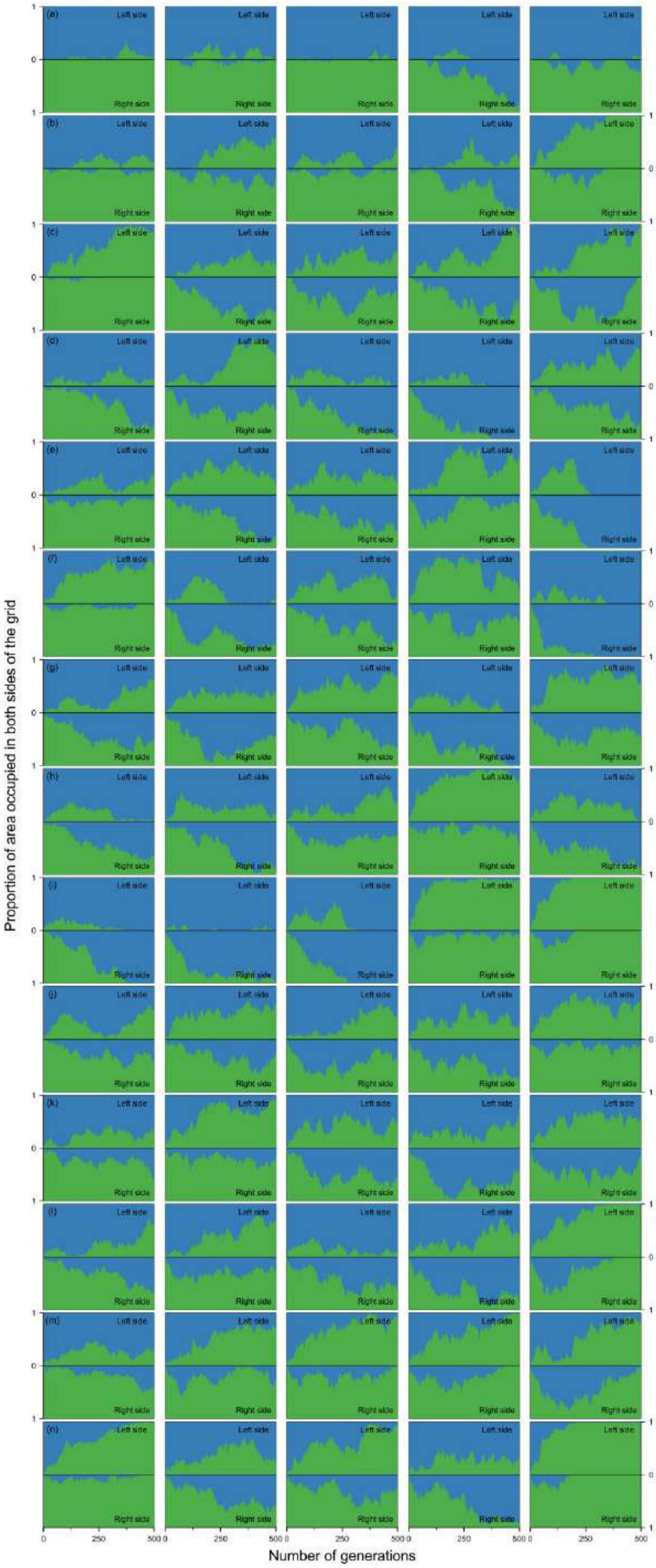

Fig. S13.13. Estimates of the proportion of area occupied on opposite sides of the grid by individuals that crossed the river (right to left side and vice-versa) over generations at local scale. Green area represents individuals that started the simulation on the right side of the grid and blue area the individuals that started the simulation on the left side. Letters represent the degrees of river permeability in each row. (a) 0.01; (b) 0.05; (c) 0.10; (d) 0.20; (e) 0.30; (f) 0.40; (g) 0.50; (h) 0.60; (i) 0.70; (j) 0.80; (k) 0.90; (l) 0.95; (m) 0.99; e (n) 1. In sequence, the columns represent the abilities of a species to disperse(Dispersal 1 to 5).

SÍNTESE

Através deste estudo, nós demonstramos que inferir mecanismos de especiação (e.g. especiação alopátrica) baseado apenas na presença ou ausência de espécies irmãs ou linhagens em margens opostas de um grande rio não deveria ser evidência suficiente para aceitar a hipótese que um grande rio funcionou como uma barreira geográfica para dispersão das espécies e como critério para indicar áreas de endemismo na Amazônia (Capitulo 1). Também demonstramos que a inclusão de um grande rio apenas reduzindo a chance dos indivíduos atravessarem de uma margem para outra pode ser suficiente para manter duas espécies alopatricamente distribuídas por centenas de gerações (Capítulo 2).

No Capítulo 1, entre as 1952 espécies distribuídas em 14 grupos taxonômicos amostradas na avaliação do impacto do hidrelétrica Santo Antônio, apenas duas espécies (0.10%) tiveram suas distribuições limitadas pelo Rio Madeira. Entre as 717 espécies de vertebrados que foram possíveis obter informações filogenéticas para determinar o número de espécies irmãs em que o rio foi uma aparente barreira vicariante, apenas 4 (0.55%) sugerem que o rio foi uma barreira geográfica causadora de especiação. Esses resultados indicam que a hipótese de grandes rios se aplica a uma porção muita pequena da biodiversidade, demonstrando que o papel de grandes rios em promover diversidade na Amazônia e como limites de areas de endemismo ainda precisam ser revistos para a maioria dos grupos taxonômicos.

Se a hipótese que grandes rios funcionam como barreiras vicariantes se aplica apenas para uma porção muita pequena da biodiversidade (Capítulo 1), quais mecanismos poderiam explicar a observação de duas espécies alopatricamente distribuídas por um grande rio quando ele não é uma barreira vicariante (e.g. Boubli et al. 2015, Lynch Alfaro et al. 2015, Byrne et al. 2018, Naka & Brumfield 2018)?

No Capítulo 2, nós demonstramos através de um autômato celular bidimensional para duas espécies alopatricamente distribuídas, que processos neutros (Hubbell 2001) e dispersão reduzida por um rio poderiam ser responsáveis por esse padrão. Quando o rio reduziu a chance de indivíduos de uma espécie atravessar para outra margem, fez com que essa espécie fosse mais fraca competitivamente por causa do efeito que a densidade exerce na competição (Eitam et al. 2005, Waters et al. 2013, Jennings et al. 2019). Deste modo, quando um grande rio apenas reduz a entrada de novos colonizadores pode ser suficiente para resultar em rios formando o limite da distribuiçao de espécies ecologicamente similares. Sob esse cenário, os indivíduos conseguiram atravessar o rio, mas não conseguiram espalhar ao ponto de eliminar a espécie que ocupava a margem oposta.

Em conclusão, avaliar a hipótese de grandes rios como barreira geográficas para dispersão das espécies vai além de apenas descrever padrões e processos na Amazônia. A hipótese de áreas de endemismo delimitadas por grandes rios tem sido utilizada em planejamentos para conservação de espécies (Caro and O’Doherty 1999, Da Silva et al. 2005), e como demonstrado no Capítulo 1, essa hipótese foi ineficiente para explicar o limite de distribuição para a maioria dos organismos. No capítulo 2, demonstramos que nem sempre a falta de habilidade de uma espécies para atravessar para outra margem ou filtros ambientais (Tuomisto & Ruokolainen 1997, Crouch et al. 2018, Alves-Martins et al. 2019) são necessários para manter espécies alopatricamente distribuídas ao longo de um rio. Além disso, é possível que processos neutros e reduzida dispersão através de um rio sejam possíveis mecanismos para manutenção da biodiversidade Amazônica. Esses processos podem permitir que duas espécies competitivamente idênticas coexistissem por muitas gerações, potencialmente facilitando processos (e.g. deriva genética e adaptação local) que poderiam resultar em isolamento reprodutivo.

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