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Estrutura de comunidades em transições ambientais: lagartos no ecótono Cerrado-Amazônia

Pedro Tourinho Dantas

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Estrutura de comunidades em transições ambientais: lagartos no ecótono Cerrado-Amazônia

Orientador: Dr. Guarino Rinaldi Colli

Dissertação apresentada ao Programa de Pós-Graduação em Ecologia da Universidade de Brasília, como requisito para obtenção do título de Mestre em Ecologia.

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Sumário

Resumo

Os limites ecológicos desempenham um papel crucial no fluxo de espécies, de genes e nutrientes entre áreas adjacentes. Os limites não apenas separam, mas também conectam estas áreas, agindo como filtros de permeabilidade variável. A estrutura das comunidades varia com a proximidade do ecótono e a riqueza de espécies no ecótono pode ser maior que, menor que, ou intermediária entre as áreas adjacentes. Aqui, eu investigo como o ecótono isola a Amazônia e o Cerrado, atuando como um filtro sobre as trocas faunísticas entre comunidades de lagartos dos dois biomas neotropicais. Com base em dados de campo e da literatura, foram realizadas análises de correlação entre índices de diversidade e a distância de cada ponto amostral ao ecótono e ao centróide dos biomas. Para investigar os processos responsáveis pelos padrões observados, foi realizada uma análise de correspondência canônica (CCA) relacionando a ocorrência das espécies nas comunidades amostras à variáveis ambientais. Os resultados demonstram que a proximidade ao ecótono Cerrado-Amazônia afeta negativamente a diversidade das comunidades de lagartos, o que é determinado por um processo de filtragem ambiental e possivelmente influenciado por fatores históricos. A ordenação da CCA foi capaz de distinguir claramente dois grupos de espécies (de habitats abertos e habitats florestais), e associá-los à variação na vegetação, umidade do solo e variação diária da temperatura.

Introdução Geral

Os limites ecológicos e seus gradientes estão entre os assuntos mais abordados na ecologia (Erdós *et al.*, 2011). Em despeito à pequena área que costumam ocupar, quando comparados com o resto da paisagem, estes limites parecem desempenhar um papel crucial no fluxo de espécies (Urbina-Cardona *et al.*, 2006), de genes (Smith *et al.*, 1997) e de matéria (Kolasa & Zalewski, 1995) entre áreas adjacentes. A estrutura das comunidades varia com a proximidade do ecótono (e.g., Hofer *et al.*, 2000; Menke, 2003b; Lloyd *et al.*, 2012) e a riqueza de espécies no ecótono pode ser maior que, menor que,ou intermediária entre as áreas adjacentes (van der Maarel, 1990). A compreensão dos padrões de riqueza nos ecótonos requer ainda o entendimento de fatores ligados à história e biogeografia das áreas, já que, em uma escala regional, os ecótonos resultam do contato de diferentes regiões biogeográficas (Nogués-Bravo & Martinez-Rica, 2004).

Uma noção amplamente difundida sobre ecótonos é a de que possuem maior diversidade biológica do que áreas adjacentes e, portanto, maior valor para a conservação (Risser, 1995; Kirkman *et al.*, 1998; Kernaghan & Harper, 2001). Para tanto, os ecótonos deveriam mostrar uma propriedade aditiva, sendo capazes de suportar espécies das áreas adjacentes (Senft, 2009). De forma oposta, a diversidade em ecótonos pode ser menor (Backeus, 1993a; Dangerfield *et al.*, 2003) caso suas condições ambientais sejam sub-ótimas em relação ao centro das áreas adjacentes, prejudicando o estabelecimento e a permanência das espécies (Temple, 1998).

A transição entre a Amazônia e o Cerrado é uma extensa zona de tensão ecológica na América do Sul, formada por um mosaico de savanas e florestas (Ratter *et al.*, 1973; Ackerly *et al.*, 1989a; Ratter, 1992). Este mosaico é irregular, apresentando características singulares e recortes de diferentes tamanhos ao longo de sua extensão (Marimon *et al.*, 2006). A zona de transição coincide espacialmente com o “arco do desmatamento”, que se inicia no Maranhão e margeia os limites sudeste, sul e sudoeste da Bacia Amazônica (Ferreira *et al.*, 2005; Fearnside & Graça, 2006; Aldrich *et al.*, 2012). Existe pouca informação sobre como as espécies de vertebrados se distribuem através desta paisagem (Lacher & Alho, 2001) e a falta de conservação desta área pouco estudada parece limitar a detecção de processos ecológicos que estariam ocorrendo no ecótono (Marimon *et al.*, 2006).

Lagartos são considerados "organismos modelo" para estudos ecológicos, apresentando características desejáveis como fácil captura, alta abundância e baixa dispersão (Huey *et al.*, 1983; Carothers *et al.*, 1996; Pianka & Vitt, 2003; Camargo *et al.*, 2010), sendo empregados com sucesso em estudos de áreas ecotonais (e.g., Hofer *et al.*, 1999, 2000; Menke, 2003b; Nogués-Bravo & Martinez-Rica, 2004; Urbina-Cardona *et al.*, 2006). Aqui, eu investigo como o ecótono isola a Amazônia e o Cerrado, atuando como um filtro sobre as trocas faunísticas entre dois biomas neotropicais. Eu caracterizo os padrões e investigo os processos responsáveis pelas mudanças na estrutura das comunidades de lagartos, em um gradiente do centro para a periferia dos dois biomas. Caso o ecótono Amazônia-Cerrado funcione como um filtro ambiental, isolando os dois biomas, é esperada uma redução nos índices de diversidade (riqueza, endemismo, diversidade funcional e diversidade filogenética) à medida que avançamos do centro para a periferia dos dois biomas, rumo ao ecótono, uma vez que a maior instabilidade e heterogeneidade ambiental da transição devem dificultar o estabelecimento e a permanência de espécies.

Métodos

Os dados relativos às comunidades de lagartos utilizados neste trabalho são provenientes da literatura e de coletas sistemáticas realizadas pelo grupo de pesquisa "Herpetologia do Cerrado". Eu considerei pontos amostrais localizados no Cerrado e na Amazônia, onde coletas foram realizadas utilizando-se de métodos e esforços semelhantes (busca ativa e armadilhas de interceptação-e-queda com cercas-guia por no mínimo três semanas em cada local). As variáveis ambientais que utilizei são aquelas disponibilizadas pelos projetos Worldclim (Hijmans *et al.*, 2005) e Atlas of the Biosphere (utilizado com permissão do Center for Sustainability and the Global Environment, Nelson Institute for Environmental Studies, Universidade de Wisconsin-Madison), correspondendo a dados de temperatura, precipitação, altitude, evapotranspiração, produtividade primária líquida, umidade do solo e vegetação potencial (variável categórica que discrimina o tipo de cobertura que existiria em um grid caso não houvesse interferência humana). Eu obtive as distâncias das comunidades amostradas ao ecótono e ao centróide dos biomas através do programa ArcGIS 9.3 (ESRI, 2009).

Como índices de diversidade, além da riqueza e do endemismo, também utilizei a diversidade filogenética e a diversidade funcional. Neste trabalho, empreguei o índice de *phylogenetic diversity* (PD), calculado pela soma dos comprimentos dos ramos da árvore filogenética das espécies de uma comunidade (Faith, 1992). Com o programa Mesquite 2.75 (Maddison & Maddison, 2011) e baseado em hipóteses filogenéticas recentes (D'Angiolella *et al.*, 2011; Harvey *et al.*, 2012; Giugliano *et al.*, 2013b; Pyron *et al.*, 2013), construí uma árvore filogenética que engloba todas as espécies registradas no presente trabalho.Calculei os valores de PD para cada comunidade com o pacote *picante* (Kembel *et al.*, 2010) no programa R (RCoreTeam, 2013). Para a medida da diversidade funcional, caracterizei as espécies com relação à morfologia e utilização de recursos, obtidos através de consulta à literatura especializada. Calculei a diversidade funcional de cada comunidade com base no índice de riqueza funcional (*functional richness*- FRic) (Villéger *et al.*, 2008), obtido através do volume ocupado por determinada comunidade em um espaço T-dimensional, relativo aos traços funcionais utilizados na análise (Cornwell *et al.*, 2006; Villéger *et al.*, 2008). Para esta análise, utilizei o pacote *FD* (Laliberté & Shipley, 2011b) do programa R (RCoreTeam, 2013).

Investiguei a relação entre os índices de diversidade e o ecótono Amazônia-Cerrado através de análises de correlação entre cada índice e a distância da comunidade em questão ao limite entre os dois biomas e ao centróide de cada bioma. Finalmente, eu investiguei os processos responsáveis pelos padrões observados ao longo do gradiente através de uma

Análise de Correspondência Canônica (CCA) (Ter Braak, 1986) entre a composição das comunidades e as variáveis ambientais dos respectivos locais.

Resultados e Discussão

O levantamento de dados proporcionou a obtenção de 46 comunidades, distribuídas entre a Amazônia e o Cerrado. Nessas comunidades foram encontrados 11.519 espécimes de lagartos, divididos em 123 espécies e 13 famílias.

Das 16 análises de correlação realizadas, nove apresentaram um resultado estatisticamente significativo ($P < 0.05$). Para a Amazônia, as correlações significativas foram aquelas que relacionaram a distância ao ecótono com a riqueza ($\rho = 0.436$ e $P = 0.013$), endemismos do bioma ($\rho = 0.677$ e $P < 0.001$), diversidade filogenética ($\rho = 0.596$ e $P < 0.001$) e diversidade funcional ($\rho = 0.403$ e $P = 0.023$), além daquelas que envolveram a distância ao centróide com os endemismos do bioma ($\rho = -0.563$ e $P < 0.001$) e com a diversidade filogenética ($\rho = -0.375$ e $P = 0.034$).

Para o Cerrado, as correlações significativas foram aquelas que relacionaram a distância ao ecótono com os endemismos do bioma ($\rho = 0.468$ e $P = 0.018$), diversidade filogenética ($\rho = 0.407$ e $P = 0.045$) e diversidade funcional ($\rho = 0.535$ e $P = 0.007$). Nenhuma correlação que envolveu a distância ao centróide deste bioma com os índices de diversidade foi estatisticamente significativa, porém podemos observar o mesmo padrão amazônico onde os índices de diversidade tendem a ser mais altos conforme nos afastamos do ecótono.

A seleção de modelos mostrou que as variáveis ambientais que mais influenciam a variação na composição das comunidades de lagartos são a vegetação potencial, a umidade no solo e a variação média na temperatura diária, além de valores extremos como as temperatura médias dos trimestres mais seco e mais frio, e a precipitação do trimestre mais quente.Os resultados da CCA mostram que as espécies endêmicas da Amazônia tendem a se agrupar com valores mais altos de umidade no solo, bem como de temperatura nos trimestres mais secos e frios. As espécies endêmicas do Cerrado se associaram a solos mais secos, maior variação na temperatura diária e a temperaturas e umidade no solo mais baixas. As espécies com ampla distribuição estão espalhadas por toda a área do gráfico, demonstrando a sua capacidade de ocupar os dois ambientes. Em escalas continentais, variáveis relacionadas ao fluxo de energia são preponderantes para explicar os padrões de diversidade (Wright, 1983; Currie, 1991). Apesar de estarem presentes no pool de variáveis ambientais, estas variáveis (produtividade primária líquida, evapotranspiração, evapotranspiração potencial) não foram incluídas no modelo final como aquelas que mais contribuíram para a variação na estrutura das comunidades estudadas. As variáveis que melhor explicam essa variação estão intimamente ligadas com diferenças ambientais entre os biomas e com a história natural dos lagartos.

Os resultados apresentados demonstram que o ecótono entre a Amazônia e o Cerrado exerce uma influência negativa sobre os índices de diversidade de comunidades de lagartos. A zona de transição estudada atua como um filtro ambiental, limitando a presença de espécies endêmicas ou características de ambientes abertos/fechados. Em escalas amplas de tempo e espaço, o ecótono Amazônia/Cerrado é uma zona altamente instável (Haffer, 1969; Werneck *et al.*, 2012), o que a torna menos favorável para a colonização e permanência das espécies (van der Maarel, 1990). No entanto, o ecótono Amazônia/Cerrado ainda é um ambiente pouco estudado e a sua localização no arco do desmatamento torna ainda mais difícil a compreensão de seus padrões e processos. Estudos com dinâmica e genética de populações ao longo do gradiente seriam interessantes de ser conduzidos para um melhor entendimento da dinâmica do ecótono.

Referências

Ackerly, D.D., Thomas, W.W., Ferreira, C.A.C. & Pirani, J.R. (1989) The Forest-Cerrado Transition Zone in Southern Amazonia - Results of the 1985 Projeto Flora Amazonica Expedition to Mato-Grosso. *Brittonia*, 41, 113-128.

Aldrich, S., Walker, R., Simmons, C., Caldas, M. & Perz, S. (2012) Contentious land change in the Amazon's Arc of Deforestation. *Annals of the Association of American Geographers*, 102, 103-128.

Backeus, I. (1993) Ecotone Versus Ecocline - Vegetation Zonation and Dynamics around a Small Reservoir in Tanzania. *Journal of Biogeography*, 20, 209-218.

Blevins, E., Wisely, S.M. & With, K.A. (2011) Historical processes and landscape context influence genetic structure in peripheral populations of the collared lizard (*Crotaphytus collaris*). *Landscape Ecology*, 26, 1125-1136.

Camargo, A., Sinervo, B. & Sites, J.W., Jr. (2010) Lizards as model organisms for linking phylogeographic and speciation studies. *Molecular Ecology*, 19, 3250-70.

Carothers, J.H., Jaksic, F.M. & Marquet, P.A. (1996) A model for species distributions along a gradient: Lizards as study systems. *Revista Chilena de Historia Natural*, 69, 301-307.

Cornwell, W.K., Schwilk, L.D. & Ackerly, D.D. (2006) A trait-based test for habitat filtering: convex hull volume. *Ecology*, 87, 1465-71.

Currie, D.J. (1991) Energy and Large-Scale Patterns of Animal- and Plant-Species Richness. *The American Naturalist*, 137, 27-49.

D'Angiolella, A.B., Gamble, T., Avila-Pires, T.C.S., Colli, G.R., Noonan, B.P. & Vitt, L.J. (2011) Anolis chrysolepis Duméril and Bibron, 1837 (Squamata: Iguanidae), Revisited: Molecular Phylogeny and Taxonomy of the Anolis chrysolepis Species Group. *Bulletin of the Museum of Comparative Zoology*, 160, 35-63.

Dangerfield, J.M., Pik, A.J., Britton, D., Holmes, A., Gillings, M., Oliver, I., Briscoe, D. & Beattie, A.J. (2003) Patterns of invertebrate biodiversity across a natural edge. *Austral Ecology*, 28, 227-236.

Erdós, L., Zalatnai, M., Morschhauser, T., Bátori, Z. & Körmöczi, L. (2011) On the terms related to spatial ecological gradients and boundaries. *Acta Biologica Szegediensis*, 55, 279-287.

ESRI (2009) *ArcGIS 9.3*. ESRI (Environmental Systems Resource Institute), Redlands, California.

Faith, D.P. (1992) Conservation evaluation and phylogenetic diversity. *Biological Conservation*, 61, 1-10.

Fearnside, P.M. & Graça, P.M.L.A. (2006) BR-319: Brazil's manaus-porto velho highway and the potential impact of linking the arc of deforestation to central Amazonia. *Environmental Management*, 38, 705-716.

Ferreira, L.V., Venticinque, E. & Almeida, S. (2005) O desmatamento na Amazônia e a importância das áreas protegidas. *Estudos Avançados*, 19, 157-166.

Garner, T.W., Pearman, P.B. & Angelone, S. (2004) Genetic diversity across a vertebrate species' range: a test of the central-peripheral hypothesis. *Molecular ecology*, 13, 1047-53.

Giugliano, L.G., de Campos Nogueira, C., Valdujo, P.H., Collevatti, R.G. & Colli, G.R. (2013) Cryptic diversity in South American Teiinae (Squamata, Teiidae) lizards. *Zoologica Scripta*, n/a-n/a.

Haffer, J. (1969) Speciation in Amazonian forest birds. *Science*, 165, 131-137.

Harvey, M.B., Ugueto, G.N. & Gutberlet, R.L. (2012) Review of teiid morphology with a revised taxonomy and phylogeny of the Teiidae (Lepidosauria: Squamata). *Zootaxa*, 1-156.

Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G. & Jarvis, A. (2005) Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, 25, 1965-1978.

Hofer, U., Bersier, L.F. & Borcard, D. (1999) Spatial organization of a herpetofauna on an elevational gradient revealed by null model tests. *Ecology*, 80, 976-988.

Hofer, U., Bersier, L.F. & Borcard, D. (2000) Ecotones and gradient as determinants of herpetofaunal community structure in the primary forest of Mount Kupe, Cameroon. *Journal of Tropical Ecology*, 16, 517-533.

Huey, R.B., Pianka, E.R. & Schoener, T.W. (1983) *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge.

Kembel, S.W., Cowan, P.D., Helmus, M.R., Cornwell, W.K., Morlon, H., Ackerly, D.D., Blomberg, S.P. & Webb, C.O. (2010) Picante: R tools for integrating phylogenies and ecology. *Bioinformatics*, 26, 1463-4.

Kernaghan, G. & Harper, K.A. (2001) Community structure of ectomycorrhizal fungi across an alpine/subalpine ecotone. *Ecography*, 24, 181-188.

Killeen, T.J. & Solórzano, L.A. (2008) Conservation strategies to mitigate impacts from climate change in Amazonia. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363, 1881-1888.

Kirkman, L.K., Drew, M.B., West, L.T. & Blood, E.R. (1998) Ecotone characterization between upland longleaf pine/wiregrass stands and seasonally-ponded isolated wetlands. *Wetlands*, 18, 346-364.

Kolasa, J. & Zalewski, M. (1995) Notes on ecotone attributes and functions. *Hydrobiologia*, 303, 1-7.

Lacher, T.E. & Alho, C.J.R. (2001) Terrestrial small mammal richness and habitat associations in an Amazon Forest-Cerrado contact zone. *Biotropica*, 33, 171-181.

Laliberté, E. & Shipley, B. (2011) *FD: measuring functional diversity from multiple traits, and other tools for functional ecology.*

Lloyd, H., Rios, S.S., Marsden, S.J. & Valdes-Velasquez, A. (2012) Bird community composition across an Andean tree-line ecotone. *Austral Ecology*, 37, 470-478.

Maddison, W.P. & Maddison, D.R. (2011) *Mesquite: a modular system for evolutionary analysis*. http://mesquiteproject.org.

Marimon, B.S., De S. Lima, E., Duarte, T.G., Chieregatto, L.C. & Ratter, J.A. (2006) Observations on the Vegetation of Northeastern Mato Grosso, Brazil. Iv. An Analysis of the Cerrado–Amazonian Forest Ecotone. *Edinburgh Journal of Botany*, 63, 323.

Menke, S.B. (2003) Lizard community structure across a grassland - creosote bush ecotone in the Chihuahuan Desert. *Canadian Journal of Zoology-Revue Canadienne De Zoologie*, 81, 1829-1838.

Nogués-Bravo, D. & Martinez-Rica, J.P. (2004) Factors controlling the spatial species richness pattern of four groups of terrestrial vertebrates in an area between two different biogeographic regions in northern Spain. *Journal of Biogeography*, 31, 629-640.

Pandey, M. & Rajora, O.P. (2012) Higher fine-scale genetic structure in peripheral than in core populations of a long-lived and mixed-mating conifer--eastern white cedar (Thuja occidentalis L.). *BMC Evolutionary Biology*, 12, 48.

Parsons, P.A. (1990) The metabolic cost of multiple environmental stresses: implications for climatic change and conservation. *Trends in Ecology & Evolution*, 5, 315-317.

Pianka, E.R. & Vitt, L.J. (2003) *Lizards: Windows to the Evolution of Diversity*. University of California Press, Berkeley.

Pyron, R., Burbrink, F. & Wiens, J. (2013) A phylogeny and revised classification of Squamata, including 4161 species of lizards and snakes. *BMC Evolutionary Biology*, 13, 93.

Ratter, J.A. (1992) Transitions between cerrado and forest vegetation in Brazil. *Nature and Dyanmics of Forest-Savanna Boundaries* (ed. by P.A. Furley, J. Proctor and J.A. Ratter), pp. c417-429. Chapman & Hall, London.

Ratter, J.A., Richards, P.W., Argent, G. & Gifford, D.R. (1973) Observations on the Vegetation of Northeastern Mato Grosso: I. The Woody Vegetation Types of the Xavantina-Cachimbo Expedition Area. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 266, 449-492.

RCoreTeam (2013) *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Risser, P.G. (1995) The status of the science examining ecotones - A dynamic aspect of landscape is the area of steep gradients between more homogeneous vegetation associations. *Bioscience*, 45, 318-325.

Senft, A.R. (2009) *Species diversity patterns at ecotones*. University of North Carolina, Chapel Hill.

Smith, T.B., Wayne, R.K., Girman, D.J. & Bruford, M.W. (1997) A role for ecotones in generating rainforest biodiversity. *Science*, 276, 1855-1857.

Temple, S.A. (1998) Surviving where ecosystems meet: ecotonal animal communities of midwestern oak savannas and woodlands. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*, 86, 207-222.

Ter Braak, C.J.F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, 67, 1167-1179.

Urbina-Cardona, J.N., Olivares-Perez, M. & Reynoso, V.H. (2006) Herpetofauna diversity and microenvironment correlates across a pasture-edge-interior ecotone in tropical rainforest fragments in the Los Tuxtlas Biosphere Reserve of Veracruz, Mexico. *Biological Conservation*, 132, 61-75.

van der Maarel, E. (1990) Ecotones and ecoclines are different. *Journal of Vegetation Science*, 1, 135-138.

Villéger, S., Mason, N.W.H. & Mouillot, D. (2008) New multidimensional functional diversity indices for a multifaceted framework in functional ecology. *Ecology*, 89, 2290-2301.

Werneck, F.P., Nogueira, C., Colli, G.R., Sites, J.W. & Costa, G.C. (2012) Climatic stability in the Brazilian Cerrado: implications for biogeographical connections of South American savannas, species richness and conservation in a biodiversity hotspot. *Journal of Biogeography*, 39, 1695-1706.

Wright, D.H. (1983) Species-energy theory: an extension of species-area theory. *Oikos*, 41, 496-506.

Community structure in biome transitions: lizards in the Cerrado-Amazon ecotone

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Abstract

Ecological gradients have a crucial role in the flow of species, genes and nutrients between adjacent areas. Limits do not simply separate, but also connect areas, acting as filters of varying permeability. Community structure varies with proximity to the ecotone, and species richness in the ecotone can be higher than, lower than, or similar to adjacent areas. Here, we investigate how the ecotone isolates two Neotropical biomes, the Amazon and the Cerrado, acting as a filter on the lizard fauna exchange between them. Based on field and literature data, we performed correlation analyses between diversity indices and the distance of each sampling point to the ecotone and to the biomes centroids. To investigate the processes responsible for the observed patterns along the gradient, we conducted a canonical correspondence analysis (CCA) relating species incidences in sampled communities and environmental variables. Our results demonstrate that proximity to the Amazon-Cerrado ecotone negatively affects the diversity of lizard communities, which is determined by a process of environmental filtering and possibly influenced by historical factors. The ordination by the CCA was able to clearly distinguish two groups of species (from open and from forest habitats), and associate them to potential vegetation, soil moisture and mean diurnal range of temperature.

Introduction

Ecological limits and gradients are among the most studied subjects in ecology (Erdós *et al.*, 2011). In spite of their small geographical ranges, when compared to the rest of the regional landscape, these limits seem to have a crucial role in the flow of species (Urbina-Cardona *et al.*, 2006), genes (Smith *et al.*, 1997) and nutrients (Kolasa & Zalewski, 1995) between adjacent areas. Limits do not simply separate, but also connect areas, acting as filters of varying permeability (Wiens *et al.*, 1985). The concept of ecotones originated with the recognition of “tension zones” between plant communities (Livingston, 1903) and the term "ecotone" was first used in the beginning of the 20th century, referring to the “stress line that connects the points of accumulated or abrupt change” (Clements, 1904). In this study, we refer to ecotone as a “zone of transition between adjacent ecological systems having a set of characteristics uniquely defined by space and time scales, and by the strength of the interactions between adjacent ecological systems” (di Castri *et al.*, 1988).

The structure of biological communities varies with the proximity to the ecotone (e.g., Hofer *et al.*, 2000; Menke, 2003a; Lloyd *et al.*, 2012), and species richness in the ecotone can be higher than, lower than, or similar to the adjacent areas (van der Maarel, 1990). Understanding richness patterns in the ecotones also requires knowledge about the biogeographic history of the areas, since on a regional scale the ecotones result from the contact of regions with different histories (Nogués-Bravo & Martinez-Rica, 2004). One widespread idea is that ecotones present higher diversity levels than adjacent areas, and are thus of great value to conservation (Risser, 1995; Kirkman *et al.*, 1998; Kernaghan & Harper, 2001). This would happen due to an additive process, in which the ecotone would be able to support species from both areas (Senft, 2009). Contrary to this notion, some argue that the diversity in ecotones can be lower, if local environmental conditions are suboptimal when compared to the adjacent areas (Backeus, 1993b; Dangerfield *et al.*, 2003). In this case, the establishment and survival of species would be jeopardized (Temple, 1998). Besides species richness, other diversity measures should vary spatially with proximity to an ecotone. For instance, functional diversity (Tilman, 2001) and phylogenetic diversity (Faith, 1992) should also be affected by this gradient.

The core-periphery hypothesis postulates that selective pressures will vary from the core to the periphery of a biome (Safriel *et al.*, 1994). This way, populations and communities in the central regions would be structurally different from those in peripheral regions (Garner *et al.*, 2004; Blevins *et al.*, 2011; Pandey & Rajora, 2012). In contrast to ecotones, where the main pattern seems to be heterogeneity and instability (Kark & van Rensburg, 2006), the central areas of a biome are stable (Safriel *et al.*, 1994; Carnaval *et al.*, 2009; Werneck *et al.*, 2012). Stable areas allow for a more constant flow of resources, which may result in higher niche specialization (Pianka, 1966; Futuyma & Moreno, 1988), while unstable areas require the evolution of a wider tolerance to environmental variability (Becking, 1968; Oindo, 2002). Besides being related to local diversity, stability can also explain higher rates of endemism (Fjeldså *et al.*, 1999) and lower rates of extinction (Ricklefs, 2004).

The transition area between the Amazon and the Cerrado biomes is an extensive zone of ecological tension in South America, formed by a mosaic of tropical savannas and forests (Ratter *et al.*, 1973; Ackerly *et al.*, 1989b; Ratter, 1992). This mosaic is irregular in shape, and presents unique features and different sizes along its length (Marimon *et al.*, 2006). Also, the transition zone coincides with a region known in Brazil as the 'arc of deforestation', which originates in the state of Maranhão and runs down along the south-eastern and southern limits of the Amazon (Ferreira *et al.*, 2005; Fearnside & Graça, 2006; Aldrich *et al.*, 2012). This region is under great pressure due to the expansion of the agricultural frontier for the establishment of soy plantations and cattle farms, specially in the states of Pará, Mato Grosso and Rondônia (Fearnside, 2001; Laurance *et al.*, 2004; Fearnside, 2006). The conversion of native vegetation in the region has caused large scale environmental changes, such as alterations in the flow of carbon and biomass (Nogueira *et al.*, 2007), higher emissions of greenhouse gases (Fearnside *et al.*, 2009), and the extension of the dry season (Costa & Pires, 2010). There is still little information about how vertebrate species are distributed throughout the landscape in the region (Lacher & Alho, 2001), and the loss of these areas will prevent us from detecting natural ecological processes that take place in the ecotone (Marimon *et al.*, 2006). Studies with plant communities in the Amazon-Cerrado ecotone corroborate the hypotheses that (1) the ecotone presents higher diversity, through an additive process (Ackerly *et al.*, 1989b), and that (2) central and peripheral communities are structurally different (Marimon *et al.*, 2006).

Lizards are considered “model organisms” for ecological studies, since they present desirable attributes such as high capturability, high abundance levels and low dispersal capacity (Huey *et al.*, 1983; Carothers *et al.*, 1996; Pianka & Vitt, 2003; Camargo *et al.*, 2010). They have been successfully studied in ecotonal areas (e.g., Hofer *et al.*, 1999, 2000; Menke, 2003a; Nogués-Bravo & Martinez-Rica, 2004; Urbina-Cardona *et al.*, 2006) but without a definite pattern: lizard diversity in transition zones can be higher than (Urbina-Cardona *et al.*, 2006), lower than (Menke, 2003a) or similar to (Conroy, 1999; Nogués-Bravo & Martinez-Rica, 2004) that in adjacent areas. Here, we assess how the ecotone isolates the Amazon and the Cerrado, acting as a filter on the faunal exchange between these two Neotropical biomes. We describe the observed patterns and investigate the processes responsible for changes in lizard communities along a gradient from the core towards the periphery of the two biomes. If the Amazon-Cerrado ecotone functions as an environmental filter, isolating the biomes, we expect a reduction in diversity indices (richness, endemism, functional diversity and phylogenetic diversity) as we get closer to the ecotone, from the core to the periphery of both biomes. We hypothesize that the higher instability and environmental heterogeneity of the ecotone should limit the establishment and survival of species typical of each biome.

Methods

Study area

The Amazon and the Cerrado are, respectively, the two largest Brazilian biomes (IBGE, 2004). Both are extremely heterogeneous, presenting different geological, pedological and vegetational features within their geographic ranges (Eiten, 1972; Prance & Lovejoy, 1985). The Cerrado originally covered 2 million km² or approximately 25% of the Brazilian territory (IBGE, 2004). The climate is markedly seasonal, with a rainy season between October and March, and a dry season between April and September. The mean temperature varies between 22°C and 27°C, and the mean annual precipitation is 1500 mm. The climate in Cerrado allows the establishment of forest vegetation in a large part of its range (Oliveira-Filho & Ratter, 2002), but latosols poor in nutrients, with high aluminum levels (Haridasan, 1982) and frequent fires (Miranda *et al.*, 2002) determine the formation of a savanic vegetation, characterized by abundant grasslands and fire-tolerant species (Pennington *et al.*, 2000). The Amazon covers 8 million km², with about 4.2 million km² in the Brazilian territory (IBGE, 2004). With a wet tropical climate, the mean temperature ranges between 24°C and 26°C, and the mean annual precipitation is 2300 mm (Fisch *et al.*, 1998). Overall, the Amazon presents an acidic and poor soil, which is a limiting factor to forest productivity (Cunha *et al.*, 2007). However, the lack of nutrients in the soil is counterbalanced by a rich leaf litter, which, together with high temperatures and pluviosity, is able to maintain a productive and diverse system (Schuur, 2003; Moreira & Costa, 2004).

Data gathering and processing

The data relative to the characterization of lizard communities used in this study derived from field work and the literature (Appendix 1, Table A1). We selected sampling points located in the Amazon and in the Cerrado, where sampling was performed using similar methods and efforts (active search and pitfall traps with drift fences, for at least three weeks in each location). The expressions used in the boolean search of the literature were "lizard AND Amazon", "lizard AND Cerrado", "reptile AND Amazon", "reptile AND Cerrado", herpetofauna AND Amazon" and "herpetofauna AND Cerrado, both in english and in portuguese. To evaluate variations in richness, endemism rates, and functional and phylogenetic diversities, we considered differences in community composition. The list of endemic species in both biomes followed recent syntheses (Nogueira *et al.*, 2011; Ribeiro Júnior, 2013). The environmental variables we used are available from the WorldClim (Hijmans *et al.*, 2005) and the Atlas of the Biosphere (used by permission of The Center for Sustainability and the Global Environment, Nelson Institute for Environmental Studies, University of Wisconsin-Madison) projects, and correspond to temperature, precipitation, altitude, evapotranspiration, primary productivity, soil moisture and potential vegetation (a categorical variable which corresponds to the land cover type that would exist in a gridcell had humans not interfered). The limits of the Cerrado and brazilian Amazon are those proposed by IBGE, 2004. The limits of the Amazon outside Brazil follows (Olson *et al.*, 2001). The distance of each sampling point to the ecotone line and to biome centroids were calculated with ArcGIS version 9.3 (ESRI, 2009). The centroid corresponds to the geographical centre of each biome.

Analyses

The relationship between the diversity indices and Amazon-Cerrado ecotone were determined by correlation analyses conducted between each index and the distance of each sampling point to the ecotone and to the centroid of each biome. Since most variable pairs did not present a normal distribution (verified by a Shapiro-Wilk test), we used the nonparametric Spearman's correlation index (ρ). For those pairs which did present a normal distribution, we used the Pearson correlation index (*r*).

To generate measures of functional diversity, we characterized each species according to its morphology and resource use, using on the following traits: size (maximum snout-vent length), presence of sexual dimorphism, habitat (open or closed vegetation), microhabitat (arboreal, leaf litter, fossorial, terrestrial, saxicolous, semi-arboreal and semi-aquatic), diet (carnivore or herbivore), foraging behavior (active search, sit-and-wait, or both), activity pattern (diurnal or nocturnal), reproduction strategy (oviparous or viviparous), maximum clutch size, temperature regulation strategy (thermoconformer or thermoregulator) and mean activity temperature. These traits represent the species' functional aspects in relation to the ecosystem. This information was obtained from the literature (Supplementary material Appendix 2, Table A2). We calculated the functional diversity of each community based on the index of functional richness (FRic) (Villéger *et al.*, 2008), because it is more sensible to the structuring of communities than richness itself (Mouchet *et al.*, 2010). It is obtained by calculating the volume occupied by a specific community in a *n*-dimensional space, relative to the functional traits used in the analysis (Cornwell *et al.*, 2006; Villéger *et al.*, 2008). For this step in the analysis, we used the package *FD* (Laliberté & Legendre, 2010; Laliberté & Shipley, 2011a) in program R (R Core Team, 2014).

The phylogenetic diversity index of a community represents the relationship between the number of species and the phylogenetic distance between them (Faith, 1992). This index can be obtained by estimating the topological distance separating species in a phylogenetic tree (Webb, 2000), and can be used to analyze the ecological processes that structure a community (Webb *et al.*, 2002). In this study, we used a measure of phylogenetic diversity (PD) calculated by the sum of the branch lengths of the phylogenetic tree separating species in a given community (Faith, 1992). Long branch lengths correspond to longer evolutionary time, and consequently, more distinct taxonomic groups (Cianciaruso *et al.*, 2009). Using program Mesquite 2.75 (Maddison & Maddison, 2011), and based on recent phylogenies (D'Angiolella *et al.*, 2011; Harvey *et al.*, 2012; Giugliano *et al.*, 2013a; Pyron *et al.*, 2013), we built a phylogenetic tree that encompasses all species included in this study. We obtained branch lengths from Pyron et al. (2013), which covers 96 of the 123 species used here. The branch lengths uniting the remaining taxa to the tree were estimated by ultrametric distances. We used package *picante* (Kembel *et al.*, 2010) in program R (R Core Team, 2014) to calculate PD values for each community.

To investigate the processes responsible for the observed patterns along the gradient, we conducted a canonical correspondence analysis (CCA) (Ter Braak, 1986) relating the species composition in the sampled communities and the environmental variables for each location. The CCA is an ordination exploratory analysis that is being successfully used for investigating species variation across environmental gradients (Hofer *et al.*, 2000; Kernaghan & Harper, 2001; Vitt *et al.*, 2007). The CCA associates the variation in the lizard community composition matrix (dependent variable) to the environmental variables matrix (independent variable). Beforehand, we performed a selection of environmental variables that most influenced community composition, by comparing CCA models based on the Akaike Information Criterion (AIC). The matrix for the dependent variables was structured with each lizard species as columns and each sampling location as lines, and the presence/absence of a species in a location was coded as 1/0, respectively. The matrix for the independent variables was structured with the environmental variables as columns and locations as lines, and filled out by the values of each variable in the sampling locations. To test the significance of the CCA results, we performed a Monte Carlo permutation test, with 1,000 iterations, using package *vegan* (Oksanen *et al.*, 2013) in program R (R Core Team, 2014).

Results

We had access to data from 118 communities, but to work with only high quality data (larger sampling efforts and reliability in species identification), the total number was reduced to 46 communities, from both the Amazon and the Cerrado (Fig. 1, Table 1). Overall in these communities, 11,519 lizard specimens were collected, from 123 species and 13 families (Fig. 2). The obtained values of richness, endemism, functional diversity and phylogenetic diversity are presented in Table 1. It is noteworthy that endemic species from both biomes were found in those communities close to the ecotone.

For the Amazon, significant correlations were obtained which related distance to the ecotone with richness ($\rho = 0.436$ and $P = 0.013$), with biome endemism ($\rho = 0.677$ and $P < 0.001$), with phylogenetic diversity ($\rho = 0.596$ and $P < 0.001$), with functional diversity ($\rho = 0.403$ and $P = 0.023$), and also those which related distance to the centroid with biome endemism ($\rho = -0.563$ and $P < 0.001$) and with phylogenetic diversity ($r = -0.375$ and $P = 0.034$) (Fig. 3). Overall, the diversity indices presented a positive relationship with distance to the ecotone and a negative relationship with distance to the biome centroid, which means that as the distance from the ecotone increases, lizard diversity increases.

For the Cerrado, the significant correlations observed related distance to the ecotone with biome endemism ($\rho = 0.468$ and $P = 0.018$), phylogenetic diversity ($\rho = 0.407$ and $P = 0.045$) and functional diversity ($\rho = 0.535$ and $P = 0.007$) (Fig. 4). No statistically significant correlation between distance to the centroid and the measures of diversity was obtained. However, in those significant relationships, we observed the same general pattern as for the Amazon, in which diversity indices tended to be higher with increased distance to the ecotone.

Model selection indicated that the most influential variables on lizard distributions are potential vegetation, soil moisture, mean daily temperature range, as well as extreme temperature values, such as mean temperature from the hottest and coldest quarters, and mean precipitation of the hottest quarter. The Monte Carlo permutations revealed a significant relationship between the environmental variables selected and the structure of lizard communities ($F = 2.440$ and $P < 0.001$). The CCA (Fig. 5) indicated that Amazonian endemic species, typically from forest habitats, tended to group together towards the right end of the first CCA axis, characterized by higher values of soil moisture and temperatures from the hottest and coldest quarters. Cerrado endemic species grouped together towards the left end of the first CCA axis, being associated with drier soils, higher daily temperature range, and lower values of temperature and precipitation. Widespread species were scattered across the graphic area, demonstrating their ability to occupy both biomes.

Discussion

Our results demonstrate that the Amazon-Cerrado ecotone influences negatively the diversity of lizard communities. Even though the idea of a greater diversity in ecotones is more broadly accepted and corroborated in the literature (Risser, 1995; Kirkman *et al.*, 1998; Kernaghan & Harper, 2001), this work, along with a few other studies, refutes this hypothesis (Backeus, 1993b; Dangerfield *et al.*, 2003). Despite the low diversity indices for lizards, ecotonal areas can harbor genetically diverse populations (Garner *et al.*, 2004; Blevins *et al.*, 2011; Pandey & Rajora, 2012), resistant to environmental changes (Parsons, 1990) and are able to survive in unstable environments. In the face of the predicted global climate changes, transition zones could prove to be an important genetic repository (Killeen & Solórzano, 2008).

The transition zone seems to act as an environmental filter, and does not allow species that are endemic or typical from closed/open habitats to advance into the other biome. However, the presence of endemic species of both biomes in ecotonal communities is evidence that this zone can support species from either closed or open environments, although it does not sustain comparably high lizard diversity levels. This lower diversity can be explained by the fact that, in large scales of space and time, the ecotone seems to be an unstable zone (Haffer, 1969; Werneck *et al.*, 2012). This instability can turn the ecotone into an unfavorable area to species colonization and permanence (van der Maarel, 1990). In large biogeographic scales, ecotones can act as population sinks (Woodroffe & Ginsberg, 1998), where some species are at the edge of their distributions. The fitness of marginal populations is expected to be lower than that of central populations (Haak *et al.*, 2010; Zhigalskii, 2011), and this would affect the establishment and survival rates of the species, and the community structure as a whole (Temple, 1998). One way in which ecotones would present higher diversity levels is by harboring ecotonal species (Jose *et al.*, 1996), which would be adapted to the intermediate conditions found in the transition zone and would present an abundance peak or even be endemic to the ecotone (Walker *et al.*, 2003). However, in this study, no species with these characteristics were identified in the Amazon-Cerrado transition zone.

The results obtained for the Amazon indicate that all diversity indices analyzed were positively correlated with distance to the ecotone, and two indices (biome endemism and phylogenetic diversity) were negatively correlated with distance to the biome's centroid. Correlation indices varied between 0.37 and 0.67, suggesting that there must be factors other than distance that may also be influencing lizard community structure. This is perfectly intuitive, since distances to the ecotone and to the centroid simply summarize a shift in environmental conditions along the gradient. What remains clear is that the diversity indices tend to decrease with proximity to the ecotone. These results corroborate our predictions, despite some works that suggest higher diversity at disturbed areas due to a higher environmental heterogeneity, which would promote the establishment and occupation of more ecological niches (Biswas & Mallik, 2010; Carreño-Rocabado *et al.*, 2012). By observing the opposite, we can suppose that this heterogeneity hinders the establishment of species typical from either biomes, and only those species that are generalists or resistant to environmental variations would be able to occupy the transition zone (Devictor *et al.*, 2008). Another explanation, which would contribute to the understanding of the distribution of species along the ecotonal gradient, is the Pleistocene Refugia hypothesis. Firstly proposed by Haffer (1969) and Vanzolini & Williams (1970), this hypothesis suggests that climatic oscillations in the Quaternary would have led to expansions and contractions of forest areas. These events would isolate and concentrate species in forest islands with stable climatic conditions (refugia), in times when conditions outside them were unsuitable for the survival of the species (Simpson & Haffer, 1978). Refugia would have been concentrated in the core of the biome, while peripheral areas would have been subject to a greater instability in geological time scales. Despite being strongly discussed and criticized (Colinvaux *et al.*, 2000; Bush & Oliveira, 2006; Haffer, 2008), this hypothesis has gained support in recent studies involving biogeography and phylogeography (Peterson & Nyari, 2008; Carnaval *et al.*, 2009). Also, palynological and isotopic studies show that the peripheral areas have undergone vegetation changes(Servant *et al.*, 1993; Desjardins *et al.*, 1996), suggesting that the extent of forest and savanna have varied during the geological time and supporting the notion of instability in the ecotone.

For the Cerrado, results obtained were similar, although less significant. Only three correlations were statistically significant, and in all of them a positive relationship between the diversity indices and distance to the ecotone were observed. The same way as for the Amazon, correlation indices were not very high, varying between 0.40 and 0.53, indicating that other factors apart from the distance should also be responsible for variations in diversity levels. There were no significant correlations between the diversity indices and distance to the centroid. This can be due to the central position of the biome in South America, which brings the Cerrado in contact with other Brazilian biomes (Amazon, Caatinga, Atlantic Forest and Pantanal) and create other ecotonal zones not considered in this study. Stable zones can also explain a higher diversity in central areas of the Cerrado. Recently, stable climatic areas have been proposed for the Cerrado and for other open habitat areas in South America (Werneck *et al.*, 2011; Werneck *et al.*, 2012). These areas correspond to regions in the Cerrado that have maintained stable environmental conditions for at least 120,000 years. The area where the Amazon-Cerrado ecotone is located today seems to be an unstable area (Werneck *et al.*, 2012), and must have undergone expansion and contraction events in both savanna and forest areas. Studies on the biogeography of Cerrado squamates corroborate our results, indicating that the area of contact with the Amazon tends to be less species–rich than the core of the biome (Costa *et al.*, 2007), and that endemic species are more associated with open habitats, while forest areas (in the ecotone and in gallery forests) play a role in faunal exchange with other biomes (Nogueira *et al.*, 2011).

In this study, the ordination by the CCA was able to clearly distinguish two groups of species (from open and from forest habitats), and associate them to variables that influenced this clustering the most. In continental scales, energy–related variables are usually thought of as predominant factors in explaining diversity patterns (Wright, 1983; Currie, 1991). Despite being present in our initial pool of environmental variables, these energy–related variables (net primary productivity, evapotranspiration, and potential evapotranspiration) were not selected to compose the final model. The variables which better explained the variation in community structure are intimately linked to the environmental differences between the two biomes and to the lizards' natural history. Potential vegetation is the most apparent difference between forest and savanna physiognomies, exerting a direct influence on the faunal composition of these regions (Cavalcanti, 1992; Conroy, 1999). The mean daily temperature range also differs clearly between both biomes. While in the Amazon the mean daily temperature variation is 5 ºC, ranging between 25 °C at night and 30 °C during the day (Jacob & Wofsy, 1988), the Cerrado presents a far greater daily temperature range, with a mean of 12 °C (Hijmans *et al.*, 2005). Soil moisture directly influences the microhabitat occupied by many lizard species and is important in the selection of sites for oviposition and egg incubation (Christian *et al.*, 1991; Warner & Andrews, 2002; Marco *et al.*, 2004). Besides, soil moisture is an important limiting factor for vegetation growth (Li *et al.*, 2013) and will vary greatly in an ecotonal gradient (Pockman & Small, 2010). The selection of temperature in the driest and coldest quarters and precipitation in the hottest quarter by the analysis highlights the lizard species' need to adapt to seasonality in these environments. While the Cerrado presents a highly seasonal climate, the seasonality in the Amazon is lessened, and this distinction can be perceived along the ecotonal gradient (da Rocha *et al.*, 2009). These differences put a selective pressure on the communities, which will consequently influence species composition.

Overall, this study demonstrates that lizard communities in the Amazon and in the Cerrado follow a pattern of diversity loss with proximity to the ecotone, which is determined by a process of environmental filtering and possibly influenced by historical factors. However, the Amazon-Cerrado ecotone is still poorly studied and its location in the Brazilian 'arc of deforestation' renders our knowledge of its natural patterns and processes even more difficult. We thus highlight that future studies concerning the dynamics and genetics of the populations along the gradient would be interesting for further understanding the ecotonal dynamics.

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References

Ackerly, D.D., Thomas, W.W., Ferreira, C.A.C. & Pirani, J.R. (1989a) The Forest-Cerrado Transition Zone in Southern Amazonia - Results of the 1985 Projeto Flora Amazonica Expedition to Mato-Grosso. *Brittonia*, **41**, 113-128.

Ackerly, D.D., Thomas, W.W., Ferreira, C.A.C. & Pirani, J.R. (1989b) The forest-cerrado transition zone in southern Amazonia: Results of the 1985 Projeto Flora Amazônica expedition to Mato Grosso. *Brittonia*, **41**, 113-128.

Aldrich, S., Walker, R., Simmons, C., Caldas, M. & Perz, S. (2012) Contentious land change in the Amazon's arc of deforestation. *Annals of the Association of American Geographers*, **102**, 103-128.

Ávila, R.W. & Kawashita-Ribeiro, R.A. (2011) Herpetofauna of São João da Barra Hydroelectric Plant, state of Mato Grosso, Brazil. *Check List*, **7**, 750-755.

Backeus, I. (1993a) Ecotone Versus Ecocline - Vegetation Zonation and Dynamics around a Small Reservoir in Tanzania. *Journal of Biogeography*, **20**, 209-218.

Backeus, I. (1993b) Ecotone versus ecocline: vegetation zonation and dynamics around a small reservoir in Tanzania. *Journal of Biogeography*, **20**, 209-218.

Becking, R. (1968) Vegetational response to change in environment and change in species tolerance with time. *Vegetatio*, **16**, 135-158.

Bernarde, P.S., Machado, R.A. & Turci, L.C.B. (2011) Herpetofauna da área do Igarapé Esperança na Reserva Extrativista Riozinho da Liberdade, Acre – Brasil. *Biota Neotropica*, **11**, 117-144.

Bernardo, P.H., Guerra-Fuentes, R.A., Matiazzi, W. & Zaher, H. (2012) Checklist of amphibians and reptiles of Reserva Biológica do Tapirapé, Pará, Brazil. *Check List*, **8**, 839-846.

Biswas, S.R. & Mallik, A.U. (2010) Disturbance effects on species diversity and functional diversity in riparian and upland plant communities. *Ecology*, **91**, 28-35.

Blevins, E., Wisely, S.M. & With, K.A. (2011) Historical processes and landscape context influence genetic structure in peripheral populations of the Collared Lizard (*Crotaphytus collaris*). *Landscape Ecology*, **26**, 1125-1136.

Bush, M.B. & Oliveira, P.E.d. (2006) The rise and fall of the Refugial Hypothesis of Amazonian speciation: a paleoecological perspective. *Biota Neotropica*, **6**, 0-0.

Camargo, A., Sinervo, B. & Sites, J.W., Jr. (2010) Lizards as model organisms for linking phylogeographic and speciation studies. *Molecular Ecology*, **19**, 3250-70.

Carnaval, A.C., Hickerson, M.J., Haddad, C.F., Rodrigues, M.T. & Moritz, C. (2009) Stability predicts genetic diversity in the Brazilian Atlantic forest hotspot. *Science*, **323**, 785-9.

Carothers, J.H., Jaksic, F.M. & Marquet, P.A. (1996) A model for species distributions along a gradient: Lizards as study systems. *Revista Chilena de Historia Natural*, **69**, 301-307.

Carreño-Rocabado, G., Peña-Claros, M., Bongers, F., Alarcón, A., Licona, J.-C. & Poorter, L. (2012) Effects of disturbance intensity on species and functional diversity in a tropical forest. *Journal of Ecology*, **100**, 1453-1463.

Cavalcanti, R.B. (1992) The importance of forest edges in the ecology of open country Cerrado birds. *The Nature and Dynamics of Forest-Savanna Boundaries* (ed. by P.A. Furley, J. Proctor and J.A. Ratter), pp. 513-518. Chapman and Hall, Cambridge.

Christian, K.A., Lawrence, W.T. & Snell, H.L. (1991) Effect of soil moisture on yolk and fat distribution in hatchling lizards from natural nests. *Comparative Biochemistry and Physiology Part A: Physiology*, **99**, 13-19.

Cianciaruso, M.V., Silva, I.A. & Batalha, M.A. (2009) Diversidades filogenética e funcional: novas abordagens para a ecologia de comunidades. *Biota Neotropica*, **9**, 93-103.

Clements, F.E. (1904) *The Development and Structure of Vegetation*. The Botanical Seminar, Lincoln, Nebraska.

Cole, C.J., Townsend, C.R., Reynolds, R.P., MacCulloch, R.D. & Lathrop, A. (2013) Amphibians and reptiles of Guyana, South America: Illustrated keys, annotated species accounts, and a biogeographic synopsis. *Proceedings of the Biological Society of Washington*, **125**, 317-578.

Colinvaux, P.A., De Oliveira, P.E. & Bush, M.B. (2000) Amazonian and Neotropical plant communities on glacial time-scales: The failure of the aridity and refuge hypotheses. *Quaternary Science Reviews*, **19**, 141-169.

Conroy, S. (1999) Lizard assemblage response to a forest ecotone in northeastern Australia: A synecological approach. *Journal of Herpetology*, **33**, 409-419.

Cornwell, W.K., Schwilk, L.D. & Ackerly, D.D. (2006) A trait-based test for habitat filtering: convex hull volume. *Ecology*, **87**, 1465-71.

Costa, G.C., Nogueira, C., Machado, R.B. & Colli, G.R. (2007) Squamate richness in the Brazilian Cerrado and its environmental-climatic associations. *Diversity and Distributions*, **13**, 714-724.

Costa, M.H. & Pires, G.F. (2010) Effects of Amazon and Central Brazil deforestation scenarios on the duration of the dry season in the arc of deforestation. *International Journal of Climatology*, **30**, 1970-1979.

Cunha, T.J.F., Madari, B.E., Benites, V.d.M., Canellas, L.P., Novotny, E.H., Moutta, R.d.O., Trompowsky, P.M. & Santos, G.d.A. (2007) Fracionamento químico da matéria orgânica e características de ácidos húmicos de solos com horizonte a antrópico da amazônia (Terra Preta). *Acta Amazonica*, **37**, 91-98.

Currie, D.J. (1991) Energy and large-scale patterns of animal- and plant-species richness. *The American Naturalist*, **137**, 27-49.

D'Angiolella, A.B., Gamble, T., Avila-Pires, T.C.S., Colli, G.R., Noonan, B.P. & Vitt, L.J. (2011) *Anolis chrysolepis* Duméril and Bibron, 1837 (Squamata: Iguanidae), revisited: molecular phylogeny and taxonomy of the *Anolis chrysolepis* species group. *Bulletin of the Museum of Comparative Zoology*, **160**, 35-63.

da Rocha, H.R., Manzi, A.O., Cabral, O.M., Miller, S.D., Goulden, M.L., Saleska, S.R., R.-Coupe, N., Wofsy, S.C., Borma, L.S., Artaxo, P., Vourlitis, G., Nogueira, J.S., Cardoso, F.L., Nobre, A.D., Kruijt, B., Freitas, H.C., von Randow, C., Aguiar, R.G. & Maia, J.F. (2009) Patterns of water and heat flux across a biome gradient from tropical forest to savanna in Brazil. *Journal of Geophysical Research: Biogeosciences*, **114**, G00B12.

Dangerfield, J.M., Pik, A.J., Britton, D., Holmes, A., Gillings, M., Oliver, I., Briscoe, D. & Beattie, A.J. (2003) Patterns of invertebrate biodiversity across a natural edge. *Austral Ecology*, **28**, 227-236.

Desjardins, T., Filho, A.C., Mariotti, A., Girardin, C. & Chauvel, A. (1996) Changes of the forest-savanna boundary in Brazilian Amazonia during the Holocene revealed by stable isotope ratios of soil organic carbon. *Oecologia*, **108**, 749-756.

Devictor, V., Julliard, R. & Jiguet, F. (2008) Distribution of specialist and generalist species along spatial gradients of habitat disturbance and fragmentation. *Oikos*, **117**, 507-514.

di Castri, F., Hansen, A.J. & Holland, M.M. (1988) A new look at ecotones: emerging international projects on landscape boundaries. *Biology International*, **Special Issue 17**, 1-163.

Eiten, G. (1972) The cerrado vegetation of Brazil. *The Botanical Review*, **38**, 201-341.

Erdós, L., Zalatnai, M., Morschhauser, T., Bátori, Z. & Körmöczi, L. (2011) On the terms related to spatial ecological gradients and boundaries. *Acta Biologica Szegediensis,* **55**, 279-287.

ESRI (2009) *ArcGIS 9.3*. ESRI (Environmental Systems Resource Institute), Redlands, California.

Faith, D.P. (1992) Conservation evaluation and phylogenetic diversity. *Biological Conservation*, **61**, 1-10.

Fearnside, P.M. (2001) Soybean cultivation as a threat to the environment in Brazil. *Environmental Conservation*, **28**, 23-38.

Fearnside, P.M. (2006) Desmatamento na Amazônia: dinâmica, impactos e controle. *Acta Amazonica*, **36**, 395-400.

Fearnside, P.M. & Graça, P.M.L.A. (2006) BR-319: Brazil's Manaus-Porto Velho highway and the potential impact of linking the arc of deforestation to central Amazonia. *Environmental Management*, **38**, 705-716.

Fearnside, P.M., Righi, C.A., Graca, P.M.L.D., Keizer, E.W.H., Cerri, C.C., Nogueira, E.M. & Barbosa, R.I. (2009) Biomass and greenhouse-gas emissions from land-use change in Brazil's Amazonian "arc of deforestation": The states of Mato Grosso and Rondônia. *Forest Ecology and Management*, **258**, 1968-1978.

Ferreira, L.V., Venticinque, E. & Almeida, S. (2005) O desmatamento na Amazônia e a importância das áreas protegidas. *Estudos Avançados*, **19**, 157-166.

Fisch, G., Marengo, J.A. & Nobre, C.A. (1998) Uma revisão geral sobre o clima da Amazônia. *Acta Amazônica*, **28**, 101-126.

Fjeldså, J., Lambin, E. & Mertens, B. (1999) Correlation between endemism and local ecoclimatic stability documented by comparing Andean bird distributions and remotely sensed land surface data. *Ecography*, **22**, 63-78.

Futuyma, D.J. & Moreno, G. (1988) The evolution of ecological specialization. *Annual Review of Ecology and Systematics*, **19**, 207-233.

Gainsbury, A.M. & Colli, G.R. (2003) Lizard assemblages from natural cerrado enclaves in southwestern Amazonia: The role of stochastic extinctions and isolation. *Biotropica*, **35**, 503-519.

Gardner, T.A., Ribeiro-Júnior, M.A., Barlow, J., Ávila-Pires, T.C.S., Hoogmoed, M.S. & Peres, C.A. (2007) The value of primary, secondary, and plantation forests for a Neotropical herpetofauna. *Conservation Biology*, **21**, 775-787.

Garner, T.W., Pearman, P.B. & Angelone, S. (2004) Genetic diversity across a vertebrate species' range: a test of the central-peripheral hypothesis. *Molecular ecology*, **13**, 1047-53.

Giugliano, L.G., de Campos Nogueira, C., Valdujo, P.H., Collevatti, R.G. & Colli, G.R. (2013a) Cryptic diversity in South American Teiinae (Squamata, Teiidae) lizards. *Zoologica Scripta*, **42**, 473-487.

Giugliano, L.G., de Campos Nogueira, C., Valdujo, P.H., Collevatti, R.G. & Colli, G.R. (2013b) Cryptic diversity in South American Teiinae (Squamata, Teiidae) lizards. *Zoologica Scripta*, n/a-n/a.

Haak, A.L., Williams, J.E., Neville, H.M., Dauwalter, D.C. & Colyer, W.T. (2010) Conserving Peripheral Trout Populations: the Values and Risks of Life on the Edge. *Fisheries*, **35**, 530-549.

Haffer, J. (1969) Speciation in Amazonian forest birds. *Science*, **165**, 131-137.

Haffer, J. (2008) Hypotheses to explain the origin of species in Amazonia. *Brazilian Journal of Biology*, **68**, 917-947.

Haridasan, M. (1982) Aluminium accumulation by some cerrado native species of central Brazil. *Plant and Soil*, **65**, 265-273.

Harvey, M.B., Ugueto, G.N. & Gutberlet, R.L. (2012) Review of teiid morphology with a revised taxonomy and phylogeny of the Teiidae (Lepidosauria: Squamata). *Zootaxa*, 1-156.

Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G. & Jarvis, A. (2005) Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, **25**, 1965-1978.

Hofer, U., Bersier, L.F. & Borcard, D. (1999) Spatial organization of a herpetofauna on an elevational gradient revealed by null model tests. *Ecology*, **80**, 976-988.

Hofer, U., Bersier, L.F. & Borcard, D. (2000) Ecotones and gradient as determinants of herpetofaunal community structure in the primary forest of Mount Kupe, Cameroon. *Journal of Tropical Ecology*, **16**, 517-533.

Huey, R.B., Pianka, E.R. & Schoener, T.W. (1983) *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge.

IBGE (2004) Mapa de Biomas do Brasil. In. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.

Ilha, P. & Dixo, M. (2010) Anurans and lizards, Rio Preto da Eva, Amazonas, Brazil. *Check List*, **6**, 17-21.

Jacob, D.J. & Wofsy, S.C. (1988) Photochemistry of biogenic emissions over the Amazon forest. *Journal of Geophysical Research: Atmospheres*, **93**, 1477-1486.

Jose, S., Gillespie, A.R., George, S.J. & Kumar, B.M. (1996) Vegetation responses along edge-to-interior gradients in a high altitude tropical forest in peninsular India. *Forest Ecology and Management*, **87**, 51-62.

Kark, S. & van Rensburg, B.J. (2006) Ecotones: marginal or central areas of transition? *Israel Journal of Ecology & Evolution*, **52**, 29-53.

Kembel, S.W., Cowan, P.D., Helmus, M.R., Cornwell, W.K., Morlon, H., Ackerly, D.D., Blomberg, S.P. & Webb, C.O. (2010) Picante: R tools for integrating phylogenies and ecology. *Bioinformatics*, **26**, 1463-4.

Kernaghan, G. & Harper, K.A. (2001) Community structure of ectomycorrhizal fungi across an alpine/subalpine ecotone. *Ecography*, **24**, 181-188.

Killeen, T.J. & Solórzano, L.A. (2008) Conservation strategies to mitigate impacts from climate change in Amazonia. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **363**, 1881-1888.

Kirkman, L.K., Drew, M.B., West, L.T. & Blood, E.R. (1998) Ecotone characterization between upland longleaf pine/wiregrass stands and seasonally-ponded isolated wetlands. *Wetlands*, **18**, 346-364.

Kolasa, J. & Zalewski, M. (1995) Notes on ecotone attributes and functions. *Hydrobiologia*, **303**, 1-7.

Lacher, T.E. & Alho, C.J.R. (2001) Terrestrial small mammal richness and habitat associations in an Amazon Forest-Cerrado contact zone. *Biotropica*, **33**, 171-181.

Laliberté, E. & Legendre, P. (2010) A distance-based framework for measuring functional diversity from multiple traits. *Ecology*, **91**, 299-305.

Laliberté, E. & Shipley, B. (2011a) *FD: measuring functional diversity from multiple traits, and other tools for functional ecology. R package version 1.0-11.*

Laliberté, E. & Shipley, B. (2011b) *FD: measuring functional diversity from multiple traits, and other tools for functional ecology.*

Laurance, W.F., Albernaz, A.K.M., Fearnside, P.M., Vasconcelos, H.L. & Ferreira, L.V. (2004) Deforestation in Amazonia. *Science,* **304**, 1109-1109.

Li, H., Shen, W., Zou, C., Jiang, J., Fu, L. & She, G. (2013) Spatio-temporal variability of soil moisture and its effect on vegetation in a desertified aeolian riparian ecotone on the Tibetan Plateau, China. *Journal of Hydrology*, **479**, 215-225.

Livingston, B.E. (1903) The Distribution of the Upland Plant Societies of Kent County, Michigan. *Botanical Gazette*, **35**, 36-55.

Lloyd, H., Rios, S.S., Marsden, S.J. & Valdes-Velasquez, A. (2012) Bird community composition across an Andean tree-line ecotone. *Austral Ecology*, **37**, 470-478.

Macedo, L.C., Bernarde, P.S. & Abe, A.S. (2008) Lagartos (Squamata: Lacertilia) em áreas de floresta e de pastagem em Espigão do Oeste, Rondônia, sudoeste da Amazônia, Brasil. *Biota Neotropica*, **8**, 133-139.

Maddison, W.P. & Maddison, D.R. (2011) *Mesquite: a modular system for evolutionary analysis*. http://mesquiteproject.org.

Marco, A., Díaz-Paniagua, C. & Hidalgo-Vila, J. (2004) Influence of egg aggregation and soil moisture on incubation of flexible-shelled lacertid lizard eggs. *Canadian Journal of Zoology*, **82**, 60-65.

Marimon, B.S., De S. Lima, E., Duarte, T.G., Chieregatto, L.C. & Ratter, J.A. (2006) Observations on the Vegetation of Northeastern Mato Grosso, Brazil. Iv. An Analysis of the Cerrado–Amazonian Forest Ecotone. *Edinburgh Journal of Botany*, **63**, 323.

Mendes-Pinto, T.J. & Tello, J.C.R. (2010) Répteis Squamata de uma área de savana no oeste do estado do Pará, Brasil. *Revista de Ciências Ambientais*, **4**, 19-35.

Mendes-Pinto, T.J. & Souza, S.M. (2011) Preliminary assessment of amphibians and reptiles from Floresta Nacional do Trairão, with a new snake record for the Pará state, Brazilian Amazon. *Salamandra*, **47**, 199-206.

Menke, S.B. (2003a) Lizard community structure across a grassland - creosote bush ecotone in the Chihuahuan Desert. *Canadian Journal of Zoology*, **81**, 1829-1838.

Menke, S.B. (2003b) Lizard community structure across a grassland - creosote bush ecotone in the Chihuahuan Desert. *Canadian Journal of Zoology-Revue Canadienne De Zoologie*, **81**, 1829-1838.

Miranda, H.S., Bustamante, M.M.C. & Miranda, A.C. (2002) The fire factor. *The Cerrados of Brazil. Ecology and Natural History of a Neotropical Savanna* (ed. by P.S. Oliveira and R.J. Marquis), pp. 51-68. Columbia University Press, New York.

Morais, A.R., Bastos, R.P., Vieira, R. & Signorelli, L. (2012) Herpetofauna of the Floresta Nacional de Silvânia, a Cerrado remnant in central Brazil. *Neotropical Biology and Conservation*, **7**, 114-121.

Moreira, A. & Costa, D.G. (2004) Dinâmica da matéria orgânica na recuperação de clareiras da floresta amazônica. *Pesquisa Agropecuária Brasileira*, **39**, 1013-1019.

Mouchet, M.A., Villéger, S., Mason, N.W.H. & Mouillot, D. (2010) Functional diversity measures: an overview of their redundancy and their ability to discriminate community assembly rules. *Functional Ecology*, **24**, 867-876.

Nogueira, C., Valdujo, P.H. & Franca, F.G.R. (2005) Habitat variation and lizard diversity in a Cerrado area of central Brazil. *Studies on Neotropical Fauna and Environment*, **40**, 105-112.

Nogueira, C., Ribeiro, S., Costa, G.C. & Colli, G.R. (2011) Vicariance and endemism in a Neotropical savanna hotspot: distribution patterns of Cerrado squamate reptiles. *Journal of Biogeography*, **38**, 1907-1922.

Nogueira, E.M., Fearnside, P.M., Nelson, B.W. & Franca, M.B. (2007) Wood density in forests of Brazil's 'arc of deforestation': Implications for biomass and flux of carbon from land-use change in Amazonia. *Forest Ecology and Management*, **248**, 119-135.

Nogués-Bravo, D. & Martinez-Rica, J.P. (2004) Factors controlling the spatial species richness pattern of four groups of terrestrial vertebrates in an area between two different biogeographic regions in northern Spain. *Journal of Biogeography*, **31**, 629-640.

Oindo, B.O. (2002) Patterns of herbivore species richness in Kenya and current ecoclimatic stability. *Biodiversity and Conservation*, **11**, 1205-1221.

Oksanen, J., Blanchet, F.G., Kindt, R., Legendre, P., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Henry, M., Stevens, H. & Wagner, H. (2013) *vegan: Community Ecology Package. R package version 2.0-10*. http://CRAN.R-project.org/package=vegan.

Oliveira-Filho, A.T. & Ratter, J.A. (2002) Vegetation physiognomies and woody flora of the cerrado biome. *The Cerrados of Brazil. Ecology and Natural History of a Neotropical Savanna* (ed. by P.S. Oliveira and R.J. Marquis), pp. 91-120. Columbia University Press, New York.

Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'Amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P. & Kassem, K.R. (2001) Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience*, **51**, 933-938.

Pandey, M. & Rajora, O.P. (2012) Higher fine-scale genetic structure in peripheral than in core populations of a long-lived and mixed-mating conifer – eastern white cedar (*Thuja occidentalis* L.). *BMC Evolutionary Biology*, **12**, 48.

Parsons, P.A. (1990) The metabolic cost of multiple environmental stresses: implications for climatic change and conservation. *Trends in Ecology & Evolution*, **5**, 315-317.

Pennington, R.T., Prado, D.E. & Pendry, C.A. (2000) Neotropical Seasonally Dry Forests and Quaternary vegetation changes. *Journal of Biogeography*, **27**, 261-273.

Peterson, A.T. & Nyari, A.S. (2008) Ecological niche conservatism and Pleistocene refugia in the Thrush-like Mourner, *Schiffornis* sp., in the neotropics. *Evolution*, **62**, 173-83.

Pianka, E.R. (1966) Latitudinal gradients in species diversity: a review of concepts. *American Naturalist*, **100**, 33-46.

Pianka, E.R. & Vitt, L.J. (2003) *Lizards: Windows to the Evolution of Diversity*. University of California Press, Berkeley.

Pockman, W. & Small, E. (2010) The influence of spatial patterns of soil moisture on the grass and shrub responses to a summer rainstorm in a Chihuahuan desert ecotone. *Ecosystems*, **13**, 511-525.

Prance, G. & Lovejoy, T. (1985) *Amazonia*. Pergamon Press, Oxford.

Prudente, A.L.C., Magalhães, F., Menks, A. & de Melo, J.F. (2013) Checklist of lizards of the Juruti, state of Pará, Brazil. *Check List*, **9**, 042-050.

Pyron, R., Burbrink, F. & Wiens, J. (2013) A phylogeny and revised classification of Squamata, including 4161 species of lizards and snakes. *BMC Evolutionary Biology*, **13**, 93.

R Core Team (2014) *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Ratter, J.A. (1992) Transitions between cerrado and forest vegetation in Brazil. *Nature and Dyanmics of Forest-Savanna Boundaries* (ed. by P.A. Furley, J. Proctor and J.A. Ratter), pp. c417-429. Chapman & Hall, London.

Ratter, J.A., Richards, P.W., Argent, G. & Gifford, D.R. (1973) Observations on the vegetation of northeastern Mato Grosso: I. The woody vegetation types of the Xavantina-Cachimbo Expedition area. *Philosophical Transactions of the Royal Society B: Biological Sciences,* **266**, 449-492.

RCoreTeam (2013) *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Recoder, R.S., Teixeira, M., Jr., Camacho, A., Nunes, P.M.S., Mott, T., Valdujo, P.H., Ghellere, J.M., Nogueira, C. & Rodrigues, M.T. (2011) Répteis da Estação Ecológica Serra Geral do Tocantins, Brasil central. *Biota Neotropica*, **11**, 263-281.

Ribeiro-Júnior, M.A., Rossi, R.V., Miranda, C.L. & Ávila-Pires, T.C.S. (2011) Influence of pitfall trap size and design on herpetofauna and small mammal studies in a Neotropical forest. *Zoologia (Curitiba)*, **28**, 80-91.

Ribeiro Júnior, M.A. (2013) *Fauna de Lagartos da Amazônia brasileira: Diversidade, Biogeografia e Conservação*. Universidade Federal do Pará, Belém.

Ricklefs, R.E. (2004) A comprehensive framework for global patterns in biodiversity. *Ecology Letters*, **7**, 1-15.

Risser, P.G. (1995) The status of the science examining ecotones - A dynamic aspect of landscape is the area of steep gradients between more homogeneous vegetation associations. *Bioscience,* **45**, 318-325.

Safriel, U.N., Volis, S. & Kark, S. (1994) Core and peripheral populations and global climate change. *Israel Journal of Plant Sciences*, **42**, 331-345.

Schuur, E.A.G. (2003) Productivity and global climate revisited: The sensitivity of tropical forest growth to precipitation. *Ecology*, **84**, 1165-1170.

Senft, A.R. (2009) *Species diversity patterns at ecotones*. University of North Carolina, Chapel Hill.

Servant, M., Maley, J., Turcq, B., Absy, M.-L., Brenac, P., Fournier, M. & Ledru, M.-P. (1993) Tropical forest changes during the late quaternary in African and South American lowlands. *Global and Planetary Change*, **7**, 25-40.

Silva, F.M., Menks, A.C., Prudente, A.L.C., Costa, J.C.L., Travassos, A.E.M. & Galatti, U. (2011) Squamate reptiles from municipality of Barcarena and surroundings, state of Pará, north of Brazil. *Check List*, **7**

Simpson, B.B. & Haffer, J. (1978) Speciation patterns in the Amazonian forest biota. *Annual Review of Ecology and Systematics*, **9**, 497-518.

Smith, T.B., Wayne, R.K., Girman, D.J. & Bruford, M.W. (1997) A role for ecotones in generating rainforest biodiversity. *Science*, **276**, 1855-1857.

Temple, S.A. (1998) Surviving where ecosystems meet: ecotonal animal communities of midwestern oak savannas and woodlands. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*, **86**, 207-222.

Ter Braak, C.J.F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, **67**, 1167-1179.

Tilman, D. (2001) Functional diversity. *Encyclopedia of Biodiversity* (ed. by S.A. Levin), pp. 109-120. Academic Press.

Turci, L.C.B. & Bernarde, P.S. (2008) Levantamento herpetofaunístico em uma localidade no município de Cacoal, Rondônia, Brasil. *Bioikos*, **22**, 101-108.

Urbina-Cardona, J.N., Olivares-Perez, M. & Reynoso, V.H. (2006) Herpetofauna diversity and microenvironment correlates across a pasture-edge-interior ecotone in tropical rainforest fragments in the Los Tuxtlas Biosphere Reserve of Veracruz, Mexico. *Biological Conservation*, **132**, 61-75.

Valdujo, P.H., Nogueira, C.d.C., Baumgarten, L., Rodrigues, F.H.G., Brandão, R.A., Eterovic, A., Ramos-Neto, M.B. & Marques, O.A.V. (2009) Squamate reptiles from

Parque Nacional das Emas and surroundings, Cerrado of central Brazil. *Check List*, **5**, 405-417.

van der Maarel, E. (1990) Ecotones and ecoclines are different. *Journal of Vegetation Science*, **1**, 135-138.

Vanzolini, P.E. & Williams, E.E. (1970) South American anoles: the geographic differentiation and evolution of the *Anolis chrysolepis* species group (Sauria, Iguanidae). *Arquivos de Zoologia, São Paulo*, **19**, 1-298.

Vaz-Silva, W., Guedes, A.G., de Azevedo-Silva, P.L., Gontijo, F.F., Barbosa, R.S., Aloísio, G.R. & de Oliveira, F.C.G. (2007) Herpetofauna, Espora hydroelectric power plant, state of Goiás, Brazil. *Check List*, **3**, 338-345.

Villéger, S., Mason, N.W.H. & Mouillot, D. (2008) New multidimensional functional diversity indices for a multifaceted framework in functional ecology. *Ecology*, **89**, 2290-2301.

Vitt, L.J., Colli, G.R., Caldwell, J.P., Mesquita, D.O., Garda, A.A. & Franca, F.G.R. (2007) Detecting variation in microhabitat use in low-diversity lizard assemblages across small-scale habitat gradients. *Journal of Herpetology*, **41**, 654-663.

Waldez, F., Menin, M. & Vogt, R.C. (2013) Diversidade de anfíbios e répteis Squamata na região do baixo rio Purus, Amazônia Central, Brasil. *Biota Neotropica*, **13**, 300-316.

Walker, S., Wilson, J.B., Steel, J.B., Rapson, G.L., Smith, B., King, W.M. & Cottam, Y.H. (2003) Properties of ecotones: Evidence from five ecotones objectively determined from a coastal vegetation gradient. *Journal of Vegetation Science*, **14**, 579-590.

Warner, D.A. & Andrews, R.M. (2002) Nest-site selection in relation to temperature and moisture by the lizard *Sceloporus undulatus*. *Herpetologica*, **58**, 399-407.

Webb, C.O. (2000) Exploring the phylogenetic structure of ecological communities: an example for rain forest trees. *The American Naturalist*, **156**, 145-155.

Webb, C.O., Ackerly, D.D., McPeek, M.A. & Donoghue, M.J. (2002) Phylogenies and community ecology. *Annual Review of Ecology and Systematics*, **33**, 475-505.

Werneck, F.D., Colli, G.R. & Vitt, L.J. (2009) Determinants of assemblage structure in Neotropical dry forest lizards. *Austral Ecology*, **34**, 97-115.

Werneck, F.P., Costa, G.C., Colli, G.R., Prado, D.E. & Sites, J.W. (2011) Revisiting the historical distribution of Seasonally Dry Tropical Forests: new insights based on palaeodistribution modelling and palynological evidence. *Global Ecology and Biogeography*, **20**, 272-288.

Werneck, F.P., Nogueira, C., Colli, G.R., Sites, J.W. & Costa, G.C. (2012) Climatic stability in the Brazilian Cerrado: implications for biogeographical connections of South American savannas, species richness and conservation in a biodiversity hotspot. *Journal of Biogeography*, **39**, 1695-1706.

Wiens, J.A., Crawford, C.S. & Gosz, J.R. (1985) Boundary dynamics: a conceptual framework for studying landscape ecosystems. *Oikos*, **45**, 421-427.

Woodroffe, R. & Ginsberg, J.R. (1998) Edge effects and the extinction of populations inside protected areas. *Science*, **280**, 2126-2128.

Wright, D.H. (1983) Species-energy theory: an extension of species-area theory. *Oikos*, **41**, 496-506.

Zhigalskii, O.A. (2011) Structure of the bank vole (*Myodes glareolus*) population cycles in the core and periphery of its species area. *Biology Bulletin*, **38**, 629-641.

Table 1. Lizard communities in the Cerrado and in the Amazon. *A*: Amazon, *C*: Cerrado, *CN*: community number (according to Figure 1), *DC*: distance to the centroid (km), *DE*: distance to the ecotone (km), *E*: Ecotone, *EA*: Amazon endemisms, *EC*: Cerrado endemisms, *FRic*: functional diversity index, *Lat*: latitude, *Long*: longitude, *PD*: phylogenetic diversity index, *Ric*: richness. CHUNB: Coleção Herpetológica da Universidade de Brasília.

Locality	Biome	CN	Lat	Long	Ric	EA	EC	PD	FRic	DE	DC	Source
Almas	C	33	-11.205	-47.194	20	0	6	6.68	0.00384	274	418	Recoder et al. (2011)
Almeirim	A	1	-0.975	-52.500	12	7	0	4.98	0.00007	678	1138	Gardner et al. (2007)
Alta Floresta	A	2	-9.574	-55.918	15	5	1	5.53	0.00220	278	907	CHUNB
Amapá	A	3	2.053	-50.793	24	13	0	7.25	0.00439	849	1453	CHUNB
Aporé	C	34	-18.674	-51.881	18	0	6	6.09	0.00172	588	569	Vaz-Silva et al. (2007)
Barcarena	A	4	-1.592	-48.738	17	5	0	6.79	0.00197	408	1530	Silva et al. (2011)
Berbice	A	8	5.085	-58.237	17	9	0	6.72	0.00260	1603	1088	Cole et al. (2013)
Brasília 1	C	35	-15.776	-47.798	15	0	4	4.40	0.00329	500	202	CHUNB
Brasília 2	C	36	-16.000	-47.950	17	0	5	5.18	0.00395	500	214	Nogueira et al. (2005)
Cacoal	A	5	-11.467	-61.331	15	5	0	6.08	0.00157	143	820	Turci and Bernarde (2008)
Carolina	E	20	-7.333	-47.469	14	0	2	5.12	0.00069	72	823	CHUNB

Locality	Biome	CN	Lat	Long	Ric	EA	EC	PD	FRic	DE	DC	Source
Caseara	E	21	-9.372	-49.843	17	0	1	5.83	0.00163	23	582	CHUNB
Caxiuanã	A	6	-1.960	-51.615	17	8	0	6.28	0.00161	532	1204	Ribeiro Jr. et al. (2011)
Cerejeiras	E	22	-13.189	-60.812	13	4	1	4.63	0.00029	86	1022	CHUNB
Cocos	C	37	-14.545	-45.242	12	0	4	5.41	0.00129	698	396	CHUNB
Cruzeiro do Sul	A	7	-7.956	-72.077	29	17	0	8.51	0.00427	1362	1174	Bernarde et al. (2011)
Dubulay	A	9	5.682	-57.859	21	6	0	7.42	0.00192	1618	1163	Cole et al. (2013)
Emas	C	38	-18.333	-53.000	26	0	12	7.28	0.00536	532	605	Valdujo et al. (2009)
Espigão do Oeste	E	23	-11.608	-60.717	29	14	1	9.21	0.00382	77	846	Macedo et al. (2008)
Guajará-Mirim	E	24	-10.800	-65.367	25	14	0	7.65	0.00399	579	820	CHUNB
Humaitá	A	11	-7.200	-62.900	17	11	0	6.17	0.00131	590	345	CHUNB
Juara	E	25	-10.428	-57.634	12	5	2	5.09	0.00069	154	852	Ávila and Ribeiro (2011)
Juruti	A	12	-2.520	-56.158	24	14	0	8.26	0.00324	944	693	Prudente et al. (2013)
Konawaruk	A	9	5.219	-59.045	16	6	0	6.07	0.00204	1680	1067	Cole et al. (2013)
Marabá	A	13	-5.504	-50.279	14	6	0	5.71	0.00234	233	1322	Bernardo et al. (2012)
Mateiros 1	C	39	-10.263	-46.566	14	0	3	5.27	0.00138	251	543	CHUNB

Locality	Biome	CN	Lat	Long	Ric	EA	EC	PD	FRic	DE	DC	Source
Mateiros 2	C	40	-10.702	-46.413	19	0	3	6.22	0.00302	294	509	CHUNB
Minaçu	C	41	-13.496	-48.397	13	0	4	5.00	0.00122	353	127	CHUNB
Monte Alegre	A	14	-1.200	-54.400	11	1	0	5.15	0.00031	831	928	CHUNB
Nova Xavantina	E	26	-14.673	-52.353	24	0	8	6.30	0.00351	129	343	CHUNB
Novo Progresso	A	15	-8.600	-55.500	22	7	2	7.26	0.00627	392	877	CHUNB
Palmas	C	42	-10.189	-48.109	17	0	5	5.33	0.00274	124	494	CHUNB
Paracatu	C	43	-17.109	-46.872	17	0	6	5.26	0.00278	664	382	CHUNB
Paranã	C	44	-12.753	-47.759	16	0	2	5.11	0.00142	385	235	CHUNB
Pimenta Bueno	E	27	-12.500	-60.817	12	3	2	3.85	0.00022	81	944	Gainsbury and Colli (2003)
Purus	A	16	-4.407	-62.255	29	29	0	8.30	0.00355	844	29	Waldez et al. (2013)
Querência	E	28	-12.470	-52.370	7	0	1	3.34	0.00000	67	1407	CHUNB
Ribeirão Cascalheira	E	29	-12.940	-51.820	16	1	3	5.11	0.00104	4	1486	CHUNB
Rio Preto da Eva	A	17	-2.342	-59.214	20	9	0	7.06	0.00176	1014	383	Ilha and Dixo (2010)
Santa Terezinha	E	30	-10.288	-50.798	9	0	3	3.50	0.00021	4	507	CHUNB
Santarém	A	18	-2.481	-54.770	14	2	0	5.64	0.00064	801	845	Mendes-Pinto and Tello (2010)

Locality	Biome	CN	Lat	Long	Ric	EA	EC	PD	FRic	DE	DC	Source
São Domingos	C	45	-13.398	-46.268	18	0	2	5.83	0.00242	538	314	Werneck et al. (2009)
Silvânia	C	46	-16.659	-48.608	14	0	4	4.93	0.00084	495	261	Morais et al. (2012)
Trairão	A	19	-4.576	-55.404	23	13	0	7.37	0.00164	768	749	Mendes-Pinto and Souza (2011)
Vila Bela da SS. Trindade	E	31	-14.944	-60.013	17	2	4	5.82	0.00245	76	1234	CHUNB
Vilhena	E	32	-12.717	-60.117	15	3	5	4.60	0.00120	11	982	Gainsbury and Colli (2003)

Figure Legends

Figure 1. Map presenting the sampled communities. 1: Almeirim; 2: Alta Floresta; 3: Amapá; 4: Barcarena; 5: Cacoal; 6: Caxiuanã; 7: Cruzeiro do Sul; 8: Berbice; 9: Dubulay; 10: Konawaruk; 11: Humaitá; 12: Juruti; 13: Marabá; 14: Monte Alegre; 15: Novo Progresso; 16: Purus; 17: Rio Preto da Eva; 18: Santarém; 19: Trairão; 20: Carolina; 21: Caseara; 22: Cerejeiras; 23: Espigão do Oeste; 24: Guajará-Mirim; 25: Juara; 26: Nova Xavantina; 27: Pimenta Bueno; 28: Querência; 29: Ribeirão Cascalheira; 30: Santa Terezinha; 31: Vila Bela da Santíssima Trindade; 32: Vilhena; 33: Almas; 34: Aporé; 35: Brasília 1; 36: Brasília 2; 37: Cocos; 38: Emas; 39: Mateiros 1; 40: Mateiros 2; 41: Minaçu; 42: Palmas; 43: Paracatu; 44: Paranã; 45: São Domingos; 46: Silvânia.

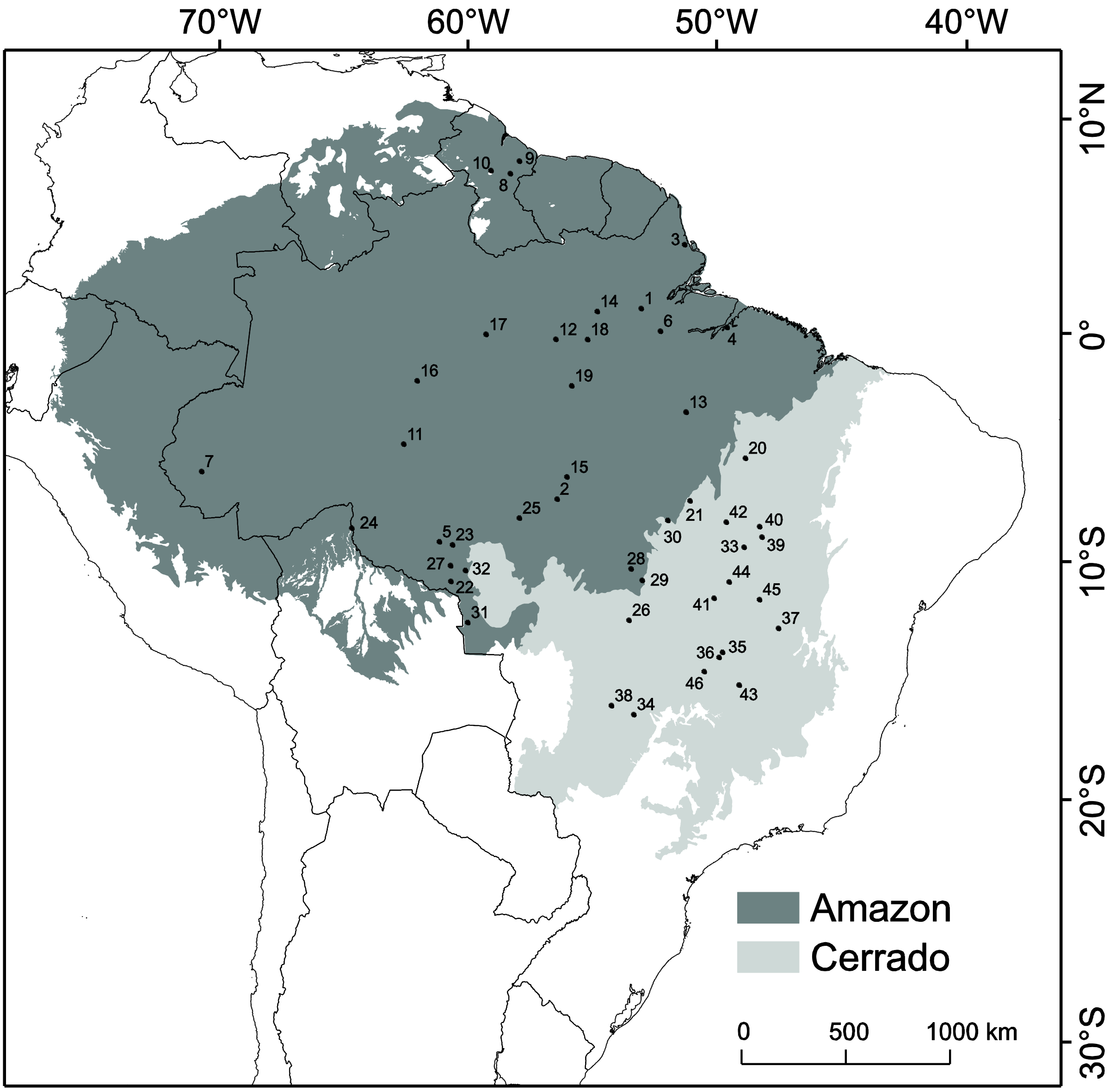
Figure 2. Phylogenetic tree representing the relationships among all the species used in this study. Branch lengths follow Pyron et al. (2013).

Figure 3. Correlations between species richness, endemisms, phylogenetic diversity (*PD*) and functional diversity (*FRic*) of communities located in the Amazon with distance to the ecotone and distance to the biome centroid. The correlation coefficients and significance values are: A: $\rho = 0.436$ and $P = 0.013$; B: $r = -0.314$ and $P = 0.08$; C: $\rho = 0.677$ and $P < 0.001$); D: $\rho = -0.563$ and $P < 0.001$; E: $\rho = 0.596$ and $P < 0.001$; F: $r = -0.375$ and $P = 0.034$; G: $\rho = 0.403$ and $P = 0.023$; H: $r = -0.118$ and $P = 0.520$.

Figure 4. Correlations between species richness, endemisms, phylogenetic diversity (*PD*) and functional diversity (*FRic*) of communities located in the Cerrado with distance to the ecotone and distance to the biome centroid. The correlation coefficients and significance values are: A: $\rho = 0.369$ and $P = 0.070$; B: $\rho = -0.119$ and $P = 0.595$; C: $\rho = 0.468$ and $P =$

0.018; D: ρ = -0.210 and $P = 0.314$; E: ρ = 0.407 and $P = 0.045$; F: ρ = 0.013 and $P = 0.952$; G: ρ = 0.535 and $P = 0.007$; H: ρ = -0.311 and $P = 0.131$.

Figure 5. Ordination diagram resulting from a canonical correspondence analysis (CCA), presenting relationships among lizard species and environmental variables. Species scores represented by circles and crosses, and environmental variables represented by arrows, jointly reflect species distributions along each environmental vector. White circles = Cerrado endemic species; black circles = Amazon endemic species; crosses = widespread species; Bio 2 = mean diurnal temperature range; Bio 9 = mean temperature of driest quarter; Bio 11 = mean temperature of coldest quarter; Bio 18 = precipitation of warmest quarter.


70°W
60°W
50°W
40°W
10°N
0°
10°S
20°S
30°S
Amazon
Cerrado
0
500
1000 km
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
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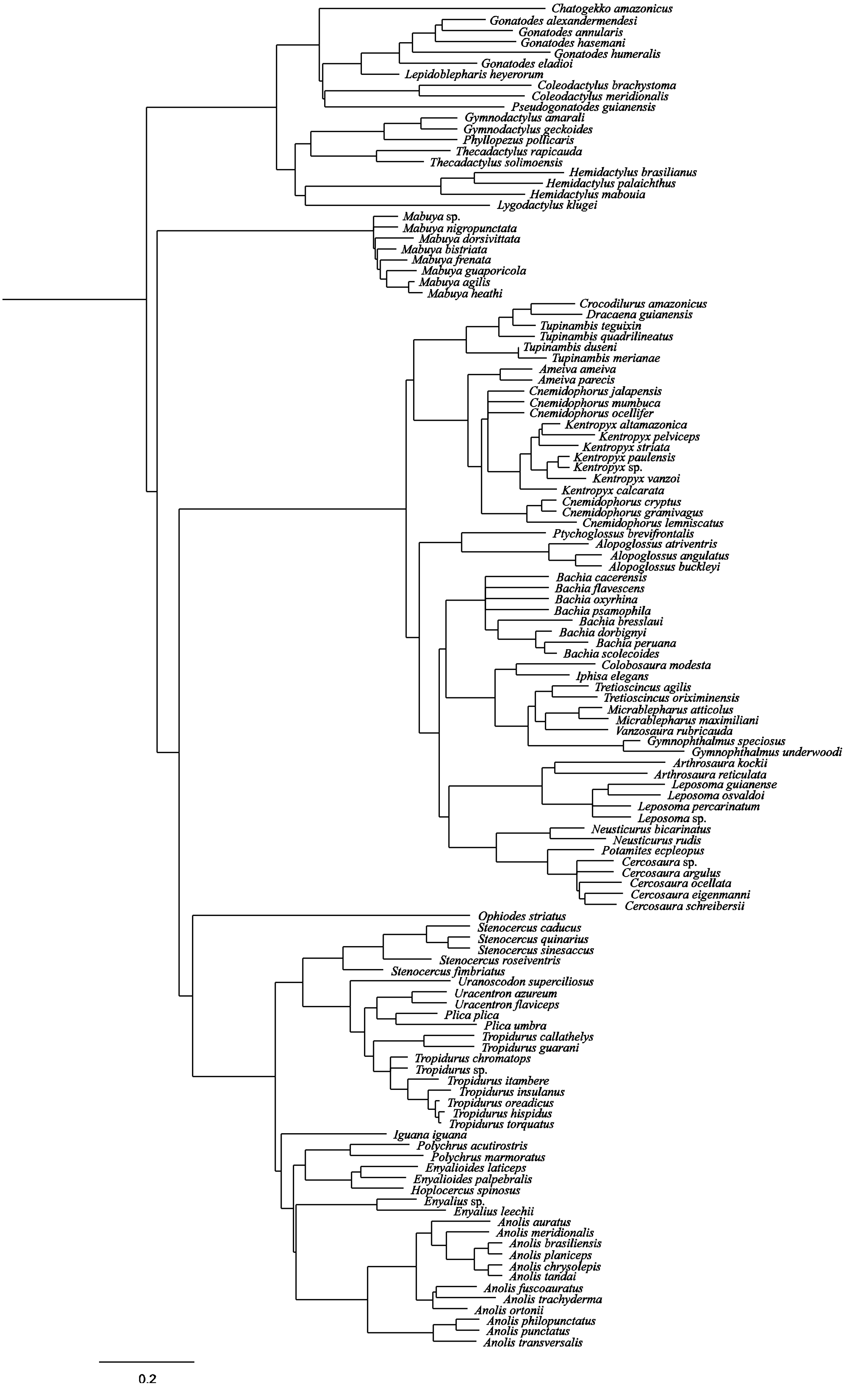
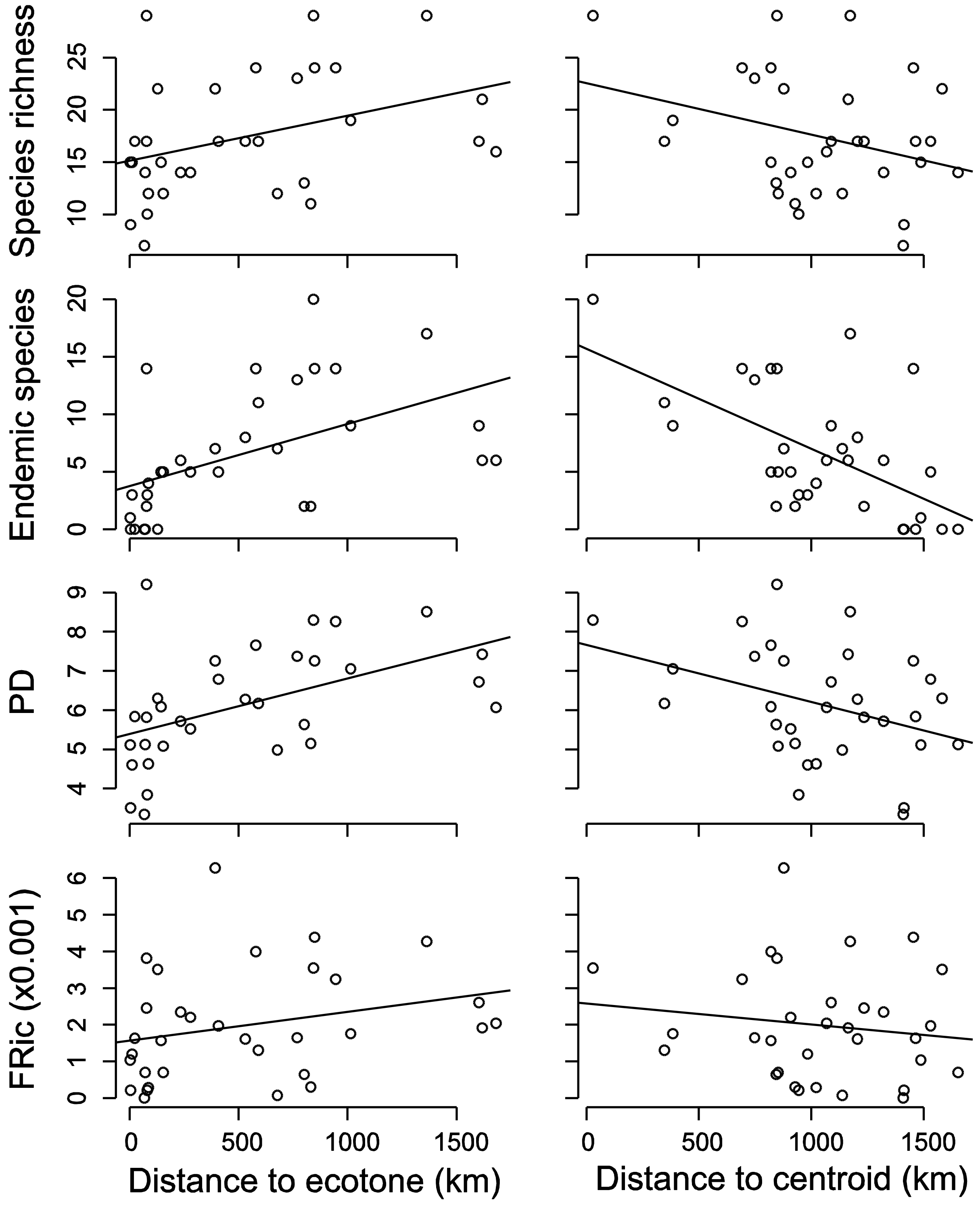
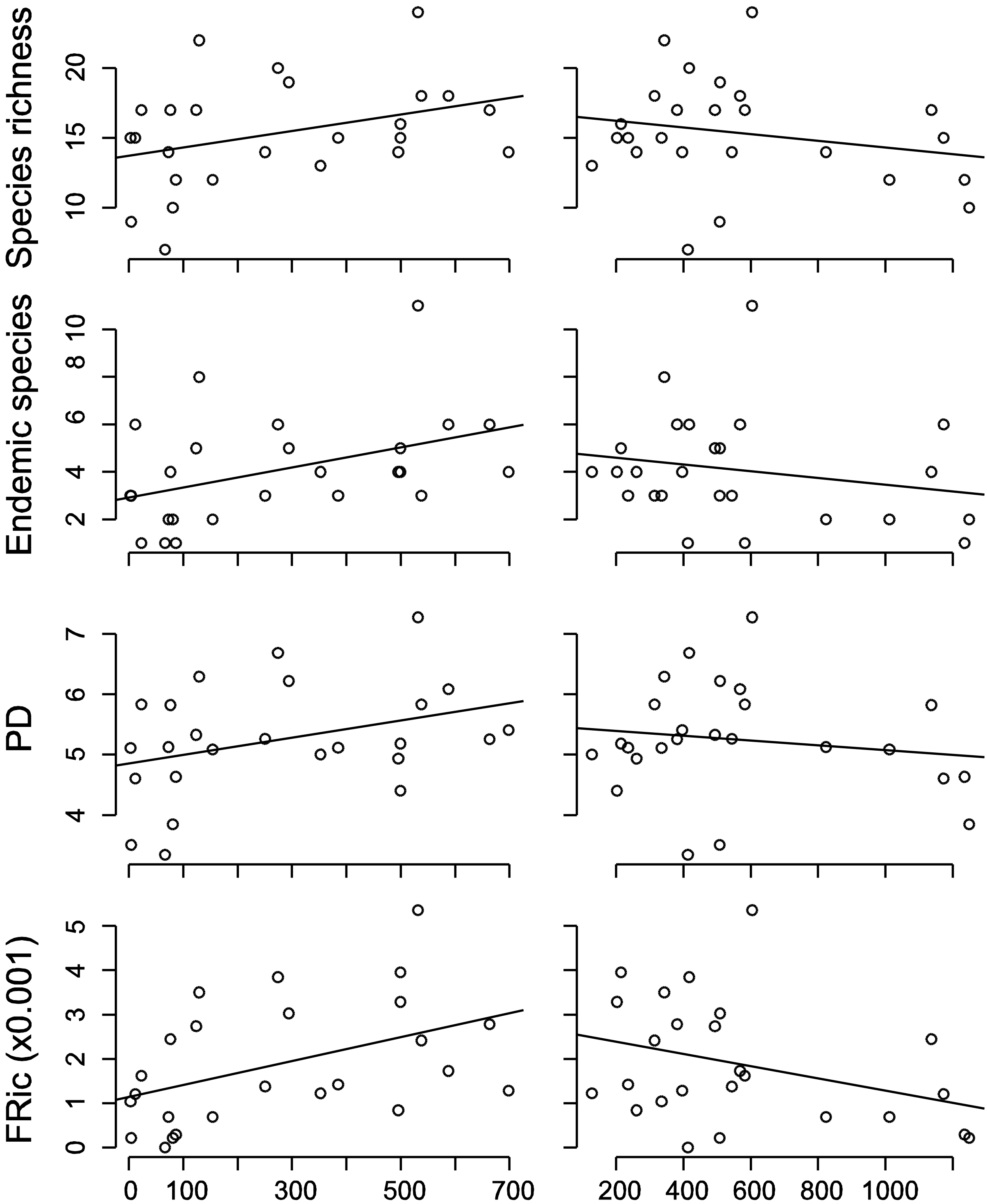
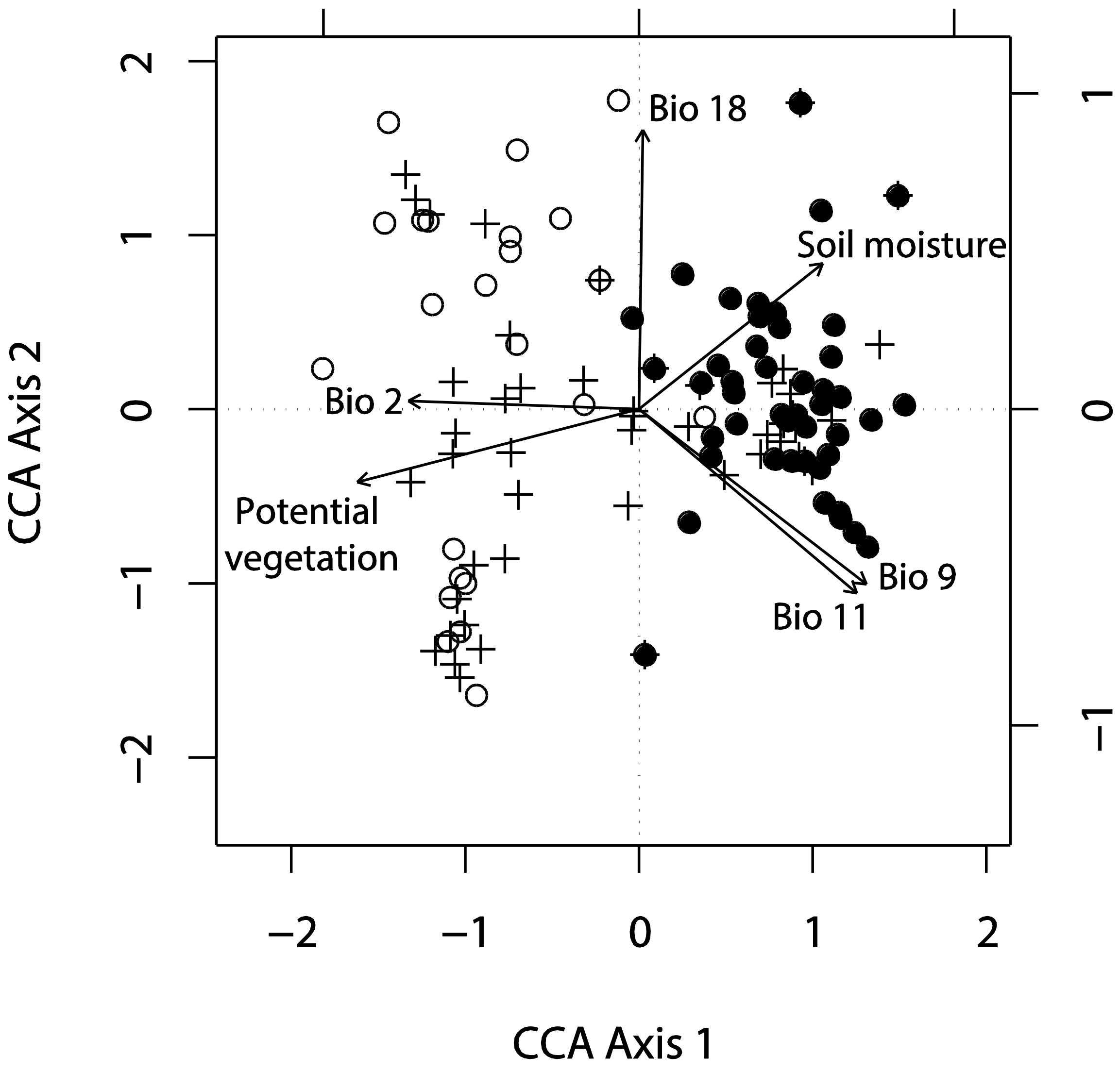

Chatogekko amazonicus
Gonatodes alexandermendesi
Gonatodes annularis
Gonatodes hasemani
Gonatodes humeralis
Gonatodes eladioi
Lepidoblepharis heyerorum
Coleodactylus brachystoma
Coleodactylus meridionalis
Pseudogonatodes guianensis
Gymnodactylus amarali
Gymnodactylus geckoides
Phyllopezus pollicaris
Thecadactylus rapicauda
Thecadactylus solimoensis
Hemidactylus brasilianus
Hemidactylus palaichthus
Hemidactylus mabouia
Lygodactylus klugei
Mabuya sp.
Mabuya nigropunctata
Mabuya dorsivittata
Mabuya bistriata
Mabuya frenata
Mabuya guaporicola
Mabuya agilis
Mabuya heathi
Crocodilurus amazonicus
Dracaena guianensis
Tupinambis teguixin
Tupinambis quadrilineatus
Tupinambis duseni
Tupinambis merianae
Ameiva ameiva
Ameiva parecis
Cnemidophorus jalapensis
Cnemidophorus mumbuca
Cnemidophorus ocellifer
Kentropyx altamazonica
Kentropyx pelviceps
Kentropyx striata
Kentropyx paulensis
Kentropyx sp.
Kentropyx vanzoi
Kentropyx calcarata
Cnemidophorus cryptus
Cnemidophorus gramivagus
Cnemidophorus lemniscatus
Ptychoglossus brevifrontalis
Alopoglossus atriventris
Alopoglossus angulatus
Alopoglossus buckleyi
Bachia cacerensis
Bachia flavescens
Bachia oxyrhina
Bachia psamophila
Bachia bresslaui
Bachia dorbignyi
Bachia peruana
Bachia scolecoides
Colobosaura modesta
Iphisa elegans
Tretioscincus agilis
Tretioscincus oriximinensis
Micrablepharus atticolus
Micrablepharus maximiliani
Vanzosaura rubricauda
Gymnophthalmus speciosus
Gymnophthalmus underwoodi
Arthrosaura kockii
Arthrosaura reticulata
Leposoma guianense
Leposoma osvaldoi
Leposoma percarinatum
Leposoma sp.
Neusticurus bicarinatus
Neusticurus rudis
Potamites ecpleopus
Cercosaura sp.
Cercosaura argulus
Cercosaura ocellata
Cercosaura eigenmanni
Cercosaura schreibersii
Ophiodes striatus
Stenocercus caducus
Stenocercus quinarius
Stenocercus sinesaccus
Stenocercus roseiventris
Stenocercus fimbriatus
Uranoscodon superciliosus
Uracentron azureum
Uracentron flaviceps
Plica plica
Plica umbra
Tropidurus callathelys
Tropidurus guarani
Tropidurus chromatops
Tropidurus sp.
Tropidurus itambere
Tropidurus insulanus
Tropidurus oreadicus
Tropidurus hispidus
Tropidurus torquatus
Iguana iguana
Polychrus acutirostris
Polychrus marmoratus
Enyalioides laticeps
Enyalioides palpebralis
Hoplocercus spinosus
Enyalius sp.
Enyalius leechii
Anolis auratus
Anolis meridionalis
Anolis brasiliensis
Anolis planiceps
Anolis chrysolepis
Anolis tandai
Anolis fuscoauratus
Anolis trachyderma
Anolis ortonii
Anolis philopunctatus
Anolis punctatus
Anolis transversalis
0.2


Species richness
10
15
20
25
Endemic species
0
5
10
15
20
PD
4
5
6
7
8
9
FRic (x0.001)
0
1
2
3
4
5
6
0
500
1000
1500
Distance to ecotone (km)
0
500
1000
1500
Distance to centroid (km)


Species richness
Endemic species
PD
FRic (x0.001)
10
15
20
2
4
6
8
10
4
5
6
7
0
1
2
3
4
5
0
100
300
500
700
200
400
600
800
1000
Distance to ecotone (km)
Distance to centroid (km)


Bio 18
Soil moisture
Bio 2
Potential vegetation
Bio 9
Bio 11
CCA Axis 1
CCA Axis 2
−2
−1
0
1
2
−1
0
1

Appendix 1

Table A1. Incidence matrix of lizard species recorded in 46 sites from the Amazon and Cerrado biomes. 1: *Alopoglossus angulatus*; 2: *Al. atriventris*; 3: *Al. buckleyi*; 4: *Ameiva ameiva*; 5: *Am. parecis*; 6: *Anolis auratus*; 7: *An. brasiliensis*; 8: *An. chrysolepis*; 9: *An. fuscoauratus*; 10: *An. meridionalis*; 11: *An. ortonii*; 12: *An. philopunctatus*; 13: *An. planiceps*; 14: *An. punctatus*; 15: *An. tandai*; 16: *An. trachyderma*; 17: *An. transversalis*; 18: *Arthrosaura kockii;* 19: *Ar. reticulata*; 20*: Bachia bresslaui*; 21: *B. cacerensis*; 22: *B. dorbignyi*; 23: *B. flavescens*; 24: *B. oxyrhina*; 25: *B. peruana*; 26: *B. psamophila*; 27: *B. scolecoides*; 28: *Cercosaura argulus*; 29: *Cercosaura eigenmanni*; 30: *Ce. ocellata*; 31: *Ce. schreibersii*; 32: *Cercosaura* sp.; 33: *Chatogekko amazonicus*; 34: *Cnemidophorus cryptus*; 35: *Cn. gramivagus*; 36: *Cn. jalapensis*; 37: *Cn. lemniscatus*; 38: *Cn. mumbuca*; 39: *Cn. ocellifer*; 40: *Coleodactylus brachystoma*; 41: *Coleodactylus meridionalis*; 42: *Colobosaura modesta*; 43: *Crocodilurus amazonicus*; 44: *Dracaena guianensis*; 45: *Enyalioides laticeps*; 46: *E. palpebralis*; 47: *Enyalius leechii*; 48: *Enyalius* sp.; 49: *Gonatodes alexandermendesi*; 50: *Go. annularis*; 51: *Go. eladioi*; 52: *Go. hasemani*; 53: *Go. humeralis*; 54: *Gymnodactylus amarali*; 55: *Gd. geckoides*; 56: *Gymnophthalmus speciosus*; 57: *Gp. underwoodi*; 58: *Hemidactylus brasilianus*; 59: *He. mabouia*; 60: *He. palaichthus*; 61: *Hoplocercus spinosus*; 62: *Iguana iguana*; 63: *Iphisa elegans*; 64: *Kentropyx altamazonica*; 65: *K. calcarata*; 66: *K. paulensis*; 67: *K. pelviceps*; 68: *Kentropyx* sp n; 69: *K. striata*; 70: *K. vanzoi*; 71: *Lepidoblepharis heyerorum*; 72: *Leposoma guianense*; 73: *Lo. osvaldoi*; 74: *Lo. percarinatum*; 75: *Leposoma* sp n; 76: *Lygodactylus klugei*; 77: *Mabuya agilis*; 78: *Ma. bistriata*; 79: *Ma. dorsivittata*; 80: *Ma. frenata*; 81: *Ma. guaporicola*; 82: *Ma. heathi*; 83: *Ma. nigropunctata*; 84: *Mabuya* sp.; 85: *Micrablepharus atticolus*; 86: *Mi. maximiliani*; 87: *Neusticurus bicarinatus*; 88: *N. rudis*; 89: *Ophiodes striatus*; 90: *Phyllopezus pollicaris*; 91: *Plica plica*; 92: *Pl. umbra*; 93: *Polychrus acutirostris*; 94: *Py.*

marmoratus; 95: *Potamites ecpleopus*; 96: *Pseudogonatodes guianensis*; 97: *Ptychoglossus brevifrontalis*; 98: *Stenocercus caducus*; 99: *S. fimbriatus*; 100: *S. quinarius*; 101: *S. roseiventris*; 102: *S. sinesaccus*; 103: *Thecadactylus rapicauda*; 104: *Th. solimoensis*; 105: *Tretioscincus agilis*; 106: *Te. oriximinensis*; 107: *Tropidurus callathelys*; 108: *Tr. chromatops*; 109: *Tr. guarani*; 110: *Tr. hispidus*; 111: *Tr. insulanus*; 112: *Tr. itambere*; 113: *Tr. oreadicus*; 114: *Tropidurus* sp.; 115: *Tr. torquatus*; 116: *Tupinambis duseni*; 117: *Tu merianae*; 118: *Tu quadrilineatus*; 119: *Tu teguixin*; 120: *Uracentron azureum*; 121: *Uc. flaviceps*; 122: *Uranoscodon superciliosus*; 123: *Vanzosaura rubricauda*.

Community	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9	sp10	sp11	sp12	sp13	sp14	sp15	sp16	sp17	sp18	sp19	sp20	sp21
Almas	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Almeirim	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Alta Floresta	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Amapá	0	0	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0
Aporé	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Barcarena	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
Berbice	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
Brasília 1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Brasília 2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Cacoal	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0
Carolina	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caseara	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caxiuanã	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0
Cerejeiras	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cocos	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Cruzeiro do Sul	0	0	1	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	0
Dubulay	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emas	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Espigão do Oeste	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	0
Guajará-Mirim	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0
Humaitá	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Juara	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juruti	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0
Konawaruk	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Marabá	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Mateiros 1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mateiros 2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Community	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9	sp10	sp11	sp12	sp13	sp14	sp15	sp16	sp17	sp18	sp19	sp20	sp21
Minaçú	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Monte Alegre	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nova Xavantina	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Novo Progresso	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0
Palmas	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Paracatu	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Paranã	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pimenta Bueno	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Purus	1	1	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0
Querência	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribeirão Cascalheira	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Rio Preto da Eva	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0	0	1	0	0
Santa Terezinha	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Santarém	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
São Domingos	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silvânia	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trairão	1	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0
Vila Bela	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vilhena	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Community	sp22	sp23	sp24	sp25	sp26	sp27	sp28	sp29	sp30	sp31	sp32	sp33	sp34	sp35	sp36	sp37	sp38	sp39	sp40	sp41
Almas	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0
Almeirim	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
Alta Floresta	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Amapá	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Aporé	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
Barcarena	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Berbice	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brasília 1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
Brasília 2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Cacoal	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Carolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Caseara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Caxiuanã	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Cerejeiras	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Cocos	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Cruzeiro do Sul	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Dubulay	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Emas	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
Espigão do Oeste	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Guajará-Mirim	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Humaitá	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0
Juara	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Juruti	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Konawaruk	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marabá	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Mateiros 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mateiros 2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0

Community	sp22	sp23	sp24	sp25	sp26	sp27	sp28	sp29	sp30	sp31	sp32	sp33	sp34	sp35	sp36	sp37	sp38	sp39	sp40	sp41
Minaçú	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
Monte Alegre	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nova Xavantina	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
Novo Progresso	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Palmas	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Paracatu	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
Paranã	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Pimenta Bueno	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Purus	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Querência	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ribeirão Cascalheira	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0
Rio Preto da Eva	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Santa Terezinha	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Santarém	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
São Domingos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Silvânia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Trairão	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Vila Bela	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Vilhena	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0

Community	sp42	sp43	sp44	sp45	sp46	sp47	sp48	sp49	sp50	sp51	sp52	sp53	sp54	sp55	sp56	sp57	sp58	sp59	sp60	sp61
Almas	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1
Almeirim	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Alta Floresta	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
Amapá	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Aporé	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Barcarena	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Berbice	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Brasília 1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Brasília 2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cacoal	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0
Carolina	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Caseara	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0
Caxiuanã	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cerejeiras	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cocos	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cruzeiro do Sul	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0
Dubulay	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	0
Emas	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Espigão do Oeste	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	0
Guajará-Mirim	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Humaitá	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Juara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Juruti	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Konawaruk	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Marabá	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Mateiros 1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Mateiros 2	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
Minaçú	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Community	sp42	sp43	sp44	sp45	sp46	sp47	sp48	sp49	sp50	sp51	sp52	sp53	sp54	sp55	sp56	sp57	sp58	sp59	sp60	sp61
Monte Alegre	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
Nova Xavantina	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Novo Progresso	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0
Palmas	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Paracatu	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Paranã	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pimenta Bueno	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purus	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Querência	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ribeirão Cascalheira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rio Preto da Eva	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Santa Terezinha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Santarém	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
São Domingos	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Silvânia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trairão	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Vila Bela	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
Vilhena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Community	sp62	sp63	sp64	sp65	sp66	sp67	sp68	sp69	sp70	sp71	sp72	sp73	sp74	sp75	sp76	sp77	sp78	sp79	sp80	sp81
Almas	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Almeirim	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Alta Floresta	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Amapá	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0
Aporé	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Barcarena	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Berbice	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Brasília 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Brasília 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Cacoal	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carolina	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caseara	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Caxiuanã	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Cerejeiras	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Cocos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruzeiro do Sul	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dubulay	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Emas	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Espigão do Oeste	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Guajará-Mirim	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Humaitá	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Juara	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Juruti	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Konawaruk	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Marabá	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mateiros 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mateiros 2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Minaçú	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Community	sp62	sp63	sp64	sp65	sp66	sp67	sp68	sp69	sp70	sp71	sp72	sp73	sp74	sp75	sp76	sp77	sp78	sp79	sp80	sp81
Monte Alegre	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nova Xavantina	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Novo Progresso	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Palmas	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Paracatu	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Paranã	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pimenta Bueno	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purus	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0
Querência	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Ribeirão Cascalheira	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Rio Preto da Eva	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Santa Terezinha	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Santarém	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
São Domingos	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Silvânia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Trairão	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Vila Bela	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Vilhena	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0

Community	sp82	sp83	sp84	sp85	sp86	sp87	sp88	sp89	sp90	sp91	sp92	sp93	sp94	sp95	sp96	sp97	sp98	sp99	sp100
Almas	1	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Almeirim	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Alta Floresta	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Amapá	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Aporé	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Barcarena	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Berbice	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Brasília 1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Brasília 2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Cacoal	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Carolina	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caseara	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Caxiuanã	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Cerejeiras	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cocos	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Cruzeiro do Sul	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	0
Dubulay	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
Emas	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Espigão do Oeste	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Guajará-Mirim	0	1	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0
Humaitá	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Juara	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juruti	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0
Konawaruk	0	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0
Marabá	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mateiros 1	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mateiros 2	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Minaçú	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Community	sp82	sp83	sp84	sp85	sp86	sp87	sp88	sp89	sp90	sp91	sp92	sp93	sp94	sp95	sp96	sp97	sp98	sp99	sp100
Monte Alegre	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nova Xavantina	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Novo Progresso	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Palmas	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracatu	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Paranã	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pimenta Bueno	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purus	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Querência	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribeirão Cascalheira	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Rio Preto da Eva	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0
Santa Terezinha	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Santarém	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
São Domingos	0	1	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Silvânia	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Trairão	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0
Vila Bela	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Vilhena	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Community	sp101	sp102	sp103	sp104	sp105	sp106	sp107	sp108	sp109	sp110	sp111	sp112	sp113	sp114	sp115	sp116
Almas	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Almeirim	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Alta Floresta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amapá	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Aporé	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Barcarena	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Berbice	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Brasília 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Brasília 2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Cacoal	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Carolina	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Caseara	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Caxiuanã	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cerejeiras	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cocos	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
Cruzeiro do Sul	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Dubulay	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Emas	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Espigão do Oeste	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Guajará-Mirim	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Humaitá	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Juara	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Juruti	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Konawaruk	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Marabá	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mateiros 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mateiros 2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Minaçú	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Community	sp101	sp102	sp103	sp104	sp105	sp106	sp107	sp108	sp109	sp110	sp111	sp112	sp113	sp114	sp115	sp116
Monte Alegre	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Nova Xavantina	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Novo Progresso	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Palmas	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Paracatu	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Paranã	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Pimenta Bueno	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Querência	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Ribeirão Cascalheira	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Rio Preto da Eva	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Santa Terezinha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Santarém	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
São Domingos	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Silvânia	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Trairão	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vila Bela	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Vilhena	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Community	sp117	sp118	sp119	sp120	sp121	sp122	sp123
Almas	0	0	0	0	0	0	0
Almeirim	0	0	0	0	0	0	0
Alta Floresta	0	0	1	0	0	1	0
Amapá	0	0	1	0	0	1	0
Aporé	1	0	0	0	0	0	0
Barcarena	0	0	0	0	0	1	0
Berbice	0	0	0	0	0	1	0
Brasília 1	0	0	0	0	0	0	0
Brasília 2	0	0	0	0	0	0	0
Cacoal	0	0	0	0	0	0	0
Carolina	1	0	1	0	0	0	0
Caseara	0	0	1	0	0	0	0
Caxiuanã	0	0	0	0	0	0	0
Cerejeiras	1	0	1	0	0	0	0
Cocos	0	0	0	0	0	0	1
Cruzeiro do Sul	0	0	1	0	0	0	0
Dubulay	0	0	1	0	0	1	0
Emas	1	0	0	0	0	0	1
Espigão do Oeste	0	0	1	0	0	1	0
Guajará-Mirim	0	0	0	0	1	0	0
Humaitá	1	0	0	0	0	1	0
Juara	0	0	0	0	0	1	0
Juruti	0	0	0	1	0	1	0
Konawaruk	0	0	1	0	0	1	0
Marabá	0	0	0	0	0	1	0
Mateiros 1	0	1	0	0	0	0	1
Mateiros 2	1	1	0	0	0	0	1
Minaçú	0	0	0	0	0	0	0

Community	sp117	sp118	sp119	sp120	sp121	sp122	sp123
Monte Alegre	0	0	1	0	0	0	0
Nova Xavantina	1	1	0	0	0	0	0
Novo Progresso	0	0	1	0	0	0	0
Palmas	1	1	0	0	0	0	0
Paracatu	0	0	0	0	0	0	0
Paranã	0	1	1	0	0	0	0
Pimenta Bueno	1	0	0	0	0	0	0
Purus	0	0	1	1	0	1	0
Querência	0	0	0	0	0	0	0
Ribeirão Cascalheira	1	0	1	0	0	0	0
Rio Preto da Eva	0	0	1	0	0	0	0
Santa Terezinha	0	0	1	0	0	0	0
Santarém	0	0	0	0	0	0	0
São Domingos	1	1	0	0	0	0	0
Silvânia	1	0	0	0	0	0	0
Trairão	0	0	1	0	0	1	0
Vila Bela	1	0	1	0	0	0	0
Vilhena	1	0	0	0	0	0	0

Appendix 2

Table A2. Functional attributes matrix for each species. The species numbers follow the coding in Table A1. Max_size: maximum size reached; Dimorp_fem: females larger than males (1 and 0); Dimorp_mal: males larger than females (1 and 0); Dimorp_no: no dimorphism (1 and 0); Habitat_for: forest habitat; Habita_open: open habitat; Microhab_arb: arboreal microhabitat use; Microhab_semiarb: semi-arboreal microhabitat use; Microhab_semiaqu: semi-aquatic microhabitat use; Microhab_fos: fossorial microhabitat use; Microhab_lit: leaf litter microhabitat use; Microhab_terr: terrestrial microhabitat use; Microhab_saxi: saxicolus microhabitat use; Diet_carn: carnicore diet; Diet_herb: herbivore diet; Forag_act: active foraging; Forag_sw: sit-and-wait foraging; Forag_mix: mixed foraging; Activ_diur: diurnal activity; Activ_noc: nocturnal activity; Repr_ovi: oviparous reproduction; Repr_vivi: viviparous reproduction; Max_clutch: maximum clutch size; Temp: mean activity temperature; Regtemp_helio: thermoregulator; Regtemp_conf: thermoconformer. NA: no data.

Functional Trait	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9	sp10	sp11	sp12	sp13	sp14	sp15	sp16	sp17	sp18	sp19	sp20
Max_size	64	53	62	180	90	57	69	74	52	59	57	75	76	90	74	61	88	54	71	106
Dimorp_fem	0	0	0	0	0	1	0	NA	1	0	0	NA	NA	0	0	1	0	0	0	NA
Dimorp_mal	0	0	1	1	0	0	0	NA	0	0	1	NA	NA	1	0	0	0	0	0	NA
Dimorp_no	1	1	0	0	1	0	1	NA	0	1	0	NA	NA	0	1	0	1	1	1	NA
Habitat_for	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0
Habita_open	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1
Microhab_arb	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Microhab_semiarb	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	1	0	0	0	0
Microhab_semiaqu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_fos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Microhab_lit	1	1	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	1	0
Microhab_terr	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0
Microhab_saxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diet_carn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Forag_sw	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Forag_mix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activ_diur	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Activ_noc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repr_ovi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Repr_vivi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max_clutch	NA	NA	NA	11	2	2	NA	2	2	2	2	NA	NA	2	NA	2	2	2	2	NA
Temp	26	26	NA	38	38	31	31	NA	29	NA	NA	NA	NA	29.2	27.7	27.8	29.8	NA	NA	NA
Regtemp_helio	0	0	0	1	1	0	0	NA	0	NA	0	0	NA	0	0	0	0	1	0	0
Regtemp_conf	1	1	1	0	0	1	1	NA	1	NA	1	1	NA	1	1	1	1	0	1	1

Functional Trait	sp21	sp22	sp23	sp24	sp25	sp26	sp27	sp28	sp29	sp30	sp31	sp32	sp33	sp34	sp35	sp36	sp37	sp38	sp39	sp40
Max_size	82	80	80	80	107	74	78	47	47	65	43	NA	25	72	76	56	78	59	117	25
Dimorp_fem	NA	NA	1	NA	NA	NA	NA	1	1	0	1	NA	NA	0	1	0	0	0	0	NA
Dimorp_mal	NA	NA	0	NA	NA	NA	NA	0	0	0	0	NA	NA	0	0	0	1	0	1	NA
Dimorp_no	NA	NA	0	NA	NA	NA	NA	0	0	1	0	NA	NA	1	0	1	0	1	0	NA
Habitat_for	1	1	1	0	1	0	1	1	1	1	0	NA	1	1	0	0	0	0	1	1
Habita_open	0	0	0	1	0	1	0	0	0	1	1	NA	0	1	1	1	1	1	1	1
Microhab_arb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_semiarb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_semiaqu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_fos	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_lit	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	1
Microhab_terr	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	1
Microhab_saxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diet_carn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
Forag_sw	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Forag_mix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activ_diur	NA	NA	0	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	1	1
Activ_noc	NA	NA	1	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	1
Repr_ovi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Repr_vivi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max_clutch	NA	NA	1	NA	NA	NA	NA	2	NA	NA	2	NA	1	3	3	1	4	1	4	1
Temp	NA	NA	NA	NA	NA	NA	NA	NA	27.2	NA	NA	NA	NA	39.4	37.7	37	38	36.9	37.5	NA
Regtemp_helio	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	1	0
Regtemp_conf	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1

Functional Trait	sp41	sp42	sp43	sp44	sp45	sp46	sp47	sp48	sp49	sp50	sp51	sp52	sp53	sp54	sp55	sp56	sp57	sp58	sp59	sp60
Max_size	25	55	250	360	157	117	115	NA	50	55	34	46	42	54	48	39	40	64	68	71
Dimorp_fem	NA	0	0	NA	0	0	1	NA	NA	NA	NA	1	0	1	1	NA	NA	NA	0	NA
Dimorp_mal	NA	1	0	NA	1	0	0	NA	NA	NA	NA	0	1	0	0	NA	NA	NA	0	NA
Dimorp_no	NA	0	1	NA	0	1	0	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	1	NA
Habitat_for	1	1	1	1	1	1	1	NA	1	1	1	1	1	0	0	NA	0	0	1	1
Habita_open	0	1	0	0	0	0	0	NA	0	0	0	0	0	1	1	NA	1	1	1	1
Microhab_arb	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Microhab_semiarb	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1
Microhab_semiaqu	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_fos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_lit	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Microhab_terr	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0
Microhab_saxi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Diet_carn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Forag_sw	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
Forag_mix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activ_diur	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	NA	NA	0	0	0
Activ_noc	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	NA	NA	1	1	1
Repr_ovi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Repr_vivi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max_clutch	1	NA	6	6	7	4	14	NA	2	NA	NA	1	1	2	2	NA	NA	NA	2	NA
Temp	NA	NA	31.2	32.2	NA	NA	NA	NA	NA	NA	NA	30.6	30.3	30.2	NA	NA	NA	NA	27.2	NA
Regtemp_helio	0	NA	1	1	NA	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
Regtemp_conf	1	NA	0	0	NA	NA	NA	NA	NA	NA	1	1	1	1	NA	NA	NA	NA	1	1

Functional Trait	sp61	sp62	sp63	sp64	sp65	sp66	sp67	sp68	sp69	sp70	sp71	sp72	sp73	sp74	sp75	sp76	sp77	sp78	sp79	sp80
Max_size	105	445	62	114	119	73	130	NA	127	65	35	39	37	37	NA	34	96	109	84	91
Dimorp_fem	NA	0	NA	0	0	NA	0	NA	0	0	0	NA	NA	NA	NA	1	1	1	1	1
Dimorp_mal	NA	1	NA	1	1	NA	1	NA	1	1	0	NA	NA	NA	NA	0	0	0	0	0
Dimorp_no	NA	0	NA	0	0	NA	0	NA	0	0	1	NA	NA	NA	NA	0	0	0	0	0
Habitat_for	0	1	1	1	1	1	1	NA	0	0	1	1	1	1	NA	0	0	1	1	0
Habita_open	1	1	0	0	0	1	0	NA	1	1	0	0	0	0	NA	1	1	0	1	1
Microhab_arb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Microhab_semiarb	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Microhab_semiaqu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_fos	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_lit	0	0	1	1	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	1
Microhab_terr	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0
Microhab_saxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Diet_carn	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	0
Forag_sw	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Forag_mix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Activ_diur	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Activ_noc	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Repr_ovi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Repr_vivi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Max_clutch	NA	71	2	9	10	6	7	NA	12	6	1	2	NA	2	NA	2	9	9	9	8
Temp	NA	38	28.2	35.9	36.5	NA	34.1	NA	37	NA	NA	NA	NA	NA	NA	NA	33.1	32.9	29.1	33.4
Regtemp_helio	0	1	NA	1	1	1	1	1	1	1	NA	0	0	0	NA	NA	1	1	1	1
Regtemp_conf	1	0	NA	0	0	0	0	0	0	0	NA	1	1	1	NA	NA	0	0	0	0

Functional Trait	sp81	sp82	sp83	sp84	sp85	sp86	sp87	sp88	sp89	sp90	sp91	sp92	sp93	sp94	sp95	sp96	sp97	sp98	sp99	sp100
Max_size	98	88	109	NA	43	41	109	94	300	78	177	97	146	147	84	30	64	93	91	90
Dimorp_fem	1	1	1	NA	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	1
Dimorp_mal	0	0	0	NA	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0
Dimorp_no	0	0	0	NA	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0
Habitat_for	1	0	1	NA	0	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0
Habita_open	1	1	1	NA	1	1	0	0	1	1	0	0	1	0	0	0	0	1	0	1
Microhab_arb	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Microhab_semiarb	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Microhab_semiaqu	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Microhab_fos	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Microhab_lit	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Microhab_terr	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Microhab_saxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diet_carn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0	0
Forag_sw	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	1	1	1
Forag_mix	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activ_diur	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Activ_noc	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Repr_ovi	0	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
Repr_vivi	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Max_clutch	NA	9	9	NA	2	2	2	2	13	3	5	2	31	12	2	1	2	4	NA	NA
Temp	35.1	NA	32.6	NA	34.6	29.1	NA	NA	NA	28.5	30.5	29.1	NA	NA	27	NA	NA	NA	NA	NA
Regtemp_helio	1	1	1	1	1	1	1	1	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	1
Regtemp_conf	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	0	0	0

Functional Trait	sp101	sp102	sp103	sp104	sp105	sp106	sp107	sp108	sp109	sp110	sp111	sp112	sp113	sp114	sp115	sp116
Max_size	99	81	115	126	62	52	90	109	125	130	86	90	97	NA	129	410
Dimorp_fem	0	1	0	0	0	0	0	0	0	0	0	0	0	NA	0	NA
Dimorp_mal	0	0	0	0	0	0	1	1	1	1	1	1	1	NA	1	NA
Dimorp_no	1	0	1	1	1	1	0	0	0	0	0	0	0	NA	0	NA
Habitat_for	1	0	1	1	1	1	0	0	0	0	0	0	0	NA	1	0
Habita_open	1	1	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
Microhab_arb	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_semiarb	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Microhab_semiaqu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_fos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_lit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microhab_terr	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Microhab_saxi	0	0	0	0	0	0	1	1	1	1	0	1	1	0	1	0
Diet_carn	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forag_act	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
Forag_sw	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0
Forag_mix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activ_diur	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Activ_noc	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Repr_ovi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Repr_vivi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max_clutch	NA	NA	1	1	NA	NA	NA	5	NA	8	NA	8	5	NA	14	NA
Temp	NA	NA	27.1	26.4	NA	NA	NA	NA	29.4	34.1	NA	33.07	35.8	NA	31.2	NA
Regtemp_helio	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Regtemp_conf	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Functional Trait	sp117	sp118	sp119	sp120	sp121	sp122	sp123
Max_size	488	254	345	87	130	166	38
Dimorp_fem	0	NA	0	0	0	0	1
Dimorp_mal	1	NA	1	0	1	0	0
Dimorp_no	0	NA	0	1	0	1	0
Habitat_for	1	1	1	1	1	1	0
Habita_open	1	0	1	0	0	0	1
Microhab_arb	0	0	0	1	1	1	0
Microhab_semiarb	0	0	0	0	0	0	0
Microhab_semiaqu	0	0	0	0	0	0	0
Microhab_fos	0	0	0	0	0	0	0
Microhab_lit	0	0	0	0	0	0	1
Microhab_terr	1	1	1	0	0	0	1
Microhab_saxi	0	0	0	0	0	0	0
Diet_carn	1	1	1	1	1	1	1
Diet_herb	0	0	0	0	0	0	0
Forag_act	1	1	1	0	0	0	1
Forag_sw	0	0	0	1	1	1	0
Forag_mix	0	0	0	0	0	0	0
Activ_diur	1	1	1	1	1	1	1
Activ_noc	0	0	0	0	0	0	0
Repr_ovi	1	1	1	1	1	1	1
Repr_vivi	0	0	0	0	0	0	0
Max_clutch	NA	NA	49	2	2	8	2
Temp	NA	37.2	35	NA	31.2	NA	NA
Regtemp_helio	1	1	1	NA	NA	NA	1
Regtemp_conf	0	0	0	NA	NA	NA	0