GUILHERME WAGNER GUTIERREZ ATENCIO

RELAÇÕES ECOLÓGICAS ENTRE *Euryades corethrus* BOISDUVAL E *Euryades. duponchelii* LUCAS (LEPIDOPTERA : TROIDINI) AVALIADAS ATRAVÉS DE MODELAGEM PREDITIVA DE DISTRIBUIÇÃO DE ESPÉCIES E INTERAÇÕES COM SUAS PLANTAS HOSPEDEIRAS E BIOGEOGRAFIA

Dissertação apresentada ao Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências da Universidade Federal do Rio Grande do Sul, como requisito parcial à obtenção do título de Mestre em Biologia Animal.

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Aprovada em _____ de _____ de 2014.

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"From this distant vantage point, the Earth might not seem of any particular interest. But for us, it's different. Consider again that dot. That's here. That's home. That's us. On it, everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there – on a mote of dust suspended in a sunbeam."

Carl Sagan - Pale blue dot

AGRADECIMENTOS

John Donne já disse que nenhum homem (ou mulher) é uma ilha, e isso é especialmente verdade quando embarcamos em uma empreitada deste tipo. Se esqueci de mencionar alguém, antecipadamente peço desculpas. Dois anos passam voando, e o que parece que vai demorar em passar acaba se tornando um tempo que passa muito rápido. Eu não conseguiria chegar até aqui sem a ajuda de muita gente, dentro e fora do laboratório. Agradeço ao meu pai, que do jeito atravessado dele sempre me incentivou e ajudou quando precisei. Agradeço à Rebeca, que entende como é a vida acadêmica e como é a vida de biólogo, e ao meu filho, que se entusiasma com a os "bichinhos do papai" e me dá ainda mais vontade de ser professor. Não poderia deixar de agradecer o pessoal do Laboratório (Andressa, Lú, Lidi, as Vanessas, Melissa, Ricardo, Lika, Maria Ostília) e especialmente à Professora Helena, que me colocou em contato com o Professor Nicolás, meu orientador, puxador de orelha, parceiro de discussões gastronômicas e acima de tudo incentivador. Agradeço também aos Professores do Laboratório de Geoprocessamento do Centro de Ecologia (Professores Heinrich Hasenack e Eliseu José Weber), que me deram uma ajuda inestimável no processamento dos dados e ao Professor Francisco Barreto pela ajuda estatística e pelas conversas "nerdísticas".

SUMÁRIO

RESUMO

Euryades corethrus e *Euryades duponchelii* são duas espécies de borboletas classificadas na família Papilionidae, que se distribuem nas províncias biogeográficas do Chaco e Pampa ao longo da Argentina, Uruguai, Paraguai e sul do Brasil. Os registros de ocorrência, obtidos através de levantamento em coleções entomológicas e inventariamentos de fauna presentes na literatura, sugerem que não há grande sobreposição ecológica entre estas espécies, apesar delas utilizarem as mesmas plantas como hospedeiras (*Aristolochia sessilifolia, Aristolochia fimbriata, Aristolochia lingua, Aristolochia angustifolia e Aristolochia labiata).* De acordo com os registros obtidos, as populações de ambas as espécies apresentam distribuições que sugerem uma especiação por alopatria. Contudo, como não existem barreiras geográficas à dispersão das espécies, os motivos de tal separação espacial entre as populações não são conhecidos. O objetivo deste trabalho é estudar os fatores ecológicos que possam estar relacionados às distribuições geográficas das duas espécies de *Euryades*. Inicialmente foi feita uma modelagem preditiva de distribuição (MPD) para as duas espécies de borboletas, utilizando para tanto as ocorrências registradas em coleções e publicações científicas. A seguir, o mesmo procedimento foi aplicado às plantas hospedeiras, a fim de relacionar a área de distribuição das borboletas com o recurso alimentar dos imaturos. A análise da sobreposição entre estas MPDs não demonstrou relação entre a ocorrência da borboleta com uma espécie particular de *Aristolochia*. Entre as espécies de *Euryades* foi verificada sobreposição de ocorrência, o que sugere requerimentos ecológicos similares, hipótese corroborada pela análise de NMDS (Nonmetric Multidimensional Scaling). A análise Panbiogeográfica suporta a hipótese de que um processo biogeográfico histórico possa ter causado a separação de uma espécie ancestral nas duas atuais. Possivelmente tenha ocorrido uma especiação por alopatria, o que levou as duas populações separadas a evoluírem adaptações específicas às condições microecológicas as quais foram submetidas.

CAPÍTULO 1

INTRODUÇÃO

A família Papilionidae

A família Papilionidae consiste de cerca de 550 espécies de borboletas, a maioria delas grandes e coloridas, sendo facilmente identificadas até por leigos. São geralmente reconhecidas pelos prolongamentos semelhantes a caudas que estão presentes nas asas posteriores de muitas espécies (CLARKE e SHEPPARD 1960), de onde surge o nome popular borboletas-rabo-de-andorinha (do inglês "swallowtail butterflies"). Com exceção da Antártica, todos os continentes possuem representantes da família, sendo que a maior riqueza de espécies está presente em latitudes tropicais (COLLINS e MORRIS 1985). Jablonski (2006) sugere que os trópicos seriam tanto um berço como um museu de papilionídeos, com as espécies originando-se nos trópicos e depois expandindo sua distribuição, corroborando a teoria de que ali estariam os centros de distribuição.

Diferentes famílias de plantas hospedeiras são utilizadas pelas larvas, mas Aristolochiaceae, Annonaceae, Lauraceae, Apiaceae e Rutaceae são as mais frequentes. Muitas dessas plantas hospedeiras produzem compostos secundários que são sequestrados pelas larvas, tornando, tanto as formas imaturas, como adultas, impalatáveis (von EUW *et al.* 1968). Geralmente as espécies impalatáveis apresentam coloração aposemática, sinalizando que possuem acúmulo de substâncias tóxicas (*e.g.* larvas do gênero *Battus*, imagos de *Parides agavus*). Algumas espécies não-impalatáveis desenvolveram sistemas de defesa baseados em mimetismo Batesiano, imitando modelos impalatáveis (*e.g. Mimoides protodamas* f. *chloridamas*, mimética de *Heliconius sara*) (Tyler *et al.* 1994).

Três características morfológicas são consideradas sinapomorfias da família Papilionidae, distinguindo-as das outras famílias de borboletas: o osmetério, uma estrutura eversível em forma de Y, localizada atrás da cabeça, que secreta compostos de defesa; a morfologia da veia A2 da asa anterior, que chega até a borda da asa ao invés de se fundir à veia A1 como em todas as outras famílias; e a presença de escleritos cervicais fusionados, localizados abaixo da cabeça do imago (MILLER 1987).

A tribo Troidini

A família Papilionidae divide-se em três subfamílias: Baroniinae, Parnassinae e Papilioninae. A subfamília Papilioninae subdivide-se em quatro tribos: Leptocircini, Papilionini, Teinopalpini e Troidini (MILLER 1987). No caso desta última, reconhece-se 130 espécies que compõem 11 gêneros (HÄUSER 2005): *Atrophaneura* Reakirt, 1865; *Battus* Scopoli, 1977; *Byasa* Moore, 1882; *Cressida* Swainson, 1832; *Euryades* Felder & Felder, 1864; *Losaria* Moore, 1902; *Ornithoptera* Boisduval, 1832; *Pachliopta* Reakirt, 1865; *Parides* Hübner, 1819; *Pharmacophagus* Haase, 1892; *Trogonoptera* Rippom, 1890; *Troides* Hübner, 1819.

Espécies de Troidini são um dos poucos grupos que se alimentam quase que exclusivamente de Aristolochiaceae (EHRLICH & RAVEN 1964; SLANSKY 1972; SCRIBER 1984, FEENY 1991, WEINTRAUB 1995). As plantas dessa família produzem e armazenam ácidos aristolóquicos, uma defesa química contra herbívoros. A existência e função desses ácidos pode ser explicada por duas diferentes teorias evolutivas. Na primeira, Feeny (1976), Rhoades e Cates (1976) sugerem que a intensidade da defesa química está diretamente ligada à conspicuidade da planta, com plantas mais aparentes ou mais facilmente atacadas pelos herbívoros necessitando de defesas que reduzam a digestibilidade de seus tecidos. Dessa forma, a evolução desse sistema atingiria a herbivoria tanto de generalistas quanto de especialistas, sendo que o grau de proteção da planta está ligado à concentração da substância nos tecidos. Já plantas com menor acessibilidade se valeriam de defesas qualitativas, presentes em baixas concentrações nos tecidos, detendo, assim, herbívoros generalistas, mas com pouca eficiência contra especialistas. A segunda teoria, proposta por Coley *et al.* (1985), sugere que a natureza e a quantidade das defesas químicas estão ligadas à disponibilidade de recursos, de maneira que plantas em ambientes pobres cresceriam lentamente e acumulando altos níveis de substâncias de defesa, enquanto que plantas em ambientes com abundância de recursos cresceriam mais rapidamente, mas sem tanto investimento em defesas químicas.

Independente da origem do sistema de defesa química de Aristolochiaceae, as populações de Troidini evoluíram estratégias para sobrepujar as defesas químicas de suas hospedeiras. Mais que isso: tornaram-se capazes de utilizar os compostos produzidos pelas plantas em seu próprio benefício, seja tornando-se impalatáveis (quando adultos) ou interferindo na predação por parasitóides (fase imatura) (GREENEY 2012). Price (1980) propôs, inclusive, que esta interação entre parasitas, parasitóides e predadores

(terceiro nível trófico) influenciaria as interações entre plantas e insetos fitófagos (segundo nível trófico) e até mesmo entre as plantas (primeiro nível trófico).

Quanto à distribuição, Troidini é predominantemente tropical, com centros de distribuição nas florestas de baixada da América Latina e também na região Indo-Australiana (WEINTRAUB 1995). São frequentemente citados na literatura como um caso típico de coevolução entre planta hospedeira e herbívoro, preenchendo a maioria dos requisitos da hipótese coevolutiva (EHRLICH & RAVEN, 1964). A hipótese coevolutiva entre plantas e herbívoros tem sido questionada por alguns autores, como Janzen (1980), que apontou a falta de indicação de que as lagartas seriam a única população ou conjunto de herbívoros causando as mudanças nas plantas. Com esse argumento, muitos autores preferem o termo coadaptação, ao invés de coevolução. Por outro lado, Thompson (1989) propôs que o termo seria apenas genérico e que deveríamos usar a expressão "mudança evolucionária recíproca". Recentemente (Janz, 2011) estes conceitos foram revisitados, sendo apontandos os problemas e as implicações dos diferentes pressupostos assumidos pelos autores ao longo dos anos. Sob este ponto de vista, "coevolução" deve sim ser usado, mas não como uma definição rígida, e sim como um arcabouço que abrace todas as variações de interação entre espécies que estão coevoluindo, ou "evoluindo juntas".

O gênero *Euryades* Felder & Felder [1864]

Segundo Lamas (2004), o gênero *Euryades* é composto por duas espécies: *Euryades corethrus* Boisduval [1863] e *Euryades duponchelii* Lucas [1839], sendo ambas encontradas na região sul do Brasil e países limítrofes (NUÑEZ-BUSTOS 2010). Essas espécies possuem estreita relação com as plantas do gênero *Aristolochia*, utilizando-as como sua fonte exclusiva de alimento durante o período larval. Além disso, possuem marcante dicromatismo sexual, os machos possuem asas pretas e opacas, com manchas vermelhas e amarelas, enquanto as fêmeas apresentam coloração marrom translúcida, com algumas poucas manchas vermelhas nas asas posteriores.

Uma característica encontrada em *Euryades* é a presença do *sphragis*, uma estrutura transferida pelo macho após a cópula que funciona como um "tampão genital", impedindo que a fêmea já inseminada copule com outro macho. Isso sugere a existência de uma forte competição intrassexual nas espécies do gênero, uma vez que esta estrutura parece ter um papel decisivo no sucesso reprodutivo dos indivíduos, possivelmente

servindo como mecanismo de dissuasão visual à copula em machos patrulhadores, conforme observado em *Cressida cressida* Fabricius [1775] (ORR & RUTOWSKI 1991).

Euryades corethrus Boisduval [1863] (figura 1) tem distribuição prevista para os estados do sul do Brasil, Argentina e Uruguai. Ela é comumente avistada em voo nas horas mais quentes do dia à procura de parceiros ou de plantas para oviposição, podendo ser encontrada de fevereiro a maio e de setembro a dezembro (LINK 1977). Está geralmente associada a áreas do Bioma Pampa, preferindo zonas de campo sujo e bordos de mato próximo a áreas campestres (TYLER 1994).
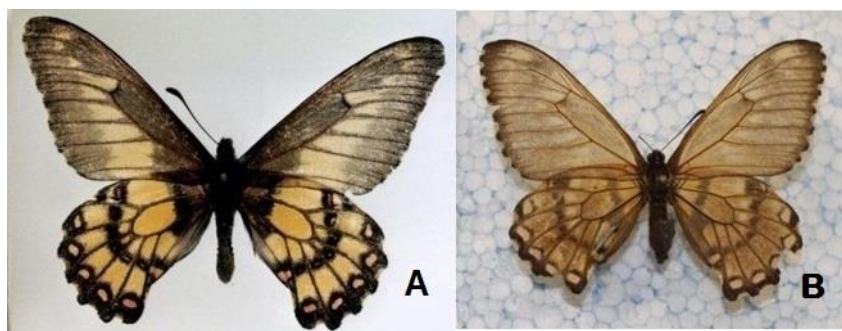

Figura 1. Espécimes de *Euryades corethrus* Boisduval [1863] em vista dorsal. A. macho tipo (Museu de Paris); B. fêmea (Coleção de Referência do Departamento de Zoologia da UFRGS).

Euryades duponchelii Lucas [1839] (figura 2), assim como *E. corethrus,* tem distribuição prevista para o sul do Brasil, Argentina e Uruguai, mas também incluindo o Paraguai e Bolívia como áreas de ocorrência. Esta espécie comumente está relacionada a áreas Chaco-Pampeanas, porém sendo comum em ambientes mais xéricos do que os ocupados por *E. corethrus* (TYLER *et al.* 1994). Possui a veia V3 alongada, sendo esta uma característica que a diferencia de *E. corethrus* (BURMEISTER 1879). (VOLKMANN & NUÑES-BUSTOS 2010).
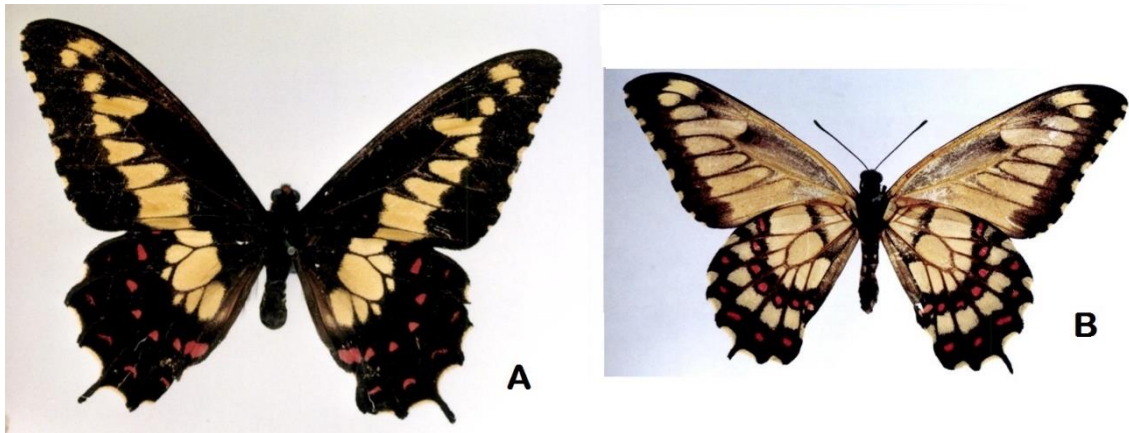
Figura 2. Espécimes tipos de *Euryades duponchelii* Lucas [1839], em vista dorsal. A. macho (Museu de Paris); B. fêmea (Museo Argentino de Ciencias Naturales Bernardino Rivadávia).

Apesar de essas espécies serem descritas na literatura como táxons que ocupam a mesma área geográfica, os registros de museus entomológicos e levantamentos de fauna realizado em diferentes localidades do Cone Sul não dão suporte a essa descrição. TYLER *et al.* (1994) propuseram uma distribuição com um alto grau de sobreposição entre as duas espécies, sendo as principais diferenças entre as ocorrências de ambas os pontos extremos de ocorrência. No Pampa gaúcho e nos Campos de Altitude do Paraná e Santa Catarina somente ocorreria *E. corethrus*, enquanto no Chaco boliviano somente ocorreria *E. duponchelii* (figura 3).
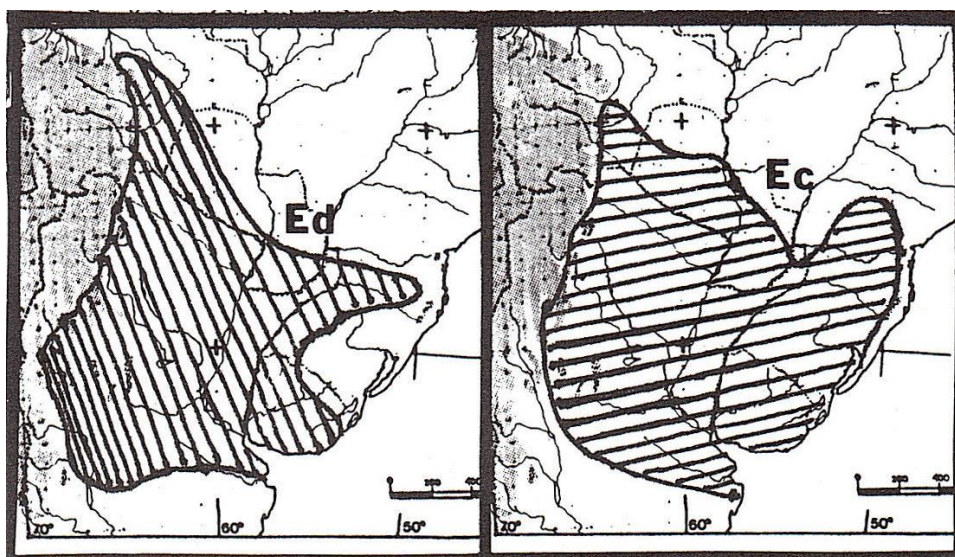

Figura 3. Distribuição proposta por TYLER *et al.* (1994) para *Euryades duponchelii* (Ed) e *Euryades corethrus* (Ec).

/Nuñez-Bustos (2010) propõe que *E. corethrus* seria encontrada no sul do Brasil, Uruguai e Argentina, enquanto *E. duponchelii* estaria presente na Bolívia, Paraguai, sul do Brasil, Uruguai e norte e centro da Argentina. De qualquer forma, nenhuma das duas distribuições propostas é suportada por registros de ocorrência observados em coleções entomológicas e em trabalhos de inventariamento de fauna publicados (figura 4). Prospecções iniciais realizadas em registros oficiais de ocorrência sugerem uma distribuição bem mais restrita para as espécies do gênero *Euryades*. Os dados sugerem que *E. duponchelii* não ocorre no Brasil, enquanto *E. corethrus* é mais restrita às áreas de campos pampeanos do Cone Sul.
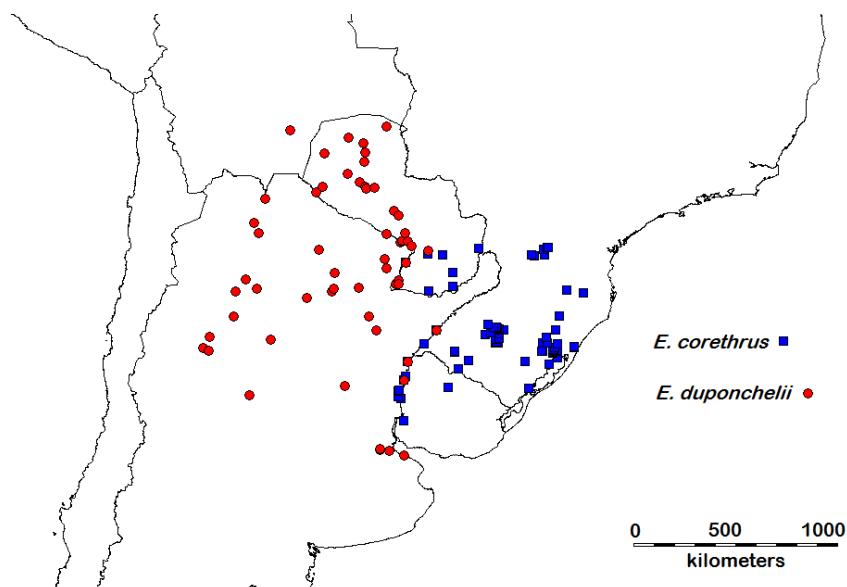

Figura 4. Mapa de registros de ocorrências para as espécies de *Euryades* em coleções científicas e trabalhos de inventariamento de fauna. Quadrados azuis - registros de *E. corethrus;* círculos vermelhos - registros de *E. duponchelii.*

A família Aristolochiaceae

A família Aristolochiaceae é constituída por quatro gêneros e aproximadamente 600 espécies com distribuição cosmopolita, principalmente em regiões tropicais, subtropicais e temperadas (GONZÁLEZ 1990; CAPELLARI Jr. 2002). É composta por plantas com hábitos arbustivos a herbáceos, podendo ser tanto eretas quanto rasteiras. Vulgarmente são chamadas de "jarrinha", "papo-de-peru", "caçaú" e "cipó mil-homens" (CAPELLARI Jr. 2002), por conta do seu hábito escandente e pelo formato tubular e

recurvado da corola de suas flores. Por terem alcaloides em suas folhas, principalmente ácidos aristolóquicos (MIX *et al.* 1982), são conhecidas e usadas na medicina herbal chinesa (NOLIN 2010) e por populações indígenas e rurais (SCHVARTZMAN 1975). Os gêneros brasileiros têm flores tubulares ou levemente campaniformes e labiadas. Como a coloração das flores depende do inseto associado, na flora sul-americana temos a predominância do vermelho escuro, em forma de venações e máculas irregulares no interior do limbo, com algumas, inclusive, produzindo odores atrativos. As plantas do gênero *Aristolochia* têm, invariavelmente, frutos capsulares deiscentes em seis partes. (HOEHNE 1942)

Aristolochia sessilifolia Klotzsch [1864] é uma das plantas da família Aristolochiaceae encontradas no RS e nos países que fazem fronteira com o estado. Possui distribuição geográfica ampla, sendo encontrada principalmente na região fitogeográfica do Pampa, mas sem ser endêmica da região (BARROS 2010). É uma planta campestre, de rizoma perene, do qual anualmente brotam novos caules eretos ou levemente inclinados, com 1-2 mm de espessura e 20-50 cm de altura. As folhas são quase sésseis, com pecíolo curto, com comprimento entre 3 e 6 cm e largura entre 1,5 e 4,5 cm. As flores são axilares, com pedicelo e ovário pubescentes e possuem bojo ovoide-piriforme com 6-10 mm de comprimento e 6-8 mm de diâmetro e colo cilíndrico (HOEHNE 1942).

Aristolochia fimbriata Cham. & Schltdl. [1832] também encontrada no RS, mas com uma distribuição mais ampla, uma vez que sua região fitogeográfica é a da Mata Atlântica, que engloba também os estados de Santa Catarina e Paraná (BARROS 2010). Herbácea, ereta ou prostrada, possui folhas reniformes, por vezes cordiformes. Planta perene, comum em campos cultivados ou de aluvião agreste. Flores axilares, bojo obovoide a globular, com 1,8cm de comprimento e 1,5cm de diâmetro. Colo curvado para cima e com borda barbelada (HOEHNE 1942).

Aristolochia lingua Malme. [1904] é encontrada principalmente no Paraguai e Argentina. É também uma planta herbácea e possui poucos registros comparada com as outras duas espécies de *Aristolochia* já citadas.

Aristolochia labiata Willd. [1809] é uma planta nativa do Brasil. É uma trepadeira com gandes flores marrons e supostas propriedades fitoterápicas, podendo atingir até 3 metros de altura. É nativa do Brasil sem ser endêmica. Ocorre na Caatinga, Cerrado e Mata Atlântica (BARROS 2010).

Aristolochia angustifolia Cham. [1832] é uma planta herbácea, nativa do Brasil sem ser endêmica do país. Encontrada também no sul da América do Sul, assim como *A. lingua.*
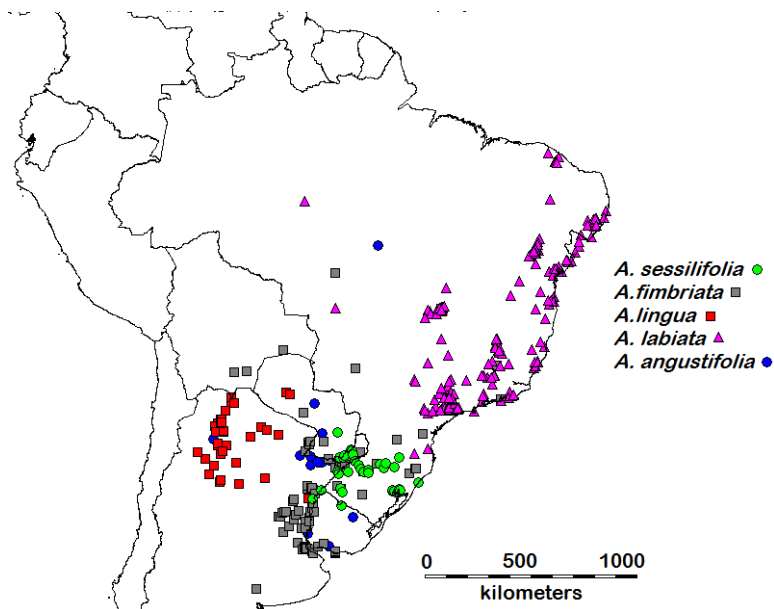

Figura 5. Mapa de registros de ocorrências para as espécies de *Aristolochia* depositadas em herbários e em trabalhos publicados. Círculos verdes- registros de *A. sessilifolia;* quadrados vermelhos– registros de *A. lingua;* triângulos rosas- registros de *A. labiata;* círculos azuis – *A. angustifolia;* quadrados cinzas – *A. fimbriata.*

Interações *Troidini-Aristolochia*

Os atributos das plantas hospedeiras podem limitar ou influenciar as estratégias dos insetos herbívoros (HOCHULI 2001), de modo que cada espécie exibe certo grau de seletividade no momento de escolher uma planta em algum dos estágios de sua história de vida (BERNAYS & CHAPMAN 1994). Desta forma, os insetos podem assumir diferentes estratégias para aumentar o sucesso durante o forrageio, podendo utilizar-se de apenas uma espécie (monófagos), de um pequeno número de espécies (oligófagos), ou de um grande número de espécies (polífagos) (BERNAYS & CHAPMAN 1994).

De modo geral, as larvas de Troidini alimentam-se de várias espécies de aristoloquiáceas, sendo, portanto, polífagos (TYLER *et al.* 1994, NUNEZ-BUSTOS 2010). Espécies com grandes áreas de distribuição e ampla plasticidade ecológica costumam utilizar várias plantas hospedeiras diferentes (*e.g. Battus polydamas*, *Parides anchises*), enquanto que espécies com pequenas áreas de ocorrência e plasticidades

ecológicas menores utilizam um número restrito de hospedeiras (*e.g. Parides ascanius*; *Battus polystictus*) (SILVA-BRANDÃO & SOLFERINI 2007). Uma planta hospedeira adequada para uma espécie em particular é aquela capaz de garantir um melhor desempenho larval e, consequentemente, a que assegura a sobrevivência da espécie (BERNAYS & GRAHAM 1988, BERNAYS & CHAPMAN 1994). A interação Troidini-Aristolochia é um exemplo típico de coevolução envolvendo interações inseto-planta. Para a maioria dos insetos, o ácido aristolóquico produzido pelas *Aristolochia* funciona como deterrente contra a ação de herbívoros, constituindo uma estratégia de defesa química. Insetos especialistas, como os Troidini, onde as larvas consomem os tecidos da planta contendo o ácido aristolóquico são capazes de se defender contra a ação deterrente do composto e sequestrá-lo para utilizá-lo como composto para conferir impalatabilidade nos adultos (EHRLICH & RAVEN 1964, BROWN 1990). Outro exemplo semelhante de coevolução entre borboletas e plantas hospedeiras é observado entre Helinoniini e *Passiflora* (GILBERT 1975).

As duas espécies de *Euryades* utilizam poucas espécies de *Aristolochia.* De acordo com a literatura disponível (KLITZKE 2000, BROWN 1995), *E. corethrus* utiliza preferencialmente *A. sessilifolia*, com alguns autores como BIEZANKO (1974) e NUNEZ-BUSTOS (2010) sugerindo também *A. fimbriata* e *A. triangularis* como fontes de alimento. Já *E. duponchelii* parece alimentar-se das mesmas plantas utilizadas pela sua coirmã, além de utilizar outra não descrita como hospedeira de *E. corethrus: A. lingua* (anteriormente *A ceresensis*) (VOLKMANN & NUÑES-BUSTOS 2010). Beccaloni (2008) também sugere algumas espécies adicionais de *Aristolochia* como hospedeira de *Euryades*, entre elas *A. angustifolia, A. labiata, A. sessilifolia* e *A. fimbriata.* Em função dessa relação tão estreita com suas plantas hospedeiras é razoável associar a distribuição das plantas usadas como recurso alimentar dos imaturos com a distribuição das próprias borboletas. Isso foi discutido por Krauss (2004), que mostrou que presença da planta hospedeira era o principal fator que influenciava a ocorrência da borboleta *Cupido minimus* Fuessly [1775] (Lepidoptera: Lycaenidae). Mas não só a disponibilidade de recursos alimentares é um fator limitante à ocorrência de espécies: as próprias características climáticas de uma determinada região interferem diretamente na capacidade de ocupação (STORCH 2003). Efeitos decorrentes de variações sazonais no volume de precipitação, temperatura e insolação, entre outros, podem influenciar diretamente a atividade dos indivíduos e, por consequência, a ocorrência de espécies. Algumas espécies apresentam grandes exigências ecológicas, ocorrendo somente em

zonas fisionômicas muito restritas (*e.g. Parides ascanius,* nas restingas litorâneas no sul do Estado do Rio de Janeiro). Outras espécies possuem grande plasticidade ecológica, sendo pouco seletivas quanto ao hábitat, podendo ocorrer em praticamente qualquer zona continental (*e.g. Battus polydamas*, em áreas continentais das Américas).

Distribuição de espécies e ecologia: o problema entre o nicho fundamental e realizado

Quando Grinnell (1904, 1917, 1924) propôs o conceito de nicho, a definição do conceito se referia mais a um atributo do espaço do que da espécie, definindo assim as condições e situações que permitiriam a sobrevivência e reprodução. Outros autores refinaram esta definição, levando também em conta o impacto que a espécie e o ambiente causam um no outro (ELTON 1927), enfocando nas relações tróficas e comportamentais das espécies. No entanto, Hutchinson foi quem mais avançou no desenvolvimento desde conceito, reestruturando-o como a soma de todos os fatores ambientais que atuam sobre o organismo (HUTCHINSON 1944) e diferenciando-o em nicho fundamental e nicho efetivo (HUTCHINSON 1957). A conjunção de todas as variáveis ambientais necessárias para que a espécie ocupe uma área define o nicho fundamental, mas não considera as restrições que podem ser impostas por outras espécies ou fatores que acabam por diminuir esta área, que recebe o nome de nicho efetivo ou realizado. Em resumo, o nicho fundamental é o conjunto de condições e recursos que permitem que uma espécie exista, cresça e se reproduza quando isoladamente de outras espécies que poderiam prejudicar sua existência; o nicho realizado é o mesmo conjunto de características, mas na presença de outras espécies que podem prejudicá-la.

Neste contexto, as modelagens de distribuição potencial (MDP) de espécies nada mais são do que as distribuições das condições ambientais referentes aos pontos de ocorrência da espécie, baseada nos dados ambientais utilizados (LORENA *et al.* 2008). Ou seja, é utilizada uma parte da distribuição real da espécie (amostra) e uma parte das variáveis ambientais responsáveis pela distribuição da espécie (camadas bioclimáticas) sem considerar fatores bióticos e nem barreiras geográficas. Assim, é geradauma distribuição potencial que é análoga ao nicho fundamental Em última instância, os resultados obtidos por MDP para uma dada espécie podem ser considerados como uma expressão complexa de toda sua ecologia (BROWN & LOMOLINO, 2006). Eles oferecem a oportunidade de elaborar mapas de distribuição que podem aumentar a

compreensão de aspectos desconhecidos da história natural de uma espécie, tais como sua capacidade de dispersão, biogeografia e evolução (GIOVANELLI *et al.* 2010).

É sabido, também, que a qualidade dos recursos disponíveis a uma comunidade afeta a dinâmica populacional das espécies que consomem estes recursos (BACH 1980). Poucos dados estão disponíveis sobre o desempenho dos Troidini quando fazem uso de diferentes espécies de *Aristolochia.* Também se sabe pouco sobre a presença de plantas de alto desempenho e sua relação com a ocorrência de espécies de herbívoro. Com relação ao gênero *Euryades*, nada se sabe sobre o quanto a ocorrência das plantas hospedeiras influencia na distribuição das borboletas. Informações preliminares sugerem que *E. corethrus* utiliza preferencialmente *A. sessilifolia*, enquanto *E. duponchelii* utilizaria preferencialmente *A. fimbriata*. Considerando que ambas as espécies de *Euryades* utilizam-se de plantas do mesmo gênero e que ocupam ambientes semelhantes, que estão bastante próximos geograficamente, elaboramos as seguintes hipóteses sobre o atual padrão de distribuição destas espécies de borboletas: (i) as espécies de *Euryades* apresentam separação geográfica de distribuição como consequência de preferências ecológicas, que são determinadas por variáveis ambientais limitantes; (ii) a distribuição das espécies de *Euryades* está sendo determinada pela distribuição das diferentes espécies de *Aristolochia* utilizadas; (iii) os padrões atuais de ocorrência das duas espécies de *Euryades* estão relacionadas a processos de biogeografia histórica.

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CAPÍTULO 2

Towards the understanding of *Euryades* species (Lepidoptera, Papilionidae) distributions: the role of ecological specialization, presence of host plants and historical biogeographical processes.

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Title:

"Towards the understanding of *Euryades* species (Lepidoptera, Papilionidae) distributions: the role of ecological specialization, presence of host plants and historical biogeographical processes."

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Short running head: Ecology and biogeography of *Euryades*

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ABSTRACT

Aim: Populations of *Euryades* seem to exist alongside each other in the South America but there is no mixture even though there are no significant geographic barriers that would explain the separation between the taxa. The current work investigates the reasons for this disjunction regarding the differences in their ecological requirement, the relationship with host plants and historical biogeography.

Location: South America, mainly southern Brazil and neighbouring countries.

Methods: Occurrence data gathering followed by potential species distribution modelling using bioclimatic and soil characteristic layers. The resulting models were later assessed using statistical techniques to measure their accuracy. Biogeographic analysis were performed in order to look for explanations to current patterns and environmental data from occurrence points were analysed with NMDS to corroborate niche overlapping between the butterfly species. Panbiogeographical analysis was applied to access information on the historical events responsible for present day distributions.

Results: The resulting models for potential distributions butterflies were not associated with any particular host plant distribution. The niche for *E corethrus* and *E. duponchelii* showed large overlapping between them, which was corroborated by NMDS statistics. Panbiogeographical tracks suggest that processes related to *E. corethrus* ditribuition were associated to Pampa province, while for *E. duponchelii* events were associated to the Chaco province

Main conclusions: There does not seem to be a direct relation between a specific host plant availability and *Euryades* species presence. Both butterflies have similar ecological requirements, thus environmental constrains cannot be evocated as parsimoniously reason for present day distributions. Biogeographic analysis suggests that changes in the habitat and past conditions or processes are responsible for the current day distributions.

Keywords: *Aristolochia,* biogeography, Troidini, host plant, Lepidoptera, niche overlap, South America, species modelling.

INTRODUCTION

When Grinnell (1904, 1917, 1924) proposed the concept of "niche", the definition was more about attributes of the environment than of the species, thus defining the conditions and situations that would make survival and reproduction possible. However, Hutchinson took this concept further, restructuring it as the sum of all environmental factors acting on an organism (Hutchinson 1944), and creating the distinction between fundamental and realized niche (Hutchinson 1957). In short, the fundamental niche is the group of conditions and resources that allow a species to survive, grow and reproduce when isolated from other species that could impair their existence, while the realized niche represents the same group of conditions but in the presence of competitor species.

Adding to that, there is also the "competitive exclusion principle" (Hardin 1960), that although highly controversial has become one of the cornerstones of ecological thinking (Meszena 2006). Hardin (1960) briefly stated: "complete competitors cannot coexist", willingly choosing ambiguous wording in order to expose the fact that the exact limits of that principle are not comprehended. He also put it another way: "ecological differentiation is the necessary condition for coexistence", further emphasizing that the species must occupy different niches to avoid extinction. This happens by the inherent differences between competing species, where even the slightest advantage is enough to upset the balance between the two competitors, eventually leading to one species replacing the other. That also brings attention to the many ecological preferences that influence niche occupancy, factors that are not only related to resources presence, but many others that might affect the species ability to disperse and survive in a new area. Those factors, like humidity, temperature and rainfall can effectively change the habitat breadth and give the advantage or disadvantage to one of the competing species.

In the environmental ecology context, the potential distribution modelling of species is nothing more than the distribution of the environmental conditions referred to occurrence points of the species, based on the environmental data used (Lorena *et al.* 2008). That is, part of the real distribution of the species (sample) and part of the environmental variables responsible for the species distribution (bioclimatic layers) are used, disregarding biotic factors or geographic barriers. This generates a potential distribution that is analogue to the fundamental niche because the actual distribution is smaller due to habitat loss, existence of geographical barriers and competition with another species. They offer the

opportunity of producing maps that can improve on the understanding of unknown aspects of the natural history of a species, such as dispersal capacity, biogeography and evolution (Giovanelli *et al.* 2010).

Butterfly species of the tribe Troidini (Papilionidae) are one of the few taxa that feed exclusively on Aristolochiaceae plants (Ehrlich & Raven 1964; Slansky 1972; Scriber 1984, Feeny 1991, Weintraub 1995). In fact, they are cited as an example of coevolution between herbivores and host plants (Ehrlich & Raven 1964). The Troidini are also predominantly tropical, with distribution centres in Southern South America and the Indo-Australian region. Regarding the genus *Euryades,* which is composed of two species, *Euryades corethrus* and *Euryades duponchelii*, its distribution is restricted to the south of Neotropical region, especially at southern Brazil and the neighbouring countries. Although both species are said to occupy nearly the same geographical area (Tyler *et al.* 1994), a survey of the available occurrence records in databases do not corroborate that hypothesized distribution. The available distribution data suggests a disjunction between the distributions, with *E. corethrus* occurring more towards the Savannas and Grasslands areas of Brazilian and Uruguayan territory, while *E. duponchelii* seems to be restricted to Chaco and some Savanna areas from Argentina, with a small overlapping between the two distributions along the Uruguay River.

It is known that the population dynamics of a species is affected by the diversity of the resources it consumes (Bach 1980). When dealing in particular with herbivore communities, studies have documented that their richness and abundance are strongly influenced by plant diversity (Bach 1980). Adding to that, not much data is available regarding the performance of Troidini when using different *Aristolochia* species as a host plant. Beccaloni (2008) suggests a few species of *Aristolochia* as host plants of *Euryades*, among them *Aristolochia angustifolia, Aristolochia labiata, Aristolochia sessilifolia* and *Aristolochia fimbriata.* Volkmann and Nuñez-Bustos (2010) also suggest *Aristolochia lingua* as a host plant for *Euryades.*

Considering that both *Euryades* species use plants from the same genus and occupy geographically close environments, with no apparent geographic barriers, we formulated the following hypotheses to explain the actual geographic disjunction between the two butterfly species: (i) the ecological preferences for each *Euryades* differ, producing constrains in the distribution of populations; (ii) the distribution of *Euryades* species is

being determined by the distribution of the different *Aristolochia* species along their fundamental niches, (iii) current distributions are consequence of distinct biogeographical histories for each *Euryades*. Thus, the present work investigates the reasons for distribution disjunction between the two *Euryades* species by testing the three hypotheses formulated. We applied species distribution modelling alongside biogeographical analysis, joint with the relationship between host plant presence and butterfly distribution, to identify the causes for present day occurrence patterns for *E. corethrus* and *E. duponchelii*. .

MATERIALS AND METHODS

Occurrence and environmental data

Species occurrence data was gathered from online databases such as JSTOR Global Plants (http://plants.jstor.org/), Global Biodiversity Information Facility (GBIF, http://www.gbif.org) and Species Link (SPlink http://www.splink.org.br/index), surveys in museum collections, personal field observations and literature research. Environmental data about present day climate conditions was obtained from WorldClim (HIJMANS 2005), while soil data was acquired from ORNL DAAC (Global Soil Data Task Group); both data were processed to a cell size of 0.041667 x 0.041667 decimal degrees and clipped for South America. The selection of which environmental layers would be used for modelling the distribution of each species studied here was made by means of a PCA (Principal Component Analysis), using the software XLSTAT 2013 (Addinsoft 2013-Paris, France). Variables were selected by the Kaiser rule (Kaiser 1960), that states that components with an eigenvalue of less than 1.0 should be discarded. We also verified that the accumulated explained variance for the selected variables was of at least 90% and that the selected variables had a low correlation between them.

We collected 153 occurrence points for *E. corethrus,* 61 for *E. duponchelii,* 62 for *A. sessilifolia*, 100 for *A. fimbriata* , 46 for *A. lingua* 64 for *A. angustifolia* and 407 for *A. labiata* (butterflies, Appendix S1; host-plants, (Appendix S2). Since we only used unique points, the actual number used in the models was lower: 80 for *E. corethrus,* 59 for *E. duponchelii,* 43 for *A. sessilifolia,* 85 for *A. fimbriata* and 38 for *A. lingua,* 20 for *A. angustifolia* and 216 for *A. labiata.*

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As for the environmental data, 5 were selected for *E. corethrus,* 5 for *E. duponchelii,* 14 for *A. fimbriata,* 10 for *A. sessilifolia,* 10 for *A. lingua,* 8 for *A. angustifolia* and 11 for *A. labiata.* The selected layers are in Table 1.

Species distribution models and ecological niche analysis

After the variable selection, we proceeded to generate species distribution models (SDM) for each of the seven species considered in this article (*E. corethrus, E. duponchelii, A. sessilifolia, A. fimbriata, A. lingua, A. angustifolia* and *A. labiata*) using five algorithms: BioClim (Nix 1986), GARP (Stockwell & Noble 1992), Maxent (Phillips *et al.* 2004), SVM (Cortes & Vapnik 1995) and Environmental Distance (Carpenter *et al.* 1993). The models were generated using the software OpenModeller Desktop v1.1.0 (Muñoz *et al.* 2011) for BioClim, GARP, SVM and Environmental Distance, while the software Maxent 3.3.3k (Phillips *et al.* 2004) was used for Maxent. The resulting models were adjusted to their Minimum Training Presence (*sensu* Giannini *et al.* 2012) and combined to produce a consensus model by the ensemble forecast method (Araújo & New 2007).

The resulting consensus SDMs were used to test the following assumptions: (1) the occurrence of each *Euryades* butterflies are differentially related to the distribution of distinct *Aristolochia* host plants, indicating the dependence of presence for certain types of immature food sources, and (2) the distribution of *E. corethrus* are not related to *E. duponcheliii* occurrence, suggesting the absence of niche overlapping and competitive exclusion between the *Euryades* species. To perform the tests, the consensus SDMs had their overlapping calculated in the software ENMTools 1.4.3. (Warren & Turelli 2008, Rochester, USA). Three different statistics were calculated to estimate SDM overlapping: Schoener´s *D* (Schoener 1968), the *I*-statistic (Warren *et al.* 2008), and Relative Rank, RR (Warren & Seifert 2011). Schoener's *D* relies on the assumption that the probabilities are proportional to local species densities or any other measure of relative use. On the other hand, the *I*-statistic is a modification of Hellinger's distance and was used to compare community composition (Legendre & Gallagher 2001). The *I* and *D* measures are obtained by comparing the estimates of habitat suitability calculated for each grid cell, using a Maxent-generated ENM. Each of those ENMs is normalized so that all the suitability scores within the geographic space sum to 1 (Warren *et al.* 2010). The RR is an estimate of the probability that the relative ranking of any two patches of habitat is the

same for the two models. To corroborate if the *Euryades* species had some superposition concerning the environmental space used for each one, environmental data from every occurrence point was compared by means of a three dimensional Nonmetric Dimensional Scaling Analysis (NMDS), considering the Euclidian similarity index, using the software PAST 3.01 (Hammer 2001). Areas were considered according to the world ecoregion classification (Olson *et al.* 2001)

Biogeographical analysis

To evaluate the biogeographical history of *Euryades* species, data of each occurrence record for both species were individually georeferenced, assigned to the biogeographical provinces described for Neotropical region (Morrone 2006) and subjected to Panbiogeographical Analysis (Croizat 1958). The distances among localities were calculated and the minimum spanning trees (individual tracks) obtained with software MartiTracks (Echeverría-Londoño & Miranda-Esquivel 2011). The generalized tracks were built based on the overlapping of the individual tracks of *E. corethrus* and *E. duponchelii*, and the panbiogeographic nodes were identified by the intersection of the two generalized tracks.

RESULTS

Species distribution models and ecological niche analysis

The AUC values obtained for each algorithm were considered good (*sensu* Franklin 2009), both for *Euryades* butterflies and for *Aristolochia* host plants, generally around 0.9 in both internal and external tests (Table 2). Therefore, the consensus SDMs produced by ensemble forecasting can be considered accurate (Fig. 1 and 2). In general, the consensus SDMs obtained show that the potential distributions of the species analysed have wide distribution, crossing several different ecoregions of South America. Between the butterflies, *E. duponchelii* had the widest distribution, while among the host plants the broadest distribution was observed for *A. fimbriata* (Table 3). According to the world ecoregions classification (Olson *et al.* 2001), the calculated *E. corethrus* distribution shows a higher suitability in Uruguay and the South of Brazil,specifically on the

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Uruguayan Savannah, Humid Chaco, Humid Pampa and also in the Alto Paraná Atlantic Forest and Araucaria Moist Forests (Fig. 1A). On the other hand, *E. duponchelii* shows a potential distribution that is contained mostly within the Chaco, including all of Paraguay, the borders of Bolivia and Argentina, and at some Uruguayan Savannah areas bordering the Humid Pampas of Uruguay (Fig. 1B). *Aristolochia sessilifolia* has a potential distribution that is very similar to that of *E. corethrus,* but going deeper into Uruguayan Savannah (Fig. 2A). *Aristolochia fimbriata* had a calculated distribution similar to *A. sessilifolia*, but extending towards the North and much further South, going as far as Bahía Blanca, Argentina (Fig 2B). *Aristolochia lingua* has a potential distribution encompassing the entire Chaco, Humid Pampas and Patagonian Steppe, practically covering the whole of Argentina, Paraguay and a small portion of Bolivia (Fig. 2C). *Aristolochia labiata,* on the other hand, has a potential distribution that is more concentrated in the Brazilian coast and seems to be removed from the area that arose the question, predicting low suitability in the south region of South America. *Aristolochia angustifolia* has a much smaller calculated distribution, covering most of Uruguay and sprawling to the neighbouring regions in Argentina and Brazil, with its calculated distribution being spatially similar to the higher suitability areas of *A. fimbriata.*

The SDM overlapping analyses suggested that neither the occurrence of *Euryades* butterflies were exclusively associated to a particular host plant species distribution, nor the absence of niche overlapping between *E. corethrus* and *E. duponchelii* could be assumed (Table 4). First of all, both *Euryades* showed a significant overlap with *A. frimbriata*, with *E. corethrus* also overlapping with *A. sessilifolia* while *E. duponchelii* had its second largest overlap with *A. lingua.* A lower overlap between *Euryades* and *A. labiata* was found but that was expected, since the visual inspection of the SMDs already showed the higher suitability areas to be occurring in different parts of South America. Second, high distribution overlapping between *Euryades* (specially the *I* and RR) suggests that both species have similar ecological requirements and may suffer from competitive constrains from each other. The NMDS analysis corroborated the ecological similarities between *Euryades* species (Fig. 3), indicating that there is significative (stress value =0.098) an overlap between the environmental space occupied by both species.

Biogeographical analysis

The individual track obtained for *E. corethrus* suggest that processes involving this species were associated to Pampa biogeographical province (Fig. 4A). On the other hand, the inspection of *E. duponchelii* individual tracks suggests that the events of this species were associated to the Chaco biogeographical province (Fig. 4B). When the generalized tracks for both *Euryades* are concerned, both Pampa and Chaco biogeographical provinces are associated to their distributions. (Fig. 4C). This pattern suggests the existence of a past selective geographical barrier to the dispersion of these butterfly species.

DISCUSSION

Environmental and ecological constraints to Euryades distributions

The data presented here suggest that neither the presence of a particular host plants species nor the environmental suitability are responsible for the present disruption observed in the distributions of *Euryades* species. The visual comparison of consensus SDMs obtained here could lead to the premature conclusion that the distribution of *E. corethrus* is strongly correlated with *A. sessilifolia* occurrence, and that the distribution of *E. duponchelii* is associated with the concatenation of *A. fimbriata* and *A. lingua* occurrence areas. But when the overlapping of SDMs is done considering environmental suitability for both insects and their host plants, no strong association among distributions is supported. Such lack of association suggests that none of *Euryades* species depends exclusively on the immature resources provided for any particular type of host plant, reinforcing the hypothesis that none of *Euryades* immature can be considered monophagous.

Among the Neotropical Troidini, the monophagous larval behaviour is a very rare trait. Indeed, the oligophagous situation is the most widespread larval feeding behaviour observed (Beccaloni *et al.* 2008). In general lines, derived Troidini species generally use fewer species of *Aristolochia* as host plants when compared to basal species in the phylogeny of the tribe (Silva-Brandão *et al.* 2005). Independent of the phylogenetic position of specie, most of Troidini larvae can feed from more than one *Aristolochia* species, despite the preference and performance of larvae linked to some specific plants. For instance, *Parides ascanius*, an endangered species from southeaster Brazil, is

considered a monophagous species, since in nature immature forms are generally found only in *Aristolochia macroura* (Otero & Brown 1986). However, in captivity environments, *P. ascanius* can use alternative *Aristolochia* as host plants (Tyler *et al.* 1994). In cases like this, the apparent ecological specialization may simply reflect the geographical distribution of the butterflies instead of showing a trend in the direction of specialization in host plant use, since adult forms are restrict to the habitat were the plant is plentiful. The use of suboptimal host plants could be related to the lack of best food in place and time (Fox & Morrow 1981, Bernays & Graham 1988).

Nutritional variation between different host plant species is a pattern well known in the insect-plant relationships (see discussion in Kerpel *et al.* 2006), as well as female's strategies to locate and select the best plants for their offspring (see discussion in Bernays & Chapman 1994). On Lepidoptera groups associated to certain taxa of plants, the chemical features shared by phylogenetically related hosts may have promoted the evolution of the recognition of plants by chemical similarity (Erhlich & Raven 1964, Feeny 1995). In a study performed by Klitze (1992) on 11 species of *Aristolochia* used by 17 Troidini species, the results pointed that the secondary chemical composition of leaves may influence acceptance and performance of larvae on the different host plants. While the alkaloids present in the leaves seem to influence oviposition activity of females, the diterpene molecules (labdanoic acids) appear to produce antifeedant activity on larvae. Silva-Brandão and Solferini (2007) also provided information suggesting the *Aristolochia* plants containing nitrophenanthrenes (aristolochic acids) are physiologically more advantageous for Troidini development. Despite the differences observed between the chemical composition of plants and the distinct performance of larvae when using alternative host plant, it is expected that acceptance of the larvae will happen at those species considered less suitable for development if the host plants share some chemical similarities with the preferred plant, or if the plant is the only abundant resource at the living areas of the herbivore.

The five *Aristolochia* species studied here possess scarce density in nature. They have patched distribution, since they growth by stolons in open field and at shrubby areas (Hoehne 1942). Considering such ecological traits, the oviposition behaviour of *Euryades* females in nature may be a very costly activity, due to the large distance flight by them to find a host. Plus, *Euryades* females also lay single eggs on *Aristolochia* plants (Tyler *et al.* 1994), which may also increase the costs to oviposition. From the adaptationist point

of view, it would be important for the *Euryades* species the evolution of the ability to use successfully different *Aristolochia* present at their distribution areas, the open field areas of southern South America. Thereby, host plant quality should be considered a secondary constraint on the development, while the quantity of host plant should be assumed as the most important restriction. Further investigation should be done to access information about the performance of *E. corethrus* and *E. duponchelii* on different *Aristolochia* to improve discussion on the plasticity while using alterative host plants.

The large overlap observed between the SDMs of the two species of *Euryades* indicates that, despite the disjunctive distributions register in field, *Euryades* share similar ecological preferences. In other words, the environmental differences observed among the different ecoregions occupied by each species of *Euryades* cannot satisfactory explain the distribution patterns observed. The NMDS analysis also supports this conclusion, since it suggests a considerable superposition of *E. corethrus* and *E. duponchelii* in the environmental space considering macroclimate variation derived from temperature and rainfall. Such result could be explained by the following two hypotheses: (i) the existence of competitive exclusion between the two *Euryades* species and (ii) the absence of niche divergence induced by vicariant speciationConcerning the first hypothesis, when species have very similar environment requirement regarding habitat space and food, it is expected that those species compete against each other for survival. Competing species from the same trophic level generally do not extinct each other. In turn, three different ecological processes can lead to a reduction in the interspecific competition for resources, making coexistence in simpatry possible (see discussion in Gotelli 1997). First, predation and disturbance may suppress densities to very low levels, so that shared resources never become limiting. Second, coexistence on a local scale may be transitory, but regional coexistence may be maintained through immigration and patch dynamics. Third, competitors may partition available resources so that species coexist in homeostasis, but at a lower abundance than they would in the absence of a competitor.

Regarding the second hypothesis, the conservatism of niches between sister species will occur if a short to moderate evolutionary time has pass since the divergence of lineages, or if the speciation process involved at some point a geographic isolation of populations. Speciation events do not necessary induce niche divergence, mainly because ecological niches evolve little around the time of the speciation event. Rather, niche differentiation appears to proceed slowly later, with the accumulation of adaptations due to assortative

mating (Peterson *et al.* 1999). In addition, allopatric speciation depends first on a reproductive isolation of two populations based on a geographical barrier, followed by an accumulation of genetic differences between them, without further niche segregation. Peripatric and parapatric speciation follow the opposite procedure, depending first of niche segregation and later on genetic differentiation and reproductive isolation (Futuyma 2013).

Both hypotheses presented here to explain larger niche overlapping between the *Euryades* species are plausible, but when the biogeographical analysis is concerned the most parsimonious explanation seem to be the vicariant speciation hypothesis.

Historical biogeographical reason for present Euryades distributions

The results of Panbiogeographical analysis suggest that the current distribution of *Euryades* butterflies seem to be related to some historical biogeographical processes that could have promoted the disruption of an ancestral population and gave origin to both species. The inspection of the individual tracks for *E. corethrus and E. duponchelii* strongly suggested the importance of the La Plata River basin for the historical biogeography of both species. While the first species seems to have spread towards the west of La Plata River basin, the second one seems to have spread in east direction. The individual track for *E. duponchelii* is mostly linked to the Chaco biogeographical province, with a smaller part associated to Pampa province. On the other hand, *E. corethrus* does not show such a strong association with a particular province, as *E. duponchelii* does. Its individual track shows association with four different provinces: Pampa, Chaco, Paraná Forest and *Araucaria angustifolia* Forest. When the generalized track is concerned, it can be notice that the track is contained mostly inside the Pampa province, extent north along the border of Pampa and Chaco provinces. In present day landscape, the generalized track is superimposed to the border of Argentina with Uruguay and Argentina with Brazil, covering Southern Cone Mesopotamian Savanna, Espinal, Humid Pampa and Uruguayan Savannava ecoregions. Those areas are representations of former sites where geological fragments and biotic components interacted across time and space in a complex biogeographical area (Moreira *et al.* 2011).

Jong (2003) explores the hypothesis that two sister taxa that are endemic in two different Gondwannan fragments is indication of Gondwannan ancestry, and that seems to be the case between South American *Euryades* and Australian *Cressida*. Both genera have striking similarities, such as general colour and shape, the lack of scales in the females, the fact they occupy open grasslands and the presence of the *sphragis*. Jong (2003) calculates the time of their relationship to be 30Ma, which would be too young for a break-up of Gondwanna, since the final separation between Antarctica and Australia happened 35Ma. Braby (2005) heavily criticized the methodology used in those calculations, and his adjusted results put the separation between 37 and 51Ma. This revised time of divergence would be old enough to make the taxa of Gondwanan age. Whatever and whenever the origin is, there are compelling arguments supporting all of those scenarios. According to Morrone (2006, 2009), there is supporting evidence for the prevalence of a temperate climate during the tertiary (65.5-1,806 Ma) in southern South America, allowing a continuous cloud forest that extended further south than it currently does. Later, during the Oligocene (34-23 Ma) and the Miocene (23-5.3 Ma), this forest would cool down, dry and fragment, coinciding with the expansion of the Chacoan biota, the uplift of the Andes and the climate changes associated with those events. The curved U-shape of the individual tracks is in accordance to the scenario proposed by Lundberg (1998) and Hoorn (2010), where the area currently known as Amazon was part of larger region, reaching as further south as the current province of Paraná. This indicates that Rio Grande do Sul, the southernmost Brazilian State, is an extant southern transition zone (Moreira 2011). This could be a factor in the disjunction of the distribution of *Euryades*, since the previously present forest could be a barrier impeding the occupation of this habitat that currently would be suitable. This barrier would act as wedge, splitting the advance towards the north in two directions: the Chaco and the Atlantic and Parana Forests. Those populations would possibly suffer allopatric speciation, evolving to better explore the slight differences in those habitats. Later, when the aforementioned retraction of the barrier occurred, those butterflies could occupy the new areas but would be different enough that their realized habitats would not overlap due to the competition for resources with their sister taxon.

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Guilherme Atencio is broadly interested in evolution and behaviour of Lepidoptera. Besides the geographical components, he is also interested in the dynamics that affect the community structures, especially regarding interaction of species.

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Table 1. Environmental layers selected for *Euryades* butterflies and *Aristolochia* host plants. Variables by the Kaiser rule (Kaiser 1960), with an accumulated explained variance of at least 90% and low correlation between them.

E. corethrus	*E. duponchelii*
Altitude	Altitude
Precipitation of Driest Quarter	Mean Temperature of Coldest Quarter
Mean Diurnal Range	Annual Precipitation
Mean Temperature of Coldest Quarter	Precipitation of Warmest Quarter
Temperature Annual Range	Max Temperature of Warmest Month

A. sessilifolia	*A. fimbriata*	*A. lingua*	*A. labiata*	*A. angustifolia*
Altitude	Temperature Seasonality	Horizon 4 – percentage of Silt	Minimum Temperature of Coldest Month	Soil profile
SQ5	Soil Texture	Annual Precipitation	Horizon 2 – percentage of Clay	Annual Mean Temperature
Temperature Annual Range	Horizon 3 – Percentage of Clay	Carbonate carbon density	Bulk density	Organic carbon density 30
Horizon 5 – percentage of Silt	Wilting point	Precipitation of Driest Month	Annual Precipitation	Horizon 4 –Sand percentage
Horizon 1 – percentage of Silt	Mean Temperature of Warmest Quarter	Isothermality	Precipitation of Driest Quarter	Water holding capacity
Precipitation of Driest Month	Horizon 3 – Depth of Profile	Field capacity	SQ2	Horizon 2 – Depth of Profile
Organic carbon density 0-100	Bulk density	SQ2	Mean Temperature of Wettest Quarter	SQ1
Water Capacity	Carbonate carbon density	Water holding capacity	Horizon 2 – Percentage of Silt	SQ5
Mean Temperature of Driest Quarter	Plant extraction capacity	SQ3	Horizon 4 – Depth of Profile	
Water Holding Capacity	Horizon 5 – Depth of profile	SQ4	SQ7	
	Horizon 5 – Percentage of Sand		Organic carbon density 0-100	
	Precipitation of Wettest Month			
	Horizon 2 – Depth of Profile			
	Water Holding Capacity			

Table 2. Statistics obtained for each algorithm and consensus models for the different species distribution models generated.

						E. corethrus	
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.9700	0.9718	0.9820	0.9616	0.9971	0.9765
	Sensitivity	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	0.8800	0.9764	0.2000	1.0000	1.0000	0.8113
	AUC	0.9126	0.9510	0.9710	0.9737	0.9896	0.9596
	Sensitivity	0.8800	1.0000	0.2000	1.0000	1.0000	0.8160
	Omission	0.1200	0.0000	0.8000	0.0000	0.0000	0.1840

						E. duponchelii	
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.9373	0.9469	0.9600	0.9304	0.9948	0.9539
	Sensitivity	0.5000	0.5000	0.5000	1.0000	1.0000	0.7000
	Omission	0.5000	0.5000	0.5000	0.0000	0.0000	0.3000
External	Accuracy	0.8888	0.9444	0.0000	0.7777	1.0000	0.7222
	AUC	0.8762	0.9202	0.9480	0.8581	0.9347	0.9074
	Sensitivity	0.8888	0.9444	0.0000	0.7777	1.0000	0.7222
	Omission	0.1111	0.5555	1.0000	0.2222	0.0000	0.3778

A. sessilifolia							
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.9845	0.9920	0.9930	0.9863	0.9990	0.9910
	Sensitivity	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	0.7692	0.8461	0.4615	0.9230	0.6153	0.7230
	AUC	0.8716	0.9719	0.9800	0.9804	0.8553	0.9318
	Sensitivity	0.7692	0.8461	0.4615	0.9230	0.6153	0.7230
	Omission	0.2307	0.1538	0.5384	0.0769	0.3846	0.2769

A. angustifolia							
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.9035	0.9350	0.8940	0.9169	0.9928	0.9284
	Sensitivity	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	1.0000	0.7142	0.4285	0.7142	0.2857	0.6285
	AUC	0.9001	0.7232	0.7820	0.8055	0.5852	0.7592
	Sensitivity	1.0000	0.7142	0.4285	0.7142	0.2857	0.6285
	Omission	0.0000	0.2857	0.5714	0.2857	0.7142	0.3714

A. fimbriata							
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.8613	0.9275	0.9440	0.8107	0.9945	0.9076
	Sensitivity	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	0.8461	0.9615	0.0384	1.0000	0.7307	0.7153
	AUC	0.7858	0.9423	0.9310	0.8215	0.8598	0.8681
	Sensitivity	0.8461	0.9615	0.0384	1.0000	0.7307	0.7153
	Omission	0.1538	0.0384	0.9615	0.0000	0.2692	0.2846

A. labiata							
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.8085	0.9568	0.9660	0.8892	0.9994	0.9240
	Sensitivity	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	0.9672	0.9344	0.2295	0.9672	0.9344	0.8065
	AUC	0.7900	0.9501	0.9450	0.8938	0.9342	0.9026
	Sensitivity	0.9672	0.9344	0.2295	0.9672	0.9344	0.8065
	Omission	0.0327	0.0655	0.7704	0.0327	0.0655	0.1934

A. lingua							
Test type	Statistics	Bioclim	SVM	Maxent	GARP	Environmental Distance	Consensus SDM
Internal	Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	AUC	0.9603	0.9347	0.9810	0.9523	0.9970	0.9651
	Sensitivity	0.5000	0.5000	0.8980	0.5000	0.5000	0.5796
	Omission	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
External	Accuracy	0.6666	0.8333	1.0000	1.0000	0.6666	0.8333
	AUC	0.7920	0.8903	0.9141	0.9105	0.8648	0.8743
	Sensitivity	0.6666	0.8333	1.0000	1.0000	0.6666	0.8333
	Omission	0.3333	0.1666	0.0000	0.0000	0.3333	0.1666

Table 3. Standardized niche breadth values and areas obtained from consensus species distribution models for the *Euryades* butterflies and their *Aristolochia* host plants.

Species	Niche breadth value	Area (km^2)
E. corethrus	0.196	1.852.903
E. duponchelii	0.469	4.475.218
A. sessilifolia	0.395	1.216.432
A. fimbriata	0.503	16.216.307
A. lingua	0.527	8.984.301
A. labiata	0.505	9.793.153
A. angustifolia	0.599	1.577.505

Table 4. Niche overlap analysis between consensus species distribution models obtained for the *Euryades* butterflies and their *Aristolochia* host plants with three different statistics: **(a)** Schoener's *D*, **(b)** *I* Statistic and **(c)** Relative Ranking.

a

	E. duponchelii	A. fimbriata	A. labiata	A. lingua	A. sessilifolia	A. angustifolia	E. corethrus
E. duponchelii	-	0.721	0.502	0.731	0.663	0.664	0.571
A. fimbriata	-	-	0.493	0.656	0.625	0.655	0.609
A. labiata	-	-	-	0.495	0.567	0.581	0.454
A. lingua	-	-	-	-	0.665	0.609	0.477
A. sessilifolia	-	-	-	-	-	0.622	0.751
A. angustifolia	-	-	-	-	-	-	0.535
E. corethrus	-	-	-	-	-	-	-

b.

	E. duponchelii	A. fimbriata	A. labiata	A. lingua	A. sessilifolia	A. angustifolia	E. corethrus
E. duponchelii	-	0.933	0.784	0.917	0.870	0.893	0.847
A. fimbriata	-	-	0.765	0.901	0.855	0.886	0.869
A. labiata	-	-	-	0.699	0.737	0.851	0.702
A. lingua	-	-	-	-	0.828	0.851	0.732
A. sessilifolia	-	-	-	-	-	0.837	0.928
A. angustifolia	-	-	-	-	-	-	0.805
E. corethrus	-	-	-	-	-	-	-

c.

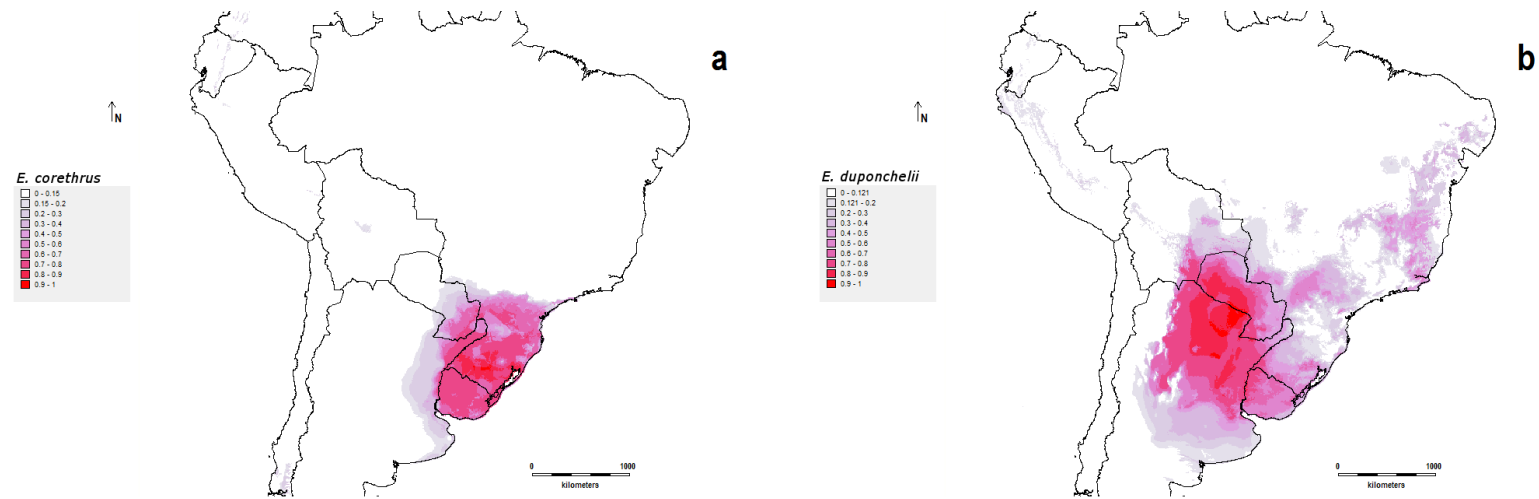|	E. duponchelii	A. fimbriata	A. labiata	A. lingua	A. sessilifolia	A. angustifolia	E. corethrus
E. duponchelii	-	0.766	0.474	0.662	0.569	0.595	0.714
A. fimbriata	-	-	0.528	0.648	0.599	0.649	0.742
A. labiata	-	-	-	0.365	0.459	0.596	0.532
A. lingua	-	-	-	-	0.440	0.489	0.520
A. sessilifolia	-	-	-	-	-	0.543	0.696
A. angustifolia	-	-	-	-	-	-	0.652
E. corethrus	-	-	-	-	-	-	-

Figure 1: Consensus species distribution models (SDMs) for the *Euryades* species obtained by the ensemble forecasting of five different mathematical algorithms (BioClim, GARP, SVM, Environmental Distance and Maxent) (a) *E. coretrhus* (b) *E. duponchelii*. The colors represent the habitat suitability of the species in a given locality (red = 100% suitability, dark blue = 0% suitability).

Figure 2. Consensus species distribution models (SDMs) for the *Aristolochia* species obtained by the ensemble forecasting of five different mathematical algorithms (BioClim, GARP, SVM, Environmental Distance and Maxent) (a) *A. sessilifolia* (b) *A. fimbriata* (c) *A. lingua* (d) *A. labiata* (e) *A. angustifolia*. The colors represent the habitat suitability of the species in a given locality (red = 100% suitability, dark blue = 0% suitability).

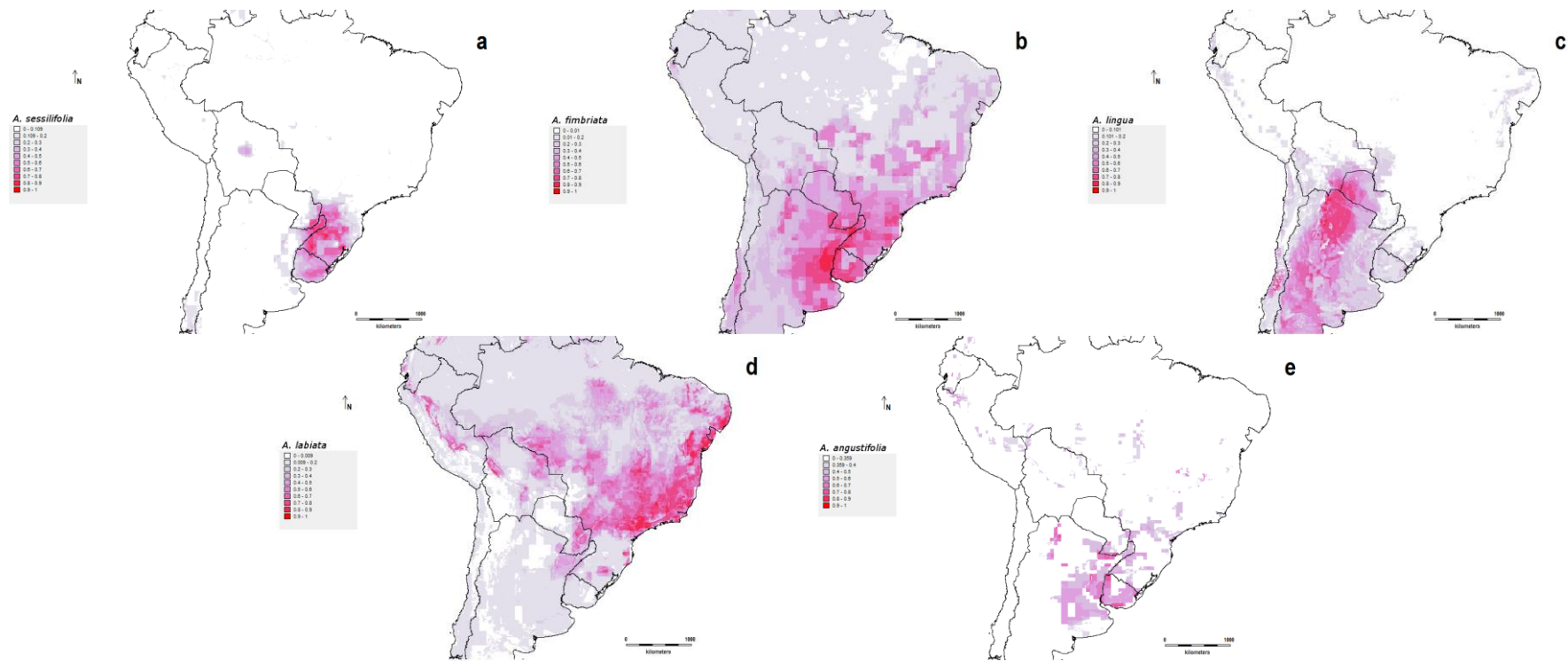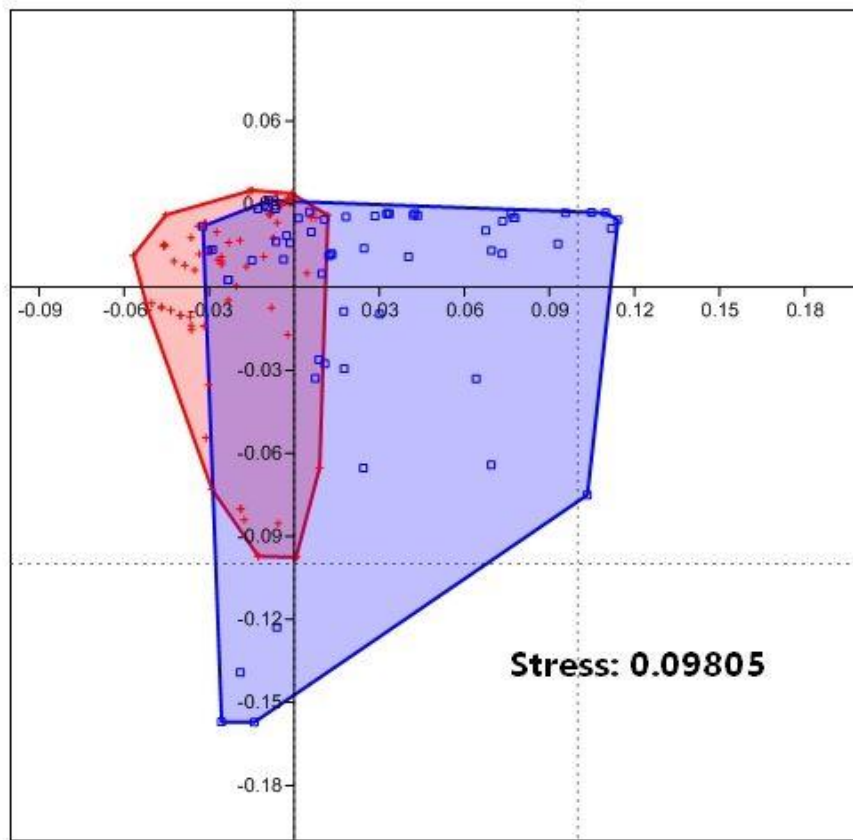**Figure 3.** Ordination analysis made by NMDS for both *Euryades* species. *Euryades corethrus* - red crosses, *Euryades duponchelii* - blue squares. The blue and red boundaries represent the convex hull for the scores of each species.
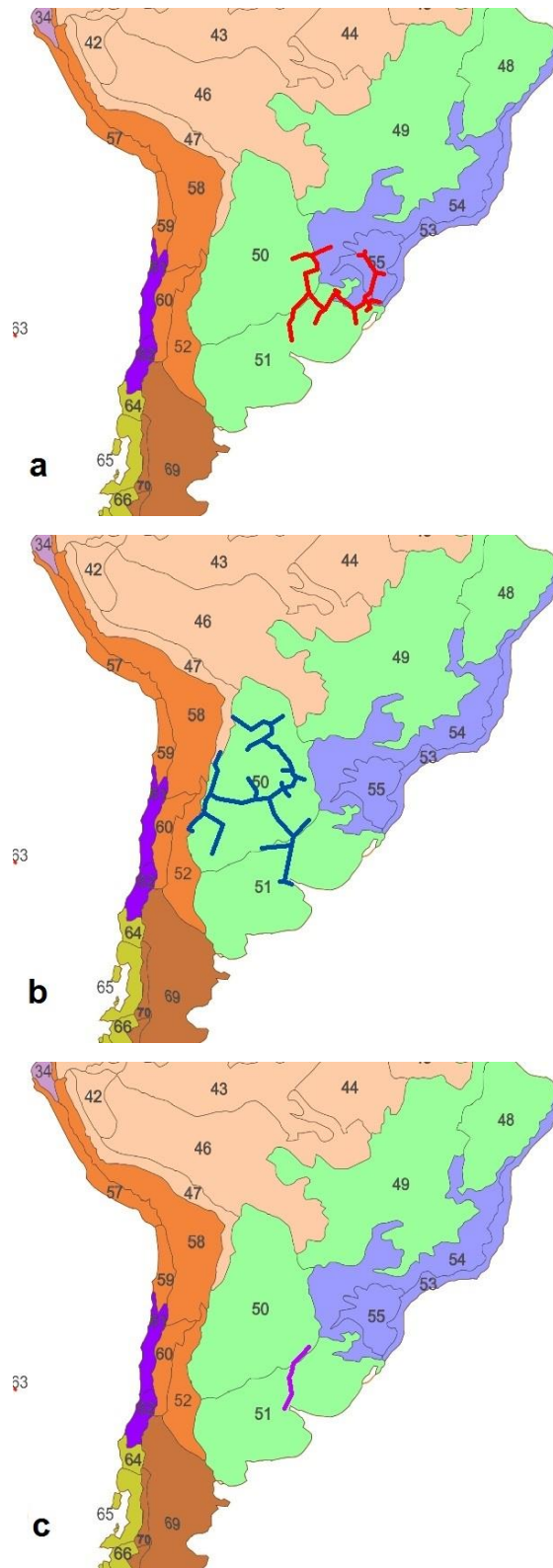
Figure 4. Individual tracks for (a) *Euryades corethrus* and (b) *Euryades duponchelii*, and generalized tracks for the two species of Euryades (c) projected over the biogeographical provinces and subregions of South America (*sensu* Morrone 2006). Transition South American subregion (orange) - Monte (52) and Pune (58); Amazon subregion (Pink): Wetland (46) and Yungas (47); Chacoan subregion (green) - Savannah (49), Chaco (50) and Pampa (51). Paraná subregion (Blue) - Atlantic Forest (53) Paraná Forest (54) and *Araucaria angustifolia* Forest (55)**.**

SUPPLEMENTARY INFORMATION

Appendix S1: List of species occurrence data gathered from Global Biodiversity Information Facility (GBIF) Species Link (SPlink) museum collections, personal field observations and literature research for (A) *Euryades corethrus* and (B) *Euryades duponchelii.*

A.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Brasil	PR	Guarapuava	Campo Nativo	-25.38	-51.45	
Paraguai	Alto Paraná	Porto Tacurupuçu		-25.42	-54.60	http://www.biodiversitylibrary.org/bibliography/44792
Paraguai	Caaguazú	Caaguazú	Caaguazú	-25.45	-56.02	GBIF
Paraguai	Paraguari	Sapucaí		-25.65	-56.93	http://www.pybio.org/1430/euryades/
Brasil	PR	Candói		-25.72	-52.18	
Brasil	PR	Pinhão		-25.72	-51.63	
Paraguai	Guaira	Colonia Independencia		-25.72	-56.25	
Brasil	PR	Foz do Jordão		-25.73	-52.09	
Paraguai	Neembucu			-26.06	-57.94	http://www.pybio.org/1430/euryades/
Argentina	Misiones	Montecarlo	Puerto Rico	-26.80	-55.02	GBIF
Argentina	Misiones	Montecarlo	Puerto Rico	-26.80	-55.02	www.herbariovaa.org
Argentina	Misiones	General San Martín	Puerto Rico	-26.88	-54.92	GBIF
Paraguai	Itapúa	Trinidad		-27.12	-55.78	E-mail David Lees NHM-UK
Argentina	Misiones		Cainguas	-27.18	-54.83	GBIF
Argentina	Misiones	San Ignacio	Desvio a Cnia.Alberdi, 5 km ruta 14	-27.27	-55.48	GBIF
Argentina	Misiones	San Ignacio	Desvio a Cnia.Alberdi, 5 km ruta 14	-27.27	-55.48	GBIF
Argentina	Misiones	San Ignacio		-27.27	-55.48	www.herbariovaa.org
Paraguai	Misiones	Ayolas		-27.37	-56.86	http://www.pybio.org/1430/euryades/
Argentina	Capital	Capital	Posadas	-27.38	-55.90	GBIF
Argentina	Capital	Capital	Posadas	-27.38	-55.90	GBIF
Argentina	Misiones	Candelaria	cerca de Santa Ana	-27.38	-55.58	GBIF
Argentina	Misiones	Candelaria	Cerca de Santa Ana	-27.38	-55.58	GBIF
Argentina	Misiones	Posadas	Posadas	-27.38	-55.90	www.herbariovaa.org
Argentina	Misiones	Santa Ana	Perto de Santa Ana	-27.38	-55.58	www.herbariovaa.org
Argentina	Capital	Capital	Posadas	-27.38	-55.88	JSTOR
Brasil	Santa Catarina	Campos Novos		-27.40	-51.23	SpLink
Brasil	Santa Catarina	Campos Novos	Rod. BR-470	-27.42	-51.21	GBIF
Brasil	Santa Catarina	Trombudo Alto		-27.45	-49.85	Email pessoal Dr. Willmot
Argentina	Capital	Capital	Sotobosque sobre Ruta 12	-27.48	-55.92	GBIF
Brasil	Rio Grande do Sul	Alegrete	20 km SE de Santa Rosa	-27.69	-54.65	SpLink

Brasil	Rio Grande do Sul	Erebango	Erebango	-27.86	-52.30	GBIF
Brasil	Rio Grande do Sul	Vila Nova	Estrada Ronda Alta a Passo Fundo	-27.91	-52.75	SpLink
Brasil	Rio Grande do Sul	Torres	Granja Sodol	-28.03	-54.35	SpLink
Brasil	Rio Grande do Sul	Ronda Alta	7 km de Lagoa Vermelha	-28.20	-51.62	SpLink
Brasil	Rio Grande do Sul	Santo ângelo	Entre Passo Fundo e Ronda Alta	-28.26	-52.41	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Granja Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Alegrete		-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Alegrete		-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Santo Antônio das Missões	Fazenda Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Granja Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Augusto Pestana	Estrada para J. Maria, Patronato	-28.42	-53.66	SpLink
Brasil	RS	Vacaria		-28.50	-50.93	
Brasil	Rio Grande do Sul	Passo Fundo		-28.51	-55.23	SpLink
Argentina	Corrientes	Santo Tomé		-28.52	-56.05	SpLink
Brasil	Rio Grande do Sul	Augusto Pestana	Boca da picada	-28.52	-53.99	SpLink
Argentina	Corrientes	Santo Tomé	Estancia Garruchos	-28.55	-56.05	GBIF
Brasil	Rio Grande do Sul	Porto Alegre		-28.64	-53.61	SpLink
Brasil	Rio Grande do Sul	Alegrete	Km 226 da rodovia Santa Maria, Passo Fundo	-28.64	-53.61	SpLink
Brasil	Rio Grande do Sul		11 km E de São Borja estrada para Santiago	-28.67	-55.93	SpLink
Brasil	RS	Jóia	Área 24	-28.88	-54.18	
Brasil	RS	Tupanciretã	Área 23	-28.97	-53.91	
Brasil	RS	Tupanciretã	Área 14	-29.03	-53.77	
Brasil	RS	Tupanciretã	Área 15	-29.06	-53.69	
Brasil	RS	Caxias do Sul	Ana Reck	-29.12	-51.09	
Brasil	RS	Tupanciretã	Área 22	-29.14	-53.65	
Brasil	RS	Jari	Área 26	-29.32	-54.32	
Brasil	Rio Grande do Sul	Santo Ângelo		-29.34	-49.73	SpLink
Brasil	RS	Salvador do Sul		-29.44	-51.51	
Brasil	RS	Val de Serra		-29.49	-53.69	
Brasil	RS	São Martinho da Serra	Distrito de Água Negra	-29.54	-53.86	
Brasil	RS	Costa da Cadeia		-29.70	-51.68	
Brasil	RS	Montenegro		-29.70	-51.47	
Brasil	RS	Santa Maria	Camobi	-29.70	-53.72	
Brasil	RS	Santa Maria	CISM	-29.73	-53.85	
Brasil	RS	Santa Maria	CISM	-29.73	-53.85	
Brasil	Rio Grande do Sul	Novo hamburgo	Lomba Grande	-29.75	-51.02	E- mail N´Guyen Rose MNHN-Paris
Brasil	RS	Lomba Grande		-29.75	-51.02	
Brasil	RS	Uruguaiana		-29.75	-57.08	
Brasil	Rio Grande do Sul	Uruguaiana		-29.76	-57.09	SPLink
Brasil	Alegrete	Alegrete	Cerro do Tigre	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Cruz Alta	Cerro do Tigre Fazenda Cerro do Tigre	-29.78	-55.79	SpLink

Brasil	Rio Grande do Sul	Santo Ângelo		-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Santo Ângelo	Junto ao Cerro do Tigre em afloramento rochoso	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Cerro do Tigre	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Osório		-29.89	-50.27	SPLink
Brasil	Rio Grande do Sul	Osório		-29.89	-50.27	SPLink
Brasil	Rio Grande do Sul	Osório		-29.90	-50.27	
Brasil	Rio Grande do Sul	Osório		-29.90	-50.27	
Brasil	Rio Grande do Sul	Canoas	Pq. Capão do Corvo (G. Vargas)	-29.91	-51.17	
Brasil	Rio Grande do Sul	Canoas	Pq. Capão do Corvo (G. Vargas)	-29.91	-51.17	
Brasil	Rio Grande do Sul	Cruz Alta		-29.92	-51.18	SpLink
Brasil	Rio Grande do Sul	Porto Alegre		-29.93	-51.18	SpLink
Brasil	Rio Grande do Sul	Triunfo		-29.94	-51.72	SpLink
Brasil	Rio Grande do Sul	Arroio dos Ratos	BR 290 km 65	-29.96	-51.72	SpLink
Brasil	Rio Grande do Sul	Canoas		-29.97	-51.19	GBIF
Brasil	Rio Grande do Sul	Guaíba	Patronato	-29.97	-57.30	SpLink
Brasil	Rio Grande do Sul	Porto Alegre		-30.02	-51.24	SPLink
Brasil	Rio Grande do Sul	Porto Alegre		-30.02	-51.24	SPLink
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	Email pessoal Dr. Willmot
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	Email pessoal Dr. Willmot
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	Email pessoal Dr. Willmot
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	Email pessoal Dr. Willmot
Brasil	Rio Grande do Sul	Eldorado		-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	São Jerônimo	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	São Borja	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Guaíba	Morro São Pedro	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Giruá	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.20	
Brasil	Rio Grande do Sul	Viamão	Tarumã	-30.05	-51.02	
Brasil	Rio Grande do Sul	Porto Alegre		-30.08	-51.73	SpLink
Brasil	Rio Grande do Sul	Santa Rosa	Fazenda Faxinal	-30.08	-51.73	SpLink
Brasil	Rio Grande do Sul	Pejuçara	Terras	-30.08	-51.62	SpLink
Brasil	Rio Grande do Sul	Arroio dos Ratos		-30.08	-51.72	
Brasil	Rio Grande do Sul	Arroio dos Ratos		-30.08	-51.72	
Brasil	Rio Grande do Sul	Viamão		-30.08	-51.03	
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	Personal observation
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	E-mail Nicolás Mega
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	Personal observation
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	E-mail Nicolás Mega
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.10	-55.68	E-mail Nicolás Mega

Brasil	Rio Grande do Sul	Guaíba		-30.11	-51.22	SpLink
Brasil	Santa Catarina	Capão Alto	BR 116; Km 308.	-30.11	-51.33	SpLink
Brasil	Rio Grande do Sul	Santo Ângelo	BR 116; Km 308.	-30.11	-51.33	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Ipanema	-30.12	-51.24	
Brasil	Rio Grande do Sul	Porto Alegre	Ipanema	-30.12	-51.24	
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.12	-55.72	E-mail Nicolás Mega
Brasil	Rio Grande do Sul	Arroio do Ratos	Fazenda São Maximiano	-30.18	-51.39	SpLink
Brasil	Rio Grande do Sul	Viamão	Depositadas no MZUEFS	-30.37	-51.03	
Brasil	Rio Grande do Sul	Rosário do Sul	BR-158, Km 60	-30.52	-55.07	*Observação pessoa (sem coleta)
Argentina	Corrientes	Mocoretá		-30.63	-57.97	GBIF
Brasil	Rio Grande do Sul	Santana do Livramento		-30.88	-55.52	
Uruguai	Rivera	Tranqueras	Rio Tacuarembó Grande	-31.19	-55.77	GBIF
Argentina	Entre Rios	Salto grande		-31.22	-57.93	Email pessoal Dr. Willmot
Argentina	Entre Rios	Concordia		-31.40	-58.03	
Argentina	Entre Rios	Concordia		-31.40	-58.03	
Uruguai	Tacuarembó	Tacuarembó		-31.73	-55.98	
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.33	GBIF
Brasil	Rio Grande do Sul	Pelotas		-31.77	-52.34	SPLink
Argentina	Colón	Entre Ríos		-31.87	-58.21	http://www.boldsystems.org/
Argentina	Colón	Entre Ríos		-31.88	-58.27	http://www.boldsystems.org/
Argentina	Entre Rios	Liebig		-32.13	-58.27	
Argentina	Entre Rios	Colon		-32.22	-58.13	GBIF

B.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Paraguai	San Juan de Ñeembucú	Pilar		-26.86	-58.25	Contreras AOCC. 2006
Paraguai	San Juan de Ñeembucú	Isla Umbú		-27.00	-58.25	Contreras AOCC. 2007
Paraguai	San Juan de Ñeembucú	Isla Umbú	Boquerón	-27.00	-58.38	Contreras AOCC. 2008
Paraguai	Boquerón	José Félix Estigarribia	Pq. Nac. Tte Agripino Enciso	-21.09	-61.65	Smith P. 2006. Fauna Paraguay
Argentina	Santiago del Estero	Quimilí	Ruta 94-89	-27.63	-62.42	
Argentina	Chaco	Gral. Pinedo		-27.34	-61.28	
Argentina	Chaco	Pampa del Infierno		-26.52	-61.17	
Bolívia	Santa Cruz	San Antonio de Parapeti	Rio Parapeti,	-20.02	-63.22	
Argentina	Capital Federal	Buenos Aires		-34.59	-58.67	*Butterflies of America
Argentina	La Rioja	La Rioja		-29.43	-66.85	*Butterflies of America
Argentina	Chaco	Charata		-27.22	-61.20	
Argentina	Sobremonte	Cordoba	Montanhas da Argentina Central	-29.55	-64.10	
Argentina	Formosa		Pq. Nac. Pilcomayo	-26.31	-58.83	
Argentina	Formosa		Pq. Nac. Pilcomayo	-26.31	-58.83	
Argentina	Formosa	Pilcomayo	Pq. Nac Pilcomayo	-25.07	-58.12	
Argentina	Salta	Anta	Pq. Nac. El Rey	-24.70	-64.63	
Argentina	Salta	Anta	Pq. Nac. El Rey	-24.70	-64.63	
Argentina	Entre Rios	Concordia		-31.40	-58.03	
Argentina	Buenos Aires	Ensenada	Punta Lara	-34.80	-58.00	
Argentina	Formosa	Gran Guardia		-25.87	-58.88	
Argentina	La Rioja	Los Colorados		-29.90	-67.15	
Argentina	Buenos Aires	Lujan	Rio Lujan	-34.57	-59.13	
Argentina	Salta	Oran		-23.13	-64.33	
Argentina	Salta	Oran		-23.13	-64.33	
Argentina	La Rioja	Patquia		-30.05	-66.88	
Argentina	La Rioja	Patquia		-30.05	-66.88	
Argentina	Santa Fé	Santa Fé	Cote Lai	-31.63	-60.70	
Argentina	Cordoba	Yacanto		-32.05	-65.05	
Argentina	Cordoba	Yacanto		-32.05	-65.05	
Argentina	Chaco	El Aguará		-27.19	-60.07	
Argentina	Tucumán	Concépcion		-27.33	-65.68	E-mail David Lees
Argentina	Jujuy	La Esperanza		-24.22	-64.85	E-mail David Lees
Argentina	Corrientes	Goya		-29.13	-59.27	E-mail David Lees
Uruguai	Artigas	San Gregório	Costas do Rio Uruguai	-30.55	-57.86	
Uruguai	Artigas	San Gregório		-30.55	-57.86	
Argentina	Argentina	El Charco		-27.23	-64.70	
Argentina	Argentina	Chaco, Charata		-27.22	-61.20	

Argentina	Argentina	Lorao Hablador		-25.47	-61.90	
Argentina	Central	Asunción		-25.27	-57.67	Anales de la Sociedad Científica Argentina. p. 293
Paraguai	Zanjita	Zanjita		-26.06	-57.94	http://www.pybio.org/1430/euryades/
Paraguai	Pirebebuy	Balneario Pinamar		-25.49	-56.94	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-25.07	-57.87	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-25.01	-58.09	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-24.71	-57.98	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-24.73	-58.80	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-23.91	-58.28	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-23.67	-58.49	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.62	-59.35	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.67	-59.75	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.59	-59.79	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.36	-60.03	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.00	-60.58	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.84	-62.00	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.58	-61.73	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-22.00	-60.58	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-21.43	-59.83	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-21.02	-59.79	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-20.63	-59.88	http://www.pybio.org/1430/euryades/
Paraguai	Presidente Hayes			-20.38	-60.53	http://www.pybio.org/1430/euryades/
Paraguai	Alto Paraguay			-19.87	-58.80	http://www.pybio.org/1430/euryades/
Argentina	Formosa	Laguna Blance	Río Pilcomayo National Park	-25.12	-58.17	http://goo.gl/aCwQkI

Appendix S2: Occurrence data gathered from JSTOR Global Plants (JSTOR), Global Biodiversity Information Facility (GBIF), Species Link (SPlink), surveys in museum collections, personal field observations and literature research for (A) *Aristolochia sessilifolia,* (B) *Aristolochia fimbriata* e (C) *Aristolochia lingua*, (D) *Aristolochia labiata* and (E) *Aristolochia angustifolia.*

A.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Argentina	Misiones	Capital	Posadas	-27.38	-55.88	JSTOR
Argentina	Corrientes	Santo Tomé		-28.52	-56.05	SpLink
Brasil	Santa Catarina	Campos Novos		-27.40	-51.23	SpLink
Brasil	Rio Grande do Sul	Triunfo		-29.94	-51.72	SpLink
Brazil	Rio Grande do Sul	Canoas		-29.93	-51.18	SpLink
Brazil	Rio Grande do Sul	Alegrete	Cerro do Tigre	-29.78	-55.79	SpLink
Brazil	Mato Grosso	São José do Xingu		-10.83	-52.87	SpLink
Brasil	Rio Grande do Sul	Guaíba	Passo do Petim, Fazenda São Maximiano; BR 116; Km 308.	-30.11	-51.33	SpLink
Brasil	Rio Grande do Sul	J. Maria	Patronato	-29.97	-57.30	SpLink
Brazil	Rio Grande do Sul	Augusto Pestana	Boca da picada	-28.52	-53.99	SpLink
Brazil	Rio Grande do Sul	Pejuçara	Estrada para J. Maria, Patronato	-28.42	-53.66	SpLink
Brazil	Rio Grande do Sul	Eldorado	Terras	-30.08	-51.62	SpLink
Brasil	Rio Grande do Sul	Porto Alegre		-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Arroio dos Ratos		-30.08	-51.73	SpLink
Brasil	Rio Grande do Sul	São Jerônimo	BR 290 km 65	-29.96	-51.72	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Cruz Alta		-28.64	-53.61	SpLink
Brasil	Rio Grande do Sul	Alegrete	Cerro do Tigre Fazenda Cerro do Tigre	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Santa Rosa	20 km SE de Santa Rosa	-27.69	-54.65	SpLink
Brasil	Rio Grande do Sul	Arroio do Ratos	Fazenda Faxinal	-30.08	-51.73	SpLink
Brasil	Rio Grande do Sul	Guaíba	Fazenda São Maximiano	-30.18	-51.39	SpLink
Brasil	Rio Grande do Sul	Vila Nova		-30.11	-51.22	SpLink
Brasil	Rio Grande do Sul	Ronda Alta	estrada Ronda Alta a Passo Fundo	-27.91	-52.75	SpLink
Brasil	Rio Grande do Sul	Lagoa Vermelha - Sananduva	7 km de Lagoa Vermelha	-28.20	-51.62	SpLink
Brasil	Rio Grande do Sul	São Borja	11 km E de São Borja estrada para Santiago	-28.67	-55.93	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Occurrence do Sul	Santo Ângelo	Granja Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Alegrete	continuação da estrada Alegrete Cerro do Tigre	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Santo Ângelo		-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Alegrete	junto ao Cerro do Tigre em afloramento rochoso	-29.78	-55.79	SpLink

Brasil	Rio Grande do Sul	Santo Ângelo		-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Passo Fundo	entre Passo Fundo e Ronda Alta	-28.26	-52.41	SpLink
Brasil	Rio Grande do Sul	Santo Antônio das Missões		-28.51	-55.23	SpLink
Brasil	Rio Grande do Sul	Santo Ângelo	Fazenda Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Guaíba	Fazenda São Maximiano Passo do Petim BR 116 Km 308	-30.11	-51.33	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	morro São Pedro	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Santo Ângelo	Granja Piratini	-28.30	-54.26	SpLink
Brasil	Rio Grande do Sul	Torres		-29.34	-49.73	SpLink
Brasil	Rio Grande do Sul	Giruá	Granja Sodol	-28.03	-54.35	SpLink
Brasil	Rio Grande do Sul	Porto Alegre	Morro do Osso	-30.03	-51.23	SpLink
Brasil	Rio Grande do Sul	Alegrete	Cerro do Tigre	-29.78	-55.79	SpLink
Brasil	Rio Grande do Sul	Cruz Alta	Km 226 da rodovia Santa Maria, Passo Fundo	-28.64	-53.61	SpLink
Brasil	Rio Grande do Sul	Canoas		-29.92	-51.18	SpLink
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	Observação pessoal
Brasil	Rio Grande do Sul	Alegrete	Fundação Marona	-30.09	-55.69	Observação pessoal
Argentina	Corrientes	Mocoretá		-30.63	-57.97	GBIF
Uruguai	Rivera	Tranqueras	Tranqueras, au long du rio Tacuarembó grande	-31.19	-55.77	GBIF
Brazil	Rio Grande do Sul	Erebango	Erebango	-27.86	-52.30	GBIF
Brazil	Rio Grande do Sul	Canoas	Canoas, in arenosis siccis, subnudis ad viam ferream	-29.97	-51.19	GBIF
Argentina	Corrientes	Santo Tomé	Estancia Garruchos	-28.55	-56.05	GBIF
Brazil	Santa Catarina	Campos Novos	Rod. BR-470, próximo à divisa com Erval do Oeste	-27.42	-51.21	GBIF
Argentina	Misiones	Capital	Sotobosque sobre Ruta 12	-27.48	-55.92	GBIF
Argentina	Misiones	Capital	Posadas	-27.38	-55.90	GBIF
Argentina	Misiones	Capital	Posadas	-27.38	-55.90	GBIF
Argentina	Misiones	Candelaria	cerca de Santa Ana	-27.38	-55.58	GBIF
Argentina	Misiones	San Ignacio	desvio a Cnia.Alberdi, 5 km ruta 14	-27.27	-55.48	GBIF
Argentina	Misiones	Candelaria	cerca de Santa Ana	-27.38	-55.58	GBIF
Argentina	Misiones	San Ignacio	desvio a Cnia.Alberdi, 5 km ruta 14	-27.27	-55.48	GBIF
Argentina	Misiones		Cainguas	-27.18	-54.83	GBIF
Argentina	Misiones	Montecarlo	Puerto Rico	-26.80	-55.02	GBIF
Argentina	Misiones	General San Martín	Puerto Rico	-26.88	-54.92	GBIF
Paraguay	Caaguazú		Caaguazú	-25.45	-56.02	GBIF

B.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Argentina	Misiones		Ruta Prov. 103, de Oberá a Santa Ana	-27.40	-55.50	GBIF
Argentina	Misiones		Ruta 2, camino de C. de la Sierra a Sta. María	-27.97	-55.43	GBIF

Argentina	Misiones		Vieja ruta 14 de San José a Cerro Azul	-27.75	-55.63	GBIF
Argentina	Corrientes		Ayo. Garabí. 10 Km E de Gdor.	-28.21	-56.23	GBIF
Bolivia	Chuquisaca		Ipauso, zona Laguna del Medio	-20.72	-63.10	GBIF
Argentina	Corrientes		RN 126, a pocos km de Curuzú-Cuatiá.	-29.64	-58.37	GBIF
Uruguai	Soriano		Ruta 21, 1 km antes de Nueva Palmira	-34.91	-56.19	GBIF
Argentina	Entre Ríos		Ruta Prov. 32, Km 19	-32.08	-60.49	GBIF
Argentina	Misiones		Santa María	-27.93	-55.41	GBIF
Argentina	Corrientes		10 km E de Gdor. Virasoro, camino a Garruchos.	-28.04	-55.88	GBIF
Argentina	Entre Ríos		Río Gualeyán	-33.00	-58.81	GBIF
Argentina	Entre Ríos		Parque Unzué	-33.00	-58.81	GBIF
Argentina	Entre Ríos		Río Guayquiraró, Sarandí-Corá	-30.89	-59.54	GBIF
Argentina	Entre Ríos		Ruta 126 a Paraná	-30.89	-59.54	GBIF
Argentina	Entre Ríos		Raíces Oeste	-31.62	-59.05	GBIF
Argentina	Entre Ríos		Colonia Berduc	-31.67	-60.05	GBIF
Argentina	Entre Ríos		Reserva Provincial de Uso Múltiple Enrique Berduc	-31.67	-60.05	GBIF
Argentina	Misiones		Campina de Belisario	-27.02	-54.27	GBIF
Argentina	Misiones		Escuela Provincial El Yazá.	-27.36	-55.07	GBIF
Argentina	Misiones		Caá-Yarí. Cercanías de arroyo Arriame.	-27.51	-55.29	GBIF
Paraguai	Paraguarí		Estancia Barrerito	-26.23	-57.07	GBIF
Argentina	Entre Ríos		Ruta 39 al W de Caseros.	-32.45	-58.55	GBIF
Venezuela	Distrito Federal		Jardin Botanico	10.50	-66.89	GBIF
Argentina	Buenos Aires		Paso del Rey	-34.63	-58.75	GBIF
Brasil	Santa Catarina		Near Encruzilhada de Boava, 8 km south of Sao Joaquim	-28.30	-49.90	GBIF
Brasil	Paraná		Santana	-25.59	-49.32	GBIF
Bolivia	Santa Cruz		Parque Nacional Kaa-Iya del Gran Chaco, Estancia El Cañon	-19.02	-60.27	GBIF
Argentina	Misiones		Ruta 2, camino de C. de la Sierra a Sta. María	-27.97	-55.43	GBIF
Argentina	Corrientes		RN 126, a pocos km de Curuzú-Cuatiá.	-29.79	-58.05	GBIF
Argentina	Misiones		Ruta Prov. 103, de Oberá a Santa Ana, 2 km pasando Mártires	-27.40	-55.50	GBIF
Brasil	Rio Grande do Sul		Sarandí. ad flumen Alto Uruguay	-27.94	52.92	GBIF
Argentina	Formosa		Ayo. Salado, 32 Km S de Formosa	-26.42	-58.24	GBIF
Uruguai	Paysandu		Chapicuy, Orillas del río Uruguay	-31.67	-57.88	GBIF
Argentina	Formosa		Arishe; Tostada; Cerón Lárshí	-26.18	-58.18	GBIF
Argentina	Entre Ríos		On bushes by road	-32.17	-58.23	GBIF
Argentina	Corrientes		4 km E de C. Cuatiá, Ayo. C. Cuatiá, Paso de las Niñas	-29.80	-58.02	GBIF
Argentina			Capital Federal, Villa Ortúzar	-34.58	-58.47	GBIF
Uruguai	Colonia		5 km NE of Route 22 on Route 1, (Km 144), Arroyo Sauce	-34.38	-57.53	GBIF
Argentina	Buenos Aires		Parque Regional, Forestal y Botánico Rafael de Aguiar.	-33.30	-60.23	GBIF
Bolivia	Chuquisaca		Saliendo de Huacareta, Hacienda San Antonio	-20.79	-64.08	GBIF

Uruguai			Montevideo	-34.81	-56.17	GBIF
Argentina	San Fernando			-34.44	-58.57	JSTOR
Argentina	Buenos Aires	Las Palmas		-34.08	-59.16	JSTOR
Argentina	Corrientes	Monte Caseros	Estancia La Potota	-30.25	-57.65	JSTOR
Argentina	Formosa	San Franciso de Laishi		-26.24	-58.63	JSTOR
Argentina	Misiones	Concepcíon	Concepcion de la Sierra	-27.98	-55.52	JSTOR
Uruguai	Montevideo	Montevideo		-34.86	-56.17	JSTOR
Brasil	Distrito Federal	Brasília		-15.78	-47.92	JSTOR
Brasil	Rio Grande do Sul	Bom Jesus	Fazenda Bernardo Velho	-28.70	-50.40	JSTOR
Argentina	Misiones	Concepción	Santa Maria	-27.93	-55.41	JSTOR
Argentina	Entre Ríos	Paraná	Parque Nacional General San Martín	-31.75	-60.35	JSTOR
Argentina	Buenos Aires	La Plata	Facultad de Agronomia	-34.91	-57.93	JSTOR
Argentina	Entre Ríos			-31.69	-58.15	JSTOR
Argentina	Buenos Aires	San Fernando		-34.47	-58.61	JSTOR
Argentina	Buenos Aires	San Isidro		-34.47	-58.53	JSTOR
Uruguai	Entre Ríos	Concepción de Uruguay	Parque La Salamanca	-32.47	-58.23	JSTOR
Argentina	Entre Ríos	Arroyo Urquiza		-32.38	-58.23	JSTOR
Brasil	Rio Grande do Sul	Alegrete		-29.69	-56.04	JSTOR
Argentina	Entre Ríos	Villa Maria Grande		-31.69	-60.16	JSTOR
Argentina	Entre Ríos	Federacíon		-31.00	-57.90	JSTOR
Argentina	Entre Ríos	Arroyo Urquiza		-32.38	-58.23	JSTOR
Argentina	Entre Ríos	Gualegay		-32.85	-59.80	JSTOR
Argentina	Buenos Aires	Belgrano		-34.56	-58.44	JSTOR
Argentina	Entre Ríos	Concordia		-31.40	-58.03	JSTOR
Argentina	Entre Ríos	La Paz	Sarandi-Cora	-30.72	-59.46	JSTOR
Argentina	Entre Ríos	Gualeguaychú	Parque Unzué	-33.01	-58.50	JSTOR
Argentina	Corrientes	Sauce		-29.91	-58.41	JSTOR
Argentina	Buenos Aires	Tigre		-34.43	-58.60	JSTOR
Argentina	Distrito Federal	Buenos Aires	Saavedra	-37.75	-62.37	JSTOR
Argentina	Buenos Aires	General San Martin		-34.57	-58.55	JSTOR
Argentina	Entre Ríos	Diamante	Diamante	-32.06	-60.64	JSTOR
Argentina	Entre Ríos	Gualeguaychú	Gualeguaychú	-33.01	-58.52	JSTOR
Argentina	Formosa	Formosa	Reserve Faunística de Guaycolet	-26.25	-58.30	JSTOR
Argentina	Misiones	Apóstoles		-27.75	-55.84	JSTOR
Argentina	Entre Ríos	Tala	Maciá	-32.27	-59.40	JSTOR
Argentina	Chaco	Bermejo		-26.93	-58.50	JSTOR
Argentina	Distrito Federal	Buenos Aires	Palermo	-34.58	-58.42	JSTOR
Argentina	Entre Ríos	Villaguay	Raíces Oeste	-31.90	-59.27	JSTOR
Argentina	Entre Ríos	Villaguay	Raíces Oeste	-31.90	-59.27	JSTOR
Argentina	Chaco	Gal Vedia		-23.94	-58.66	SPLink

Country	State/Province/Department	City	Locale	Latitude	Longitude		Source
Brasil	Mato Grosso do Sul	Campo Grande	RPPN da UFMS.	-20.44	-54.65		SPLink
Brasil	Rio de Janeiro	Rio de Janeiro	Jardim Botânico.	-22.90	-43.21		SPLink
Brasil	Santa Catarina	São Joaquim	Fazenda Araucária, na barra do Rio Postinho com o Rio Rondinha	-28.29	-49.93		SPLink
Brasil	Rio Grande do Sul	Augusto Pestana	J. Miguel	-28.52	-53.99		SPLink
Brasil	São Paulo	Nova Odessa	Instituto Plantarum	-22.78	-47.30		SPLink
Argentina	La Plata	Punta Lara		-34.82	-57.99		SPLink
Argentina	Corrientes	Monte Caseros	Ruta 122 y Ayo. Timboy, 13 km W de Monte Caseros	-30.24	-57.78		SPLink
Brasil	Minas Gerais	Ouro Preto		-20.29	-43.51		SPLink
Brasil	São Paulo	Campinas	Instituto Agron.	-22.90	-47.06		SPLink
Brasil	Rio Grande do Sul	Santa Margarida do Sul	Br 290 km 397	-30.35	-54.12		SPLink
Argentina	Corrientes	Curuzú Cuatiá	Curuzú Cuatiá	-29.79	-58.05		SPLink
Argentina	Corrientes		Ituzaingó Ruta 34 y Río Aguapey	-27.59	-56.69		SPLink
Brasil	Rio Grande do Sul	São Gabriel	BR 290	-30.35	-54.12		SPLink
Brasil	Rio Grande do Sul	Alegrete	Reserva Biológica do Ibirapuitã	-29.92	-55.77		SPLink
Uruguai	Colonia		Puente sobre Arr. Rosario Chico.	-34.17	-57.13		SPLink
Brasil	Pará	Oriximiná		-13.04	-56.16		SPLink
Argentina	Buenos Aires	Las Palmas		-34.08	-59.17		SPLink
Brasil	Santa Catarina	Sao Joaquim	Near Encruzilhada de Boava	-28.29	-49.93		SPLink
Brasil	Paraná	Cruz Machado	Santana	-26.02	-51.35		SPLink
Brasil	Rio Grande do Sul	Sarandi	Sarandí. ad flumen Alto Uruguay	-27.94	-52.92		SPLink

C.

Country	State/Province/Department	City	Locale	Latitude	Longitude		Source
Argentina			Campo Santo	-24.66	-65.10		GBIF
Argentina	La Paz		Caleras del Portillo	-29.38	-65.20		GBIF
Argentina	Catamarca	La Paz	La Brea	-29.20	-65.17		SPLink
Argentina	Orán		Urundel	-23.13	-64.33		GBIF
Argentina	Paclin		San Antonio	-28.09	-65.66		GBIF
Argentina			Catamarca	-27.00	-67.00		GBIF
Argentina	General Güemes		A 31 km del cruce de la ruta Juana Azurduy, en direcc. N por el camino hacia Nva. Pompeya.	-25.28	-61.52		GBIF
Argentina	General Güemes		A 20 km del cruce de la RN 9 (Miraflores-Castelli) en direcc. N hacia El Espinillo.	-25.70	-60.60		GBIF
Argentina	General Güemes		20 km al NW de Fuerte Esperanza, por la ruta Juana Azurduy (RP 52).	-25.07	-62.02		GBIF
Argentina	General Güemes		20 km al NW de Fuerte Esperanza, por la ruta Juana Azurduy (RP 52).	-25.07	-62.02		GBIF

País	Provincia	Departamento	Localidad	Lat	Long	Fuente
Argentina	General Güemes		A 31 km del cruce de la ruta Juana Azurduy, en direcc. N por el camino hacia Nva. Pompeya.	-25.28	-61.52	GBIF
Argentina	General Güemes		A 20 km del cruce de la RN 9 (Miraflores-Castelli) en direcc. N hacia El Espinillo.	-25.70	-60.60	GBIF
Argentina			Argentina	-27.00	-65.50	GBIF
Argentina	Jujuy	Ledesma	Calilegua, camino aledaño a un baldio. Tierra negra.	-23.83	-64.77	SPLink
Argentina	El Carmen		Ruta 66, camino a San Salvador de Jujuy, 500 km empalme R 34	-24.44	-65.15	GBIF
Argentina			Argentina	-27.00	-65.50	GBIF
Argentina	Departamento de Federacion		Federacion	-30.32	-58.33	GBIF
Argentina	Metán		Ruta Nac. 9, 27 Km de Metán camino a Gral. Güemes	-25.40	-64.92	GBIF
Argentina	El Carmen		Ruta Prov. 43, 4 km de la Ruta Nac. 34 camino a El Carmen	-24.47	-65.08	GBIF
Argentina	Metán		Ruta Nac. 9, 27 Km de Metán camino a Gral. Güemes.	-25.40	-64.92	GBIF
Paraguai			Isla Poi, Chaco Paraguayo	-22.50	-59.73	GBIF
Argentina	Trancas		Tapia	-26.32	-65.40	GBIF
Argentina	Trancas		Tapia	-26.32	-65.40	GBIF
Argentina	Capital		Autopista de acceso a la ciudad Km 1554	-24.75	-65.12	GBIF
Argentina	Capital		Autopista de acceso a la ciudad Km 1554	-24.75	-65.12	GBIF
Argentina	Ledesma		Calilegua, camino aledaño a un baldáo	-23.77	-64.78	GBIF
Argentina	Ledesma		Calilegua, camino aledaño a un baldáo	-23.77	-64.78	GBIF
Argentina	Pellegrini		Monte Quemado	-25.80	-62.87	GBIF
Argentina	Trancas		Vipos	-26.22	-65.28	GBIF
Argentina	Leales		Chañar Pozo	-27.19	-65.13	GBIF
Argentina	Cruz Alta		Las Cejas	-26.92	-64.99	GBIF
Argentina	La Viña		Ruta Nacional 68, 6 km al Sur de La Viña, camino a Cafayate	-25.48	-65.57	GBIF
Argentina	La Viña		Ruta Nacional 68, 6 km al Sur de La Viña, camino a Cafayate	-25.48	-65.57	GBIF
Argentina	Catamarca	San Antonio		-28.03	-65.68	JSTOR
Argentina	Tucumán	Burruyacu		-26.50	-64.75	JSTOR
Argentina	Salta	General Guemes		-24.67	-65.05	JSTOR
Argentina	Santiago de Estero	Fortín Inca		-29.12	-61.95	JSTOR
Argentina	Salta	Rosario de Lerma		-24.98	-65.58	JSTOR
Argentina	Tucumán	Trancas		-26.22	-65.28	JSTOR
Argentina	Jujuy	El Carmen		-24.38	-65.27	JSTOR
Argentina	Tucumán	Cruz Alta		-26.88	-64.73	JSTOR
Argentina	Salta	Orán	Ruta 50, Río Zenta, 8 km N de Orán.	-23.13	-64.33	JSTOR
Argentina	Salta	Orán	Urundel	-22.73	-64.36	JSTOR
Argentina	Tucumán	Trancas	Vipos	-26.22	-65.28	JSTOR
Argentina	Tucumán	Leales	Chañar Pozo	-27.19	-65.13	JSTOR
Argentina	Santiago de Estero	Santa Rosa Aguirre		-28.83	-63.35	JSTOR

D.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Brasil	Santa Catarina	Taió	Barragem no Rio Itajaí do Oeste	-27.1158	-49.9978	SPLink
Brasil	Santa Catarina		Luís Alves. Luís Alves	-26.7208	-48.9328	SPLink
Brasil	Santa Catarina		Luís Alves. Luís Alves	-26.7208	-48.9328	GBIF
Brasil	São Paulo	Itaberá	Quase na divisa Itaberá-Itapeva	-23.9587	-48.9502	SPLink
Brasil	São Paulo	Ilhabela	Ilha Vitória-Litoral Norte	-23.8150	-45.3706	SPLink
Brasil	São Paulo	Buri	Estação Experimental do Instituto Florestal	-23.7975	-48.5928	SPLink
Brasil	São Paulo	Taquarituba	Estrada de terra de Taquarituba - Itapeva	-23.7521	-49.1521	SPLink
Brasil	São Paulo	Ibiúna	Bairro Sorocabuçu, 8 km da estrada SP-250, no km 63	-23.7055	-47.1898	SPLink
Brasil	São Paulo	Itapetininga	E.E.Instituto Florestal	-23.7000	-47.9500	SPLink
Brasil	São Paulo	Ibiúna	Bairro do Morro Grande	-23.6599	-47.2235	SPLink
Brasil	São Paulo	Rodhia		-23.6481	-46.7316	SPLink
Brasil	São Paulo	Sarapuí		-23.6408	-47.8250	SPLink
Brasil	São Paulo	São Paulo	Jardim Botânico-Nativa no Jardim Botânico	-23.6396	-46.6222	SPLink
Brasil	São Paulo	São Paulo	Jardim Botânico. Cultivada no campo experimental	-23.6387	-46.6272	SPLink
Brasil	São Paulo	São Paulo		-23.5917	-46.6566	SPLink
Brasil	São Paulo	São Paulo	Ibirapuera. Cultivado nos viveiros da Prefeitura	-23.5878	-46.6558	SPLink
Brasil	São Paulo	São Paulo	Rio Pequeno, Butantan	-23.5663	-46.7566	SPLink
Brasil	São Paulo	São Paulo	Butantan. Horto Oswaldo Cruz	-23.5661	-46.7184	SPLink
Brasil	São Paulo	São Paulo	Horto Oswaldo Cruz	-23.5661	-46.7184	SPLink
Brasil	São Paulo	São Paulo	Horto Oswaldo Cruz	-23.5661	-46.7184	SPLink
Brasil	São Paulo	Taquarituba		-23.5377	-49.2394	SPLink
Brasil	São Paulo	Araçoiaba da Serra	Bairro do Barreiro	-23.5227	-47.5848	SPLink
Brasil	São Paulo		Estrada São Paulo - Itapetininga, bacia do Ribeirão Lajeado	-23.5167	-47.3333	SPLink
Brasil	São Paulo	São Roque	Morro do Saboó e proximidades	-23.5141	-47.1517	SPLink
Brasil	São Paulo	Sorocaba		-23.5019	-47.4578	SPLink
Brasil	São Paulo	Sorocaba		-23.4797	-47.4071	SPLink
Brasil	São Paulo	Sorocaba		-23.4797	-47.4071	SPLink
Brasil	São Paulo		Guarulhos.	-23.4667	-46.5333	SPLink
Brasil	São Paulo	Angatuba	Estação Ecológica de Angatuba (IF)	-23.4239	-48.3506	SPLink
Brasil	São Paulo	Angatuba	Estação Ecológica de Angatuba (IF)	-23.4239	-48.3506	SPLink
Brasil	São Paulo	Sorocaba	na margem do rio.	-23.4183	-47.4538	SPLink
Brasil	São Paulo	Itú		-23.2639	-47.2989	SPLink
Brasil	São Paulo	Jundiaí		-23.1858	-46.8839	SPLink
Brasil	São Paulo	Indaiatuba		-23.0900	-47.2178	SPLink
Brasil	Rio de Janeiro	Rio de Janeiro		-23.0216	-44.7308	SPLink
Brasil	São Paulo	Capivari	Along road	-22.9800	-47.5073	SPLink

Brasil	Rio de Janeiro	Rio de Janeiro		-22.9668	-43.2252	SPLink
Brasil	Rio de Janeiro	Rio de Janeiro	Jardim Botânico.	-22.9594	-43.2220	SPLink
Brasil	Rio de Janeiro	Rio de Janeiro	Jardim Botânico.	-22.9594	-43.2220	SPLink
Brasil	Rio de Janeiro	Rio de Janeiro	Jardim Botânico.	-22.9594	-43.2220	SPLink
Brasil	Rio de Janeiro		Jardim Botânico.	-22.9594	-43.2220	GBIF
Brasil	Rio de Janeiro			-22.9594	-43.2220	GBIF
Brasil	Rio de Janeiro		Jardim Botânico.	-22.9594	-43.2220	GBIF
Brasil	Rio de Janeiro		Jardim Botânico.	-22.9594	-43.2220	GBIF
Brasil	São Paulo	Campinas	Fazenda Santa Elisa	-22.9056	-47.0608	SPLink
Brasil	São Paulo	Campinas	IAC, Fazenda Santa Elisa	-22.9056	-47.0608	SPLink
Brasil	São Paulo	Botucatu	A beira de riacho sobre outras plantas	-22.8858	-48.4450	SPLink
Brasil	São Paulo	Sumaré	Horto Florestal	-22.8561	-47.2613	SPLink
Brasil	São Paulo	Campinas		-22.8167	-47.1000	SPLink
Brasil	São Paulo		Institituto de Zootecnica.	-22.7371	-47.3309	GBIF
Brasil	São Paulo	Piracicaba		-22.7253	-47.6492	SPLink
Brasil	Rio de Janeiro	Rio Bonito		-22.7148	-42.6265	SPLink
Brasil	São Paulo	Piracicaba	Horto Florestal de Tupi	-22.7122	-47.6342	SPLink
Brasil	São Paulo	Piracicaba	Mata do Eucalipto, Estrada de Limeira	-22.6767	-47.5681	SPLink
Brasil	São Paulo	Areias		-22.5796	-44.7002	SPLink
Brasil	Rio de Janeiro	Silva Jardim	Reserva Biológica de Poço das Antas	-22.5438	-42.2780	SPLink
Brasil	Rio de Janeiro		Reserva Biológica de Poço das Antas	-22.5438	-42.2780	GBIF
Brasil	Rio de Janeiro	Itatiaia	Monte Serrat.	-22.4580	-44.5791	SPLink
Brasil	São Paulo	Moji Mirim		-22.4419	-46.9430	SPLink
Brasil	São Paulo	Ipeúna		-22.4358	-47.7189	SPLink
Brasil	São Paulo	Brotas		-22.4254	-48.0207	SPLink
Brasil	São Paulo	Rio Claro	Câmpus da UNESP	-22.3971	-47.5478	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.3306	-47.4888	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.3306	-47.4888	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.3306	-47.4888	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.3306	-47.4888	SPLink
Brasil	São Paulo	Mogi Guaçu	Fazenda Campininha-Martinho Prado	-22.2911	-47.1302	SPLink
Brasil	São Paulo	Mogi Guaçu	Martinho Prado, Reserva Biológica da Fazenda Campininha	-22.2911	-47.1302	SPLink
Brasil	São Paulo	Mogi Guaçu	Martinho Prado, Reserva Biológica da Fazenda Campininha	-22.2911	-47.1302	SPLink
Brasil	São Paulo	Mogi Guaçu	Mata da Mariana. Córrego da Divisa	-22.2911	-47.1302	SPLink
Brasil	São Paulo	Mogi Guaçu	Reserva Biológica e Estação Experimental da cidade.	-22.2911	-47.1302	SPLink
Brasil	Rio de Janeiro	Nova Friburgo	Próx. do colégio Anchieta.	-22.2738	-42.5362	SPLink
Brasil	São Paulo	Mogi Guaçu	Reserva Biológica e Estação Experimental de Mogi Guaçu	-22.2539	-47.1698	SPLink
Brasil	São Paulo	Mogi Guaçu	Reserva Biológica e Estação Experimental de Mogi Guaçu	-22.2532	-47.1700	SPLink

Brasil	São Paulo	Mogi Guaçu	Reserva Biológica e Estação Experimental de Mogi Guaçu	-22.2530	-47.1678	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.2210	-47.6220	SPLink
Brasil	São Paulo	Rio Claro	Fazenda São José	-22.2210	-47.6220	SPLink
Brasil	São Paulo	Rancho Alegre	Fazenda São José	-22.2210	-47.6220	SPLink
Brasil	São Paulo	Rancho Alegre	Fazenda São José	-22.2210	-47.6220	SPLink
Brasil	São Paulo	Analândia	Camping do Escorrega	-22.1258	-47.6627	SPLink
Brasil	São Paulo		São Carlos do Pinhal.	-22.0178	-47.8908	GBIF
Brasil	São Paulo		São Carlos do Pinhal.	-22.0075	-47.8909	SPLink
Brasil	São Paulo	Pirassununga	Instituto de Zootecnica.	-21.9816	-47.4306	SPLink
Brasil	Minas Gerais	Lima Duarte	Serra do Ibitipoca. Estrada para Moreiras. Mata estacional alterada.	-21.6994	-43.9142	SPLink
Brasil	Minas Gerais		Serra do Ibitipoca. Estrada para Moreiras. Mata estacional alterada.	-21.6994	-43.9142	GBIF
Brasil	São Paulo	Cássia dos Coqueiros	Cachoeira Itambé. Beira de estrada para o mirante	-21.4694	-47.2889	SPLink
Brasil	São Paulo	Avanhandava	Margem da estrada Avanhandava - Barbosa, a ca. 8 km de Barbosa	-21.4608	-49.9500	SPLink
Brasil	Minas Gerais	Alfenas	RPPN Jequitibá.	-21.4177	-45.9318	SPLink
Brasil	Minas Gerais		RPPN Jequitibá.	-21.4177	-45.9318	GBIF
Brasil	São Paulo	Cassia dos Coqueiros	margem do Rio Boiadeiro, cachoeira Itambé, próximo da estrada.	-21.3333	-47.1333	SPLink
Brasil	São Paulo	Itapetininga	Bacia do Ribeirão Lajcado.	-21.3151	-50.0159	SPLink
Brasil	Minas Gerais	Barroso	Mata do Baú	-21.1869	-43.9758	SPLink
Brasil	Minas Gerais	Barroso	Mata do Baú	-21.1869	-43.9758	SPLink
Brasil	Minas Gerais	Barroso	Mata do Baú	-21.1869	-43.9758	SPLink
Brasil	Minas Gerais	São João del Rei	.	-21.1358	-44.2619	SPLink
Brasil	Minas Gerais	São João Del Rei		-21.1358	-44.2619	SPLink
Brasil	Minas Gerais	São João Del Rei	Distrito de Rio das Mortes (Goiabeiras).	-21.1358	-44.2619	SPLink
Brasil	Minas Gerais	São João Del Rei		-21.1358	-44.2619	SPLink
Brasil	Minas Gerais	Água Limpa	Estação Experimental	-21.0381	-44.6013	SPLink
Brasil	Minas Gerais	Água Limpa	Estação Experimental	-21.0381	-44.6013	SPLink
Brasil	Minas Gerais	Bomsucesso		-21.0328	-44.7578	SPLink
Brasil	Minas Gerais	Hermilo Alves	.	-21.0215	-43.7862	SPLink
Brasil	Minas Gerais	Carandaí	Fumaça.	-20.9506	-43.8006	SPLink
Brasil	Espírito Santo	Domingos Martins	.	-20.3667	-40.6667	SPLink
Brasil	Minas Gerais	Ouro Preto	Estrada Ouro Preto - Ouro Branco	-20.2624	-43.3349	SPLink
Brasil	Minas Gerais	Ouro Preto	Estrada Ouro Preto - Ouro Branco	-20.2624	-43.3349	SPLink
Brasil	Espirito Santo	Cariacica	Arredores da Reserva Biológica de Duas Bocas	-20.2422	-40.5222	SPLink
Brasil	Minas Gerais	Brumadinho	Inhotim, Próximo à casa do pesquisador.	-20.1261	-44.2186	SPLink
Brasil	Minas Gerais	Rio Casca	Fazenda Esmeralda	-20.1237	-42.6298	SPLink
Brasil	Minas Gerais	perto de Frutal		-20.0148	-48.9764	SPLink
Brasil	Sergipe	Capela	Refugio de Vida Silvestre Mata do Junco	-19.9619	-40.4068	SPLink

Brasil	Espírito Santo	Santa Teresa	Estrada p/ João Neiva	-19.9358	-40.6167		SPLink
Brasil	Espírito Santo	Santa Teresa	São Lourenço	-19.9311	-40.6206		SPLink
Brasil	Minas Gerais	Belo Horizonte	Horto Florestal	-19.8995	-43.9140		SPLink
Brasil	Minas Gerais	Belo Horizonte	Horto Florestal	-19.8995	-43.9140		SPLink
Brasil	Espírito Santo	Ibiraçu	Estação Ecológica, Morro da Vargem	-19.8894	-40.3769		SPLink
Brasil	Espírito Santo	Ibiraçu	Estação Ecológica do Morro da Vargem. Caminho do mirante 3.	-19.8833	-40.3833		SPLink
Brasil	Espírito Santo	Ibiraçu	Estação Ecológica do Morro da Vargem, Trilha do Mirante 3	-19.8833	-40.3833		SPLink
Brasil	Minas Gerais		Lagoa Preta-margem do Rio Paraopeba-MG.	-19.4167	-47.3667		SPLink
Brasil	Minas Gerais	S.Sebastiao do Ouro Preto		-19.2919	-43.1739		SPLink
Brasil	Minas Gerais	Morro do Pilar	Estrada Real	-19.2156	-43.3764		SPLink
Brasil	Minas Gerais	Conceição do Mato Dentro		-19.0369	-43.4250		SPLink
Brasil	Minas Gerais	Conceição do Mato Dentro		-19.0369	-43.4250		SPLink
Brasil	Minas Gerais	Serro	Sapo	-19.0369	-43.4250		SPLink
Brasil	Minas Gerais	Conceição do Mato Dentro		-19.0334	-43.4229		SPLink
Brasil	Espírito Santo	Águia Branca	Rochedo, propr.: Arlindo Breda	-18.9446	-40.8021		SPLink
Brasil	Minas Gerais	Congonhas do Norte	Congonhas do Norte, arredores	-18.8069	-43.6808		SPLink
Brasil	Minas Gerais	Alvorada de Minas	Rio das Pedras, Rod. MG-010	-18.7334	-43.3639		SPLink
Brasil	Espírito Santo	São Mateus	Palmitinho (estrada que liga São Mateus a fazenda Alegre)	-18.7161	-39.8589		SPLink
Brasil	Minas Gerais	Presidente Kubitschek	Estrada Tombadouro/Costa Sena, ca. 2,0Km do Distrito de Costa Sena.	-18.6500	-43.6764		SPLink
Brasil	Espírito Santo	Pinheiros	Reserva Biológica de Córrego do Veado	-18.3625	-40.1621		SPLink
Brasil	Espírito Santo	Pinheiros	Reserva Biológica de Córrego do Veado	-18.3625	-40.1621		SPLink
Brasil	Espírito Santo	Pinheiros	REBIO, Córrego do Veado	-18.3528	-40.1486		SPLink
Brasil	Minas Gerais	Diamantina	.	-18.2500	-43.6000		SPLink
Brasil	Goiás	Catalão	.	-18.1680	-47.9408		SPLink
Brasil	Minas Gerais		Próximo ao Córrego Soberbo, estrada Diamantina - Biri-Biri	-18.1671	-43.6165		SPLink
Brasil	Minas Gerais	Mendanha	Close to River Jequitinhonha along road	-18.1109	-43.5336		SPLink
Brasil	Bahia	Guaratinga	estrada para Cajuita	-16.5842	-39.7828		SPLink
Brasil	Goiás	Nerópolis	Parque Estadual Altamiro de Moura Pacheco - PEAMP	-16.5203	-49.1692		SPLink
Brasil	Goiás		Parque Estadual Altamiro de Moura Pacheco - PEAMP	-16.5203	-49.1692		GBIF
Brasil	Goiás	Abadiânia	Beira de córrego	-16.2039	-48.7069		SPLink
Brasil	Goiás		Estrada BR 060, Rio Descoberto.	-16.2020	-48.2864		SPLink
Brasil	Goiás	Santo Antonio do Descoberto		-15.9400	-48.2550		SPLink
Brasil	Distrito Federal	Brasília	Reserva Ecológica do IBGE-Ponte do Corujão	-15.9333	-47.9167		SPLink
Brasil	Distrito Federal	Brasília	Reserva Ecológica do Roncador. IBGE	-15.9333	-47.9167		SPLink
Brasil	Goiás	Corumbá de Goiás	.	-15.9239	-48.8089		SPLink
Brasil	Distrito Federal	Brasília	Reserva Ecológica IBGE.	-15.9124	-47.8799		SPLink
Brasil	Distrito Federal	Brasília	RECOR, Ponte do Corujão.	-15.9012	-47.8689		SPLink

Brasil	Distrito Federal	Brasília	Reserva Ecológica do IBGE	-15.8837	-47.8301	SPLink
Brasil	Distrito Federal	Brasília	Reserva Ecológica do IBGE-Córrego Roncador	-15.8837	-47.8301	SPLink
Brasil	Goiás	Pirenópolis	Região da pedreira, às margens do Córrego Zé Leite	-15.8519	-48.9589	SPLink
Brasil	Distrito Federal		Zoológico.	-15.8475	-47.9392	GBIF
Brasil	Distrito Federal	Brasília	Zoológico.	-15.8470	-47.9411	SPLink
Brasil	Distrito Federal	Brasília	Área do Zoobotânico.	-15.8470	-47.9412	SPLink
Brasil	Distrito Federal	Guará		-15.8120	-47.9706	SPLink
Brasil	Distrito Federal	Guará		-15.8120	-47.9706	SPLink
Brasil	Minas Gerais	Bandeiras	Fazenda Boi Rajado, 5.9Km a E da Rod. Macarani/Bandeiras	-15.8064	-40.5181	SPLink
Brasil	Distrito Federal		Região Administrativa (RA) XVI.	-15.7667	-47.8333	SPLink
Brasil	Distrito Federal		RegiÃ£o Administrativa (RA) XVI.	-15.7667	-47.8333	GBIF
Brasil	Distrito Federal	Brasília	Parque Olhos D'Água - Asa Norte, Plano Piloto	-15.7444	-47.8878	SPLink
Brasil	Distrito Federal	Brasília	Parque Olhos D'Água - Asa Norte, Plano Piloto	-15.7444	-47.8878	SPLink
Brasil	Mato Grosso	Várzea Grande	Lat. 13 de Setembro	-15.7414	-56.1575	SPLink
Brasil	Distrito Federal	Brasília		-15.7343	-48.0462	SPLink
Brasil	Distrito Federal	Brasília	Fundação Zoobotânica.	-15.7309	-47.9073	SPLink
Brasil	Distrito Federal	Brasília	Fundação Zoobotânica	-15.7309	-47.9073	SPLink
Brasil	Distrito Federal	Brasília	.	-15.7254	-47.9623	SPLink
Brasil	Distrito Federal	Brasília	Acampamento.	-15.7254	-47.9623	SPLink
Brasil	Distrito Federal	Brasília	North end of Lagôa Paranoá	-15.7200	-47.8700	SPLink
Brasil	Distrito Federal		Córrego Torto.	-15.7172	-47.8712	SPLink
Brasil	Distrito Federal	Brasília	Highway BR 020 from Brasília to Sobradinho	-15.6667	-47.8167	SPLink
Brasil	Distrito Federal	Brasília	Sobradinho.	-15.6595	-47.7986	SPLink
Brasil	Distrito Federal		Estrada do Fercal.	-15.6283	-47.8694	SPLink
Brasil	Distrito Federal		Planaltina	-15.6167	-47.6667	GBIF
Brasil	Bahia	Camacan	Km 15 da estrada Camacan/Canavieiras.	-15.4189	-39.4958	SPLink
Brasil	Bahia	Camacan	Estrada a Jucaracíi. Margem do Rio Panelão.	-15.4189	-39.4958	SPLink
Brasil	Bahia	Camacan	Entre Camacan e Itaimbé.	-15.4189	-39.4958	SPLink
Brasil	Bahia	Una	5Km a W de Una. Beira da estrada.	-15.2333	-39.1167	SPLink
Brasil	Bahia	Una	5Km a W Uma.	-15.2333	-39.1167	SPLink
Brasil	Bahia	Jussari	Serra do Teimoso, 7,5Km ao N depois ao W de Jussari Rod	-15.1500	-39.5167	SPLink
Brasil	Bahia	São josé da vitória	BR-101, Km 545, para Camacan. Na beira da estrada.	-15.0972	-39.3550	SPLink
Brasil	Bahia	Ilhéus	Ramal que liga Rod. BR. 415 / Itabuna do povoado Japu	-14.7962	-39.0747	SPLink
Brasil	Bahia	Ilheus	Ramal que liga Rod. BR. 415 / Itabuna do povoado Japu	-14.7962	-39.0747	SPLink
Brasil	Bahia	Licínio de Almeida	Estrada,7km de Llicínio de Almeida para Urandi. P02.	-14.7319	-42.5117	SPLink
Brasil	Bahia	Licínio de Almeida		-14.7319	-42.5117	SPLink
Brasil	Bahia	Boa Nova	Parque Nacional de Boa Nova.	-14.4126	-40.1363	SPLink
Brasil	Goiás	Alto Paraíso	Estrada para Nova Roma, ca. 8 Km de Alto Paraíso.	-14.1208	-47.5042	SPLink

Brasil	Bahia	Livramento do Brumado	Km 5 da Rodovia Livramento do Brumado/Rio de Contas.	-13.6333	-41.8167	SPLink
Brasil	Bahia	Amargosa	Serra do Timbó	-13.1722	-39.1594	SPLink
Brasil	Bahia	Salvador	Parque Metropolitano de São Bartolomeu	-12.8951	-38.4699	SPLink
Brasil	Bahia	Itaparica		-12.8742	-38.6822	SPLink
Brasil	Bahia	Santa Teresinha	Estrada da Serra da Jibóia (Pioneira).	-12.8503	-39.4756	SPLink
Brasil	Bahia		Estrada da Serra da JibÃ³ia (Pioneira).	-12.8503	-39.4756	GBIF
Brasil	Bahia	Cruz das Almas		-12.6637	-39.1006	SPLink
Brasil	Bahia	Cruz das Almas		-12.6637	-39.1006	SPLink
Brasil	Bahia	Cachoeira		-12.6167	-38.9500	SPLink
Brasil	Bahia	Amélia Rodrigues		-12.4667	-38.7333	SPLink
Brasil	Bahia	Ruy Barbosa		-12.2818	-40.4935	SPLink
Brasil	Bahia	Entre Rios	Estrada para Imbé ca. de 20 km do entroncamento.	-12.1278	-37.9872	SPLink
Brasil	Bahia	Conde	Fazenda do Bu, Mata do Bebedouro.	-12.0403	-37.7114	SPLink
Brasil	Bahia	Entre Rios	Residual stands of the Atlantic Forest	-12.0178	-38.0486	SPLink
Brasil	Bahia	Entre Rios		-11.9432	-38.0843	SPLink
Brasil	Bahia	Morro do Chapéu		-11.6750	-41.0167	SPLink
Brasil	Bahia	Morro do Chapéu		-11.6733	-41.0117	SPLink
Brasil	Bahia	Morro do Chapéu		-11.6667	-41.0167	SPLink
Brasil	Bahia	Morro do Chapéu	Distrito de Ventura	-11.6167	-40.9833	SPLink
Brasil	Bahia	Morro do Chapéu	Povoado Domingos Lopes - Cachoeira Domingos Lopes.	-11.5578	-40.9058	SPLink
Brasil	Bahia	Morro do Chapéu		-11.5578	-40.9058	SPLink
Brasil	Bahia	Miguel Calmon		-11.4522	-40.5233	SPLink
Brasil	Bahia	Miguel Calmon	Serra das Sete Passagens	-11.3883	-40.5356	SPLink
Brasil	Bahia	Miguel Calmon	Serra das Sete Passagens	-11.3883	-40.5356	SPLink
Brasil	Bahia	Miguel Calmon		-11.3883	-40.5556	SPLink
Brasil	Sergipe	Santa Luzia do Itanhy	Mata do Crasto	-11.3855	-37.4259	SPLink
Brasil	Bahia	Jacobina	Ca. 3Km S da cidade.	-11.3117	-40.7326	SPLink
Brasil	Bahia	Jacobina		-11.2773	-40.6430	GBIF
Brasil	Bahia	Jacobina		-11.2406	-40.3343	SPLink
Brasil	Bahia	Jacobina		-11.2174	-40.6309	SPLink
Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.2069	-40.4407	SPLink
Brasil	Bahia	jacobina	Cachoeira do Anibal	-11.2011	-40.4958	SPLink
Brasil	Bahia	jacobina		-11.2011	-40.4958	SPLink
Brasil	Bahia	Jacobina		-11.2011	-40.4958	SPLink
Brasil	Bahia	Jacobina	Piemonte da Diamantina. Bairro Grotinha.	-11.1958	-40.5072	SPLink
Brasil	Bahia	Jacobina	Piemonte da Diamantina. Bairro Grotinha.	-11.1958	-40.5072	SPLink
Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.1920	-40.4940	SPLink
Brasil	Bahia	Jacobina	Campo Rupestre intercalado por Mata de Galeria	-11.1920	-40.4940	SPLink
Paraguai	Bahia	Jacobina	Cachoeira do Aníbal	-11.1920	-40.4940	GBIF

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Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.1920	-40.4940		GBIF
Brasil	Bahia	Jacobina	Campo Rupestre intercalado por Mata de Galeria	-11.1920	-40.4940		GBIF
Brasil	Bahia	Jacobina		-11.1920	-40.4940		GBIF
Brasil	Bahia	Jacobina	Fazenda Boa Vista, perto de Itaetú, na base da Serra da Jaqueira.	-11.1833	-40.5167		SPLink
Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.1800	-40.5100		SPLink
Brasil	Bahia	Jacobina	Serra do Ouro	-11.1722	-40.5067		SPLink
Brasil	Bahia	Jacobina		-11.1697	-40.5064		SPLink
Brasil	Bahia	Jacobina		-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Serra do Ouro	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Cachoeira do Aníbal	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Serra do Ouro	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Serra do Ouro	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina	Serra do Ouro	-11.1672	-40.5067		SPLink
Brasil	Bahia	Jacobina		-11.1628	-40.4972		SPLink
Brasil	Bahia	Saude	Cachoeira do Paulista	-10.9408	-40.4178		SPLink
Brasil	Sergipe	Aracajú	Campus da UFS, Centro de Ciências Exatas e Tecnoló	-10.9251	-37.1029		SPLink
Brasil	Bahia	Pindobaçu		-10.7428	-40.3628		SPLink
Brasil	Sergipe	Siriri	Mata do Cipó	-10.5132	-37.1013		SPLink
Brasil	Bahia	Pindobaçu	Base da Serra da Fumaça. Próximo ao rio.	-10.5117	-40.3419		SPLink
Brasil	Bahia	senhor do bonfim	Serra da Jacobina.	-10.3000	-40.2500		SPLink
Brasil	Alagoas	Coruripe		-10.1278	-36.1721		SPLink
Brasil	Alagoas	Traipu		-9.9708	-37.0028		SPLink
Brasil	Alagoas	Murici		-9.3069	-35.9428		SPLink
Brasil	Alagoas		Serra das Aguas Belas	-9.2422	-35.7816		GBIF
Brasil	Alagoas	Flexeiras		-9.2400	-35.7800		SPLink
Brasil	Alagoas	Flexeiras	Serra das Águas Belas	-9.2333	-35.7667		SPLink
Brasil	Alagoas	Ibateguara	Usina Serra Grande-Grota da burra, próximo ao rio	-9.0129	-36.0518		SPLink
Brasil	Alagoas	Ibateguara	Coimbra, dentro do canavial	-8.9784	-35.9377		SPLink
Brasil	Alagoas	Ibateguara	Usina Serra Grande-Coimbra	-8.9780	-35.9377		SPLink
Brasil	Alagoas	Ibateguara	Coimbra	-8.9728	-35.9389		SPLink
Brasil	Pernambuco	Garanhuns	A margem do Mato entre Garanhuns e brejão.	-8.9000	-36.4833		SPLink
Brasil	Pernambuco	Quipapá	Usina Água Branca	-8.8120	-36.0140		SPLink
Brasil	Pernambuco	Quipapá	Usina Água Branca	-8.8120	-36.0140		SPLink
Brasil	Pernambuco	Maraial	Serra do Urubu	-8.7845	-35.8107		SPLink
Brasil	Pernambuco	Maraial	Serra do Urubu	-8.7799	-35.8107		SPLink
Brasil	Pernambuco	Jaqueira	Serra do Urubu.	-8.7269	-35.7928		SPLink
Brasil	Pernambuco	Jaqueira	Serra do Urubu	-8.7260	-35.7945		SPLink
Brasil	Pernambuco	Jaqueira	Serra do Urubu, Caminho para Lagoa dos Gatos	-8.7219	-35.8472		SPLink
Brasil	Pernambuco	Rio Formoso	Saltinho-mata. Viage, com Luiz Emygdio.	-8.6594	-35.1536		SPLink

Brasil	Pernambuco	Jaboatão dos Guararapes	Localidade Vila Riva, Colônia dos Padres Salesianos.	-8.1193	-35.0238		SPLink
Brasil	Amazonas	Livramento	Fazenda Rosalina, estrada Aguassu	-7.3543	-58.6204		SPLink
Brasil	Ceará		Base da Serra do Araujo, represa da usina do Crato.	-7.2269	-39.3963		SPLink
Brasil	Ceará		Base da Serra do Araujo, represa da usina do Crato.	-7.2269	-39.3963		GBIF
Brasil	Tanga		Amani Nature Reserve	-5.1000	38.6300		GBIF
Brasil	Ceará	Guaramiranga	Sa. Baturité	-4.3526	-38.8501		SPLink
Brasil	Ceará		Baturité- Caridade.	-4.2986	-39.0366		SPLink
Brasil	Ceará	Guaramiranga	Sítio cana brava	-4.2673	-38.9273		SPLink
Brasil	Ceará	Guaramiranga	Sa. Baturité	-4.2628	-38.9328		SPLink
Brasil	Ceará	Pacoti	Estação Ecológica da UECE	-4.2261	-38.9231		SPLink
Brasil	Ceará	Maranguape	Serra de Maranguape	-3.8900	-38.6858		SPLink
Brasil	Ceará	Uruburetama		-3.6250	-39.5078		SPLink
Brasil	Distrito Federal		Coletada na fercal, 40km de Brasília.	-15.6283	-47.8694		SPLink
Brasil	São Paulo	Porto Ferreira	Parque Estadual de Porto Ferreira	-21.816667	-47.416667		SPLink
Brasil	Alagoas	Quebrangulo	REBIO Pedra Talhada	-9.254167	-36.430556		SPLink
Brasil	Minas Gerais		Lagoa Preta-margem do Rio Paraopeba-MG.	-19.4167	-47.3667		GBIF
Brasil	Ceará		BaturitÃ©- Caridade.	-4.2986	-39.0366		GBIF
Brasil	Distrito Federal		Coletada na fercal, 40km de BrasÃlia.	-15.6283	-47.8694		GBIF
Brasil	Pernambuco		Garanhuns- A margem do mato entre Garanhuns e Brejão.	-8.9000	-36.4833		GBIF
Brasil	Distrito Federal		Fundação Zoobotânica.	-15.7309	-47.9073		GBIF
Brasil	Distrito Federal		Sobradinho.	-15.6595	-47.7986		GBIF
Brasil	São Paulo		Sitio Bela Vista (Mun. Areias) São Paulo.	-22.5788	-44.6996		GBIF
Brasil	Rio de Janeiro		Distrito de Basílio	-22.7148	-42.6265		GBIF
Brasil	Rio de Janeiro			-23.0216	-44.7308		GBIF
Brasil	Rio de Janeiro		Próximo do Colégio Anchieta	-22.2738	-42.5362		GBIF
Brasil	Pernambuco		Serra do Urubu.	-8.7799	-35.8107		GBIF
Brasil	SÃ£o Paulo		Guarulhos.	-23.4667	-46.5333		GBIF
Brasil	Santa Catarina		Luís Alves	-26.7300	-48.9500		GBIF
Brasil	São Paulo		Estrada do Fercal.	-15.6283	-47.8694		GBIF
Brasil	São Paulo		Sitio Bela Vista (Mun. Areias) São Paulo.	-22.5788	-44.6996		GBIF
Brasil	Rio de Janeiro		Monte Serrat.	-22.0163	-43.3102		GBIF
Brasil	Distrito Federal		RECOR, Ponte do Corujão.	-15.9012	-47.8689		GBIF
Brasil	Minas Gerais		Fumaça.	-20.9506	-43.8006		GBIF
Brasil	Distrito Federal		Reserva Ecológica do IBGE	-15.8837	-47.8301		GBIF
Brasil	Distrito Federal		Reserva Ecológica do IBGE	-15.8837	-47.8301		GBIF
Brasil	Ceará		3 km east of Guaramiranga, Ceará	-4.2600	-38.9033		GBIF
Brasil	Ceará		2 km. east of Guaramiranga	-4.2607	38.9177		GBIF
Brasil	São Paulo		Capital, Sao Paulo Nativa no Jardin Botanico	-23.6416	-46.6206		GBIF
Brasil	Goiás		5-12 km S of Alto Paraiso de Goias	-14.2179	-47.5564		GBIF

E.

Country	State/Province/Department	City	Locale	Latitude	Longitude	Source
Uruguai	Tacuarembo	Tacuarembo	Rio Negro	-32.10	-54.87	SPLink
Uruguai	San José	San José de Mayo	Habitat ad S. José d'Uruguay	-34.34	-56.71	SPLink
Argentina	Entre Ríos	Colón	Palmar Grande de Colón	-31.88	-58.26	GBIF
Argentina	Corrientes	Mburucuy	Estancia Santa Teresa	-27.99	-58.18	GBIF
Argentina	Corrientes	Mburucuy	Ea. San Juan Poriajhu, ruta 17, 18 km ruta 12.Potrero Tres Marias	-27.80	-57.46	GBIF
Argentina	Corrientes	Mburucuy	Camino entre Beron de Astrada y general Paz.	-27.35	-58.16	GBIF
Uruguai	San José	San José de Mayo	Brasil Meridional "San José de Uruguay"	-27.60	-56.68	GBIF
Argentina	Corrientes		Ituzaingó	-23.16	-57.84	GBIF
Paraguai	Maldonado	Isla de Lobos	Rincón de Gallinas ad ripas fluminis Rio Negro	-33.40	-58.40	GBIF
Paraguai	Paraguari	Paraguari		-25.52	-57.27	GBIF
Paraguai	Paraguari		Cordillera de Altos	-27.77	-57.28	GBIF
Argentina	Corrientes		Ea. San Juan Poriajhu, ruta 17, 18 km ruta 12.Potrero Tres Marias	-27.27	-58.97	GBIF
Paraguai	Paraguarí		Cordillera de Altos	-25.97	-65.75	GBIF
Argentina	Corrientes		Estancia Santa Teresa	-30.22	-57.86	GBIF
Paraguai	Paraguarí		Cordillera de Altos	-27.75	-57.62	GBIF
Argentina	Chaco		Margarita Belen	-29.92	-57.88	GBIF
Paraguai	Paraguarí		Cordillera de Altos	-15.73	-47.96	GBIF
Paraguai	Paraguarí		Cordillera de Altos	-15.78	-47.92	GBIF
Paraguai	Gran Chaco	Santa Elisa		-23.16	-57.84	GBIF
Argentina	Corrientes		Estancia La Potota, Laguna del Yacará, próxima a Estación Libertad.	-30.35	-57.98	GBIF

CAPÍTULO 3

CONSIDERAÇÕES FINAIS

Ao contrário do que foi suposto na redação do projeto e no delineamento experimental, as espécies de *Euryades* não parecem ter uma predileção particular por uma das espécies de *Aristolochia* estudadas neste trabalho. Tal predileção explicaria as disjunções, uma vez que a presença da planta hospedeira seria o fator que limitaria ou apenas induziria a presença das espécies de borboleta naquela área, mas comparando-se as áreas de ocorrência calculadas, não houve indicação de que isso estivesse ocorrendo. Na verdade, ao ser feita uma análise visual dos modelos de predição de ocorrência de *Aristolochia,* verifica-se que há sobreposição entre os modelos de *A. sessilifolia* e *A. fimbriata,* especialmente sobre o estado do Rio Grande do Sul (e consequentemente a área de ocorrência de *E. corethrus).* As outras três espécies não seguem esta tendência, com as áreas previstas para *A. lingua* e *A. labiata* tendo pouca sobreposição e não indicando alta adequabilidade para o estado do Rio Grande do Sul, enquanto *A. angustifolia* limita-se à uma pequena área no Uruguai e Argentina. A distribuição prevista para *A. fimbriata* estende-se muito além dos limites da distribuição calculada para *A. sessilifolia,* para áreas onde não há registro e tampouco previsão de ocorrência de *E. corethrus. A. lingua* tem uma área de adequabilidade prevista inserida no Chaco, Pampas Úmidos e Estepe Patagônica, praticamente cobrindo toda a Argentina, Paraguai e uma pequena porção da Bolívia. *Aristolochia labiata,* por outro lado, tem uma distribuição potencial que concentra-se na área de costa Brasileira, aparentemente longe da área que a questão original de distribuição das espécies. *Aristolochia angustifolia* tem uma área pequena cobrindo a maior parte do Uruguai e regiões próximas no Brasil e Argentina, com semelhanças espaciais com as áreas de maior adequabilidade de *A. fimbriata.* A área de ocorrência prevista para *E. corethrus* parece ter um tamanho intermediário entre as distribuições de *A. fimbriata e A. sessilifolia*, mas bem menor do que a área calculada para *E. duponchelii*. Por outro lado, a distribuição prevista para *E. duponchelii* parece ser uma composição das distribuições de *A. fimbriata* e de *A. lingua,* já que a sobreposição entre ambas é pequena e *A. fimbriata* mostra-se mais presente no Rio Grande do Sul e áreas perto da fronteira do Estado com os países no ConeSul, enquanto que *A. lingua* tem maior probabilidade de ocorrência em áreas mais afastadas, como, por exemplo, na Bolívia e

Paraguai. Desta forma, torna-se difícil estabelecer uma relação direta entre a presença da planta hospedeira e a presença da borboleta, pois, com os presentes resultados, não há suporte estatístico para a sobreposição dos nichos entre a hospedeira e o herbívoro, e tampouco há um padrão aparente que indique que isto ocorra.

Apesar disso, os resultados obtidos neste trabalho não são definitivos, uma vez que a literatura que descreve o uso de tais plantas pelas borboletas do gênero *Euryades* é conflitante e possivelmente incompleta. Algumas plantas são usualmente citadas, mas não há um consenso sobre a adequabilidade de certas espécies como hospedeiras. Alguns autores inclusive citam plantas que não fazem parte do gênero *Aristolochia* (*e.g. Hydrocotyle bonariensis*, família Apiaceae), ou referem o uso da planta ao verem um adulto pousado na mesma, o que não é um bom indicativo do uso da planta pelos imaturos. Uma investigação futura sobre o desempenho de das duas espécies de *Euryades* ao utilizarem os diferentes tipos de *Aristolochia* ocorrentes em áreas do Pampa e Chaco poderia nos indicar com maior precisão quais são as espécies realmente utilizadas como hospedeiras, e se há alguma preferência por elas, o que tornaria o estudo desta relação muito mais eficiente e conclusivo. Infelizmente, trabalhos deste tipo são escassos, além de demandar muito tempo e serem praticamente inviáveis sem uma colaboração com entidades de pesquisa baseadas em países que tenham ocorrência de *E. duponchelii.* O plantio das *Aristolochia* também seria necessário para garantir um suprimento constante e regular para as criações, pois não seria desejável depender de coletas em campo e de condições climáticas (nem sempre previsíveis) para o suprimento de alimento e para o bom andamento dos testes que seriam feitos. Além disso, o cultivo de Aristolochiaceae em condições de jardinagem é extremamente difícil, devido à dificuldade em quebrar a latência das sementes para a geração de novas plântulas, ou devido a impossibilidade de se realizar transplantes de plantas de seus ambientes naturais para vasos, em função do crescimento por estolão promovido pelos tubérculos das Aristolochia.
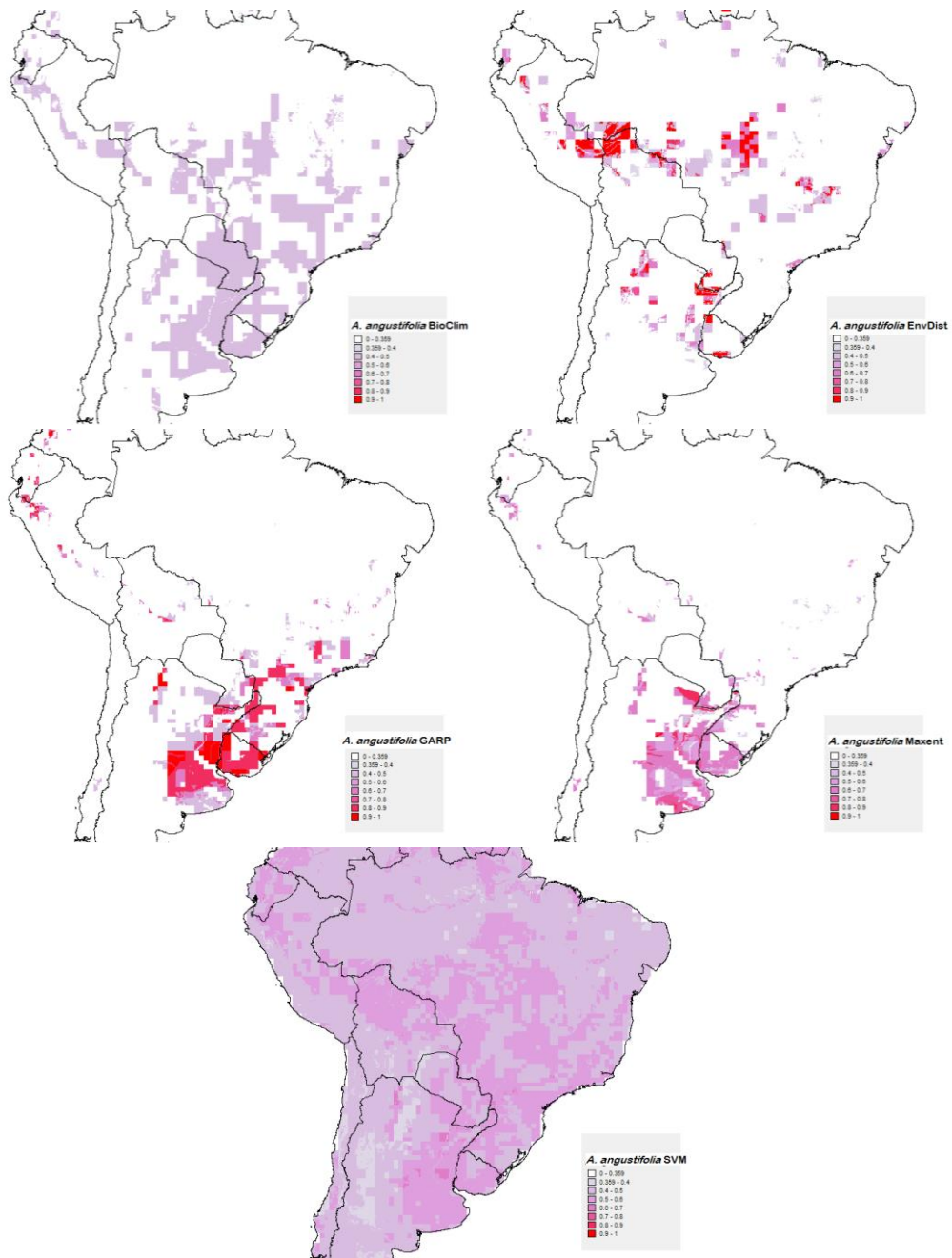
Ainda no campo das possibilidades futuras, estudos moleculares das duas espécies de borboleta abririam novas possibilidades de exploração da relação entre elas. Com posse dos dados moleculares, seria possível embasar com mais consistência as conjecturas feitas à cerca de suas histórias evolutivas e de como ocorreu a sua especiação, ou até mesmo chegar a outras conclusões que não foram consideradas no presente trabalho. Entre as possibilidades de estudos futuros envolvendo aspectos biogeográficos do grupo, podem ser consideradas as relações com a espécies irmã *Cressida cressida*, que tem ocorrência
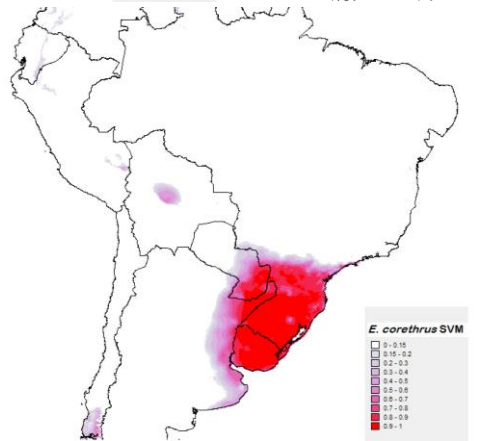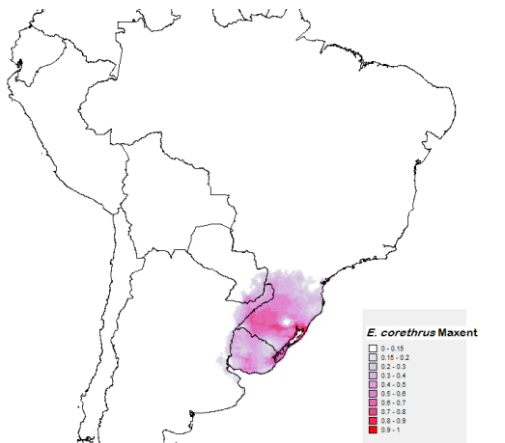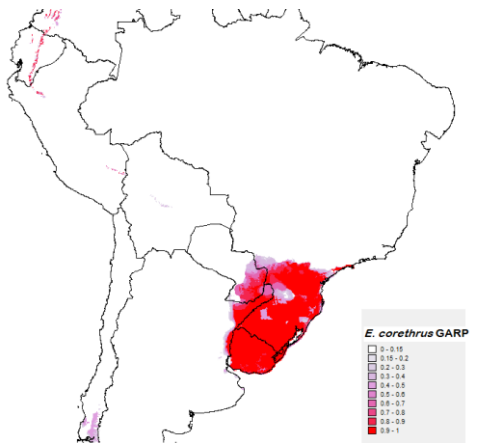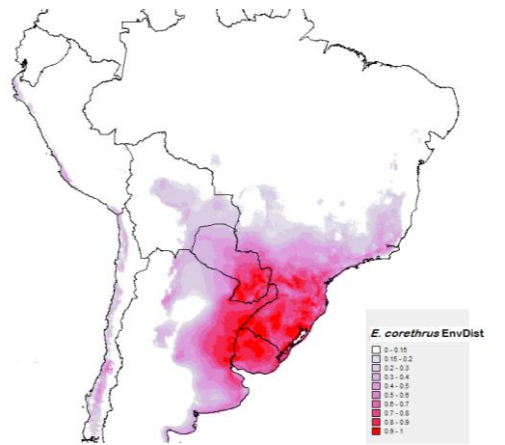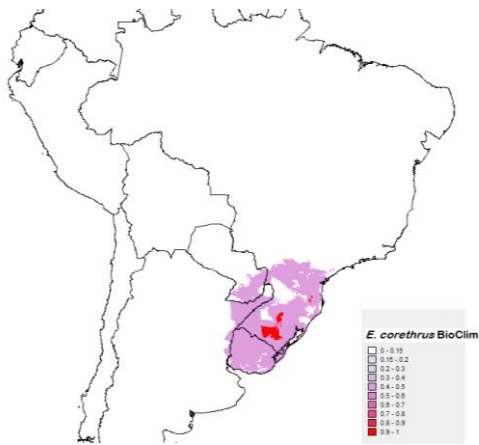
restrita ao sudoesta da Austrália, e a posição intermediária do gênero *Euryades* entre os gêneros *Battus* e *Parides*, que sugerem uma origem comum com a linhagem de deu origem ao grupo mais recente dentro dos Troidini Neotropicais.
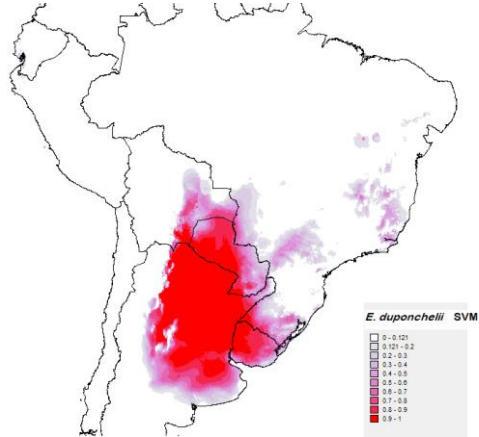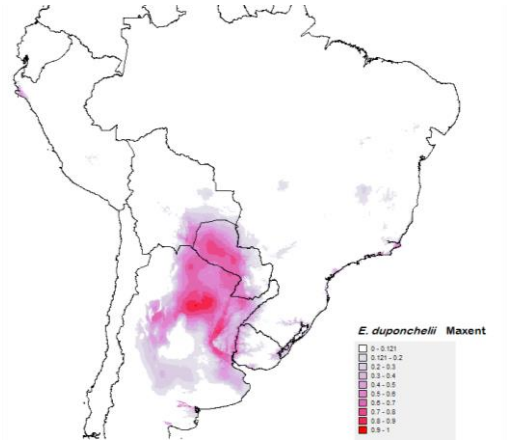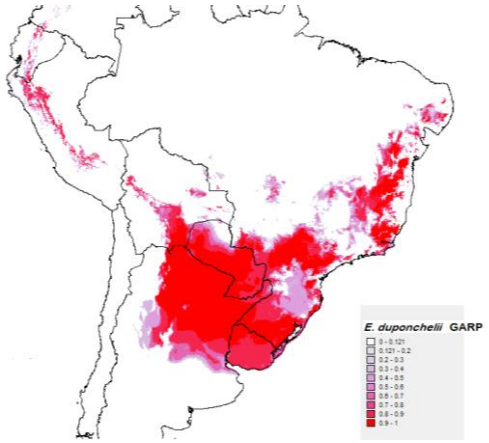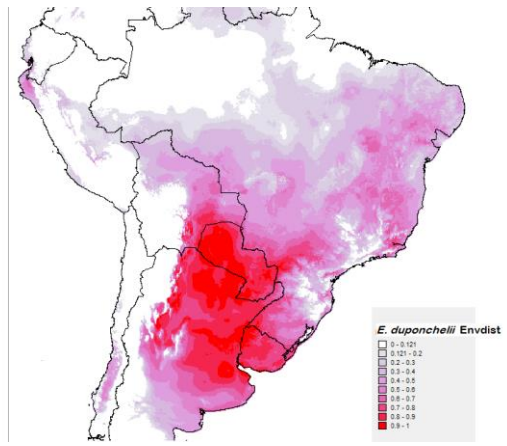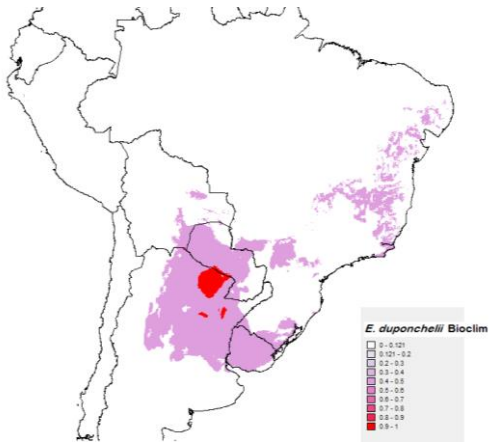
Além disso, a realização de excursões aos locais onde, supostamente, as duas espécies ocorrem em conjunto seria importante para corroborar as teorias de exclusão competitiva abordadas neste trabalho. Neste sentido, estudos relacionados às dinâmicas populacionais ao longo das estações do ano, em diferentes ecorregiões do ConeSul, poderiam ajudar a elucidar as relações ecológicas e evolutivas entre as duas espécies de *Euryades*. Entre estas questões, está a controversa hipótese de que a zona de sobreposição entre as duas *Euryades* seria, de fato, uma barreira genética gerada por hibridação entre as espécies. Em uma conversa informal com colaboradores argentinos, nos foi relatado que um entomologista amador da Província de Entre Ríos, na Argentina, teria material coletado na região de Colón indicando a ocorrência de indivíduos híbridos entre as duas *Euryades*. Tal material estaria depositado na coleção particular do referido entomólogo, que estaria sob o cuidado de terceiros. Estas hipóteses merecem futuras investigações em estudos mais detalhados de biologia molecular e filogeografia. .
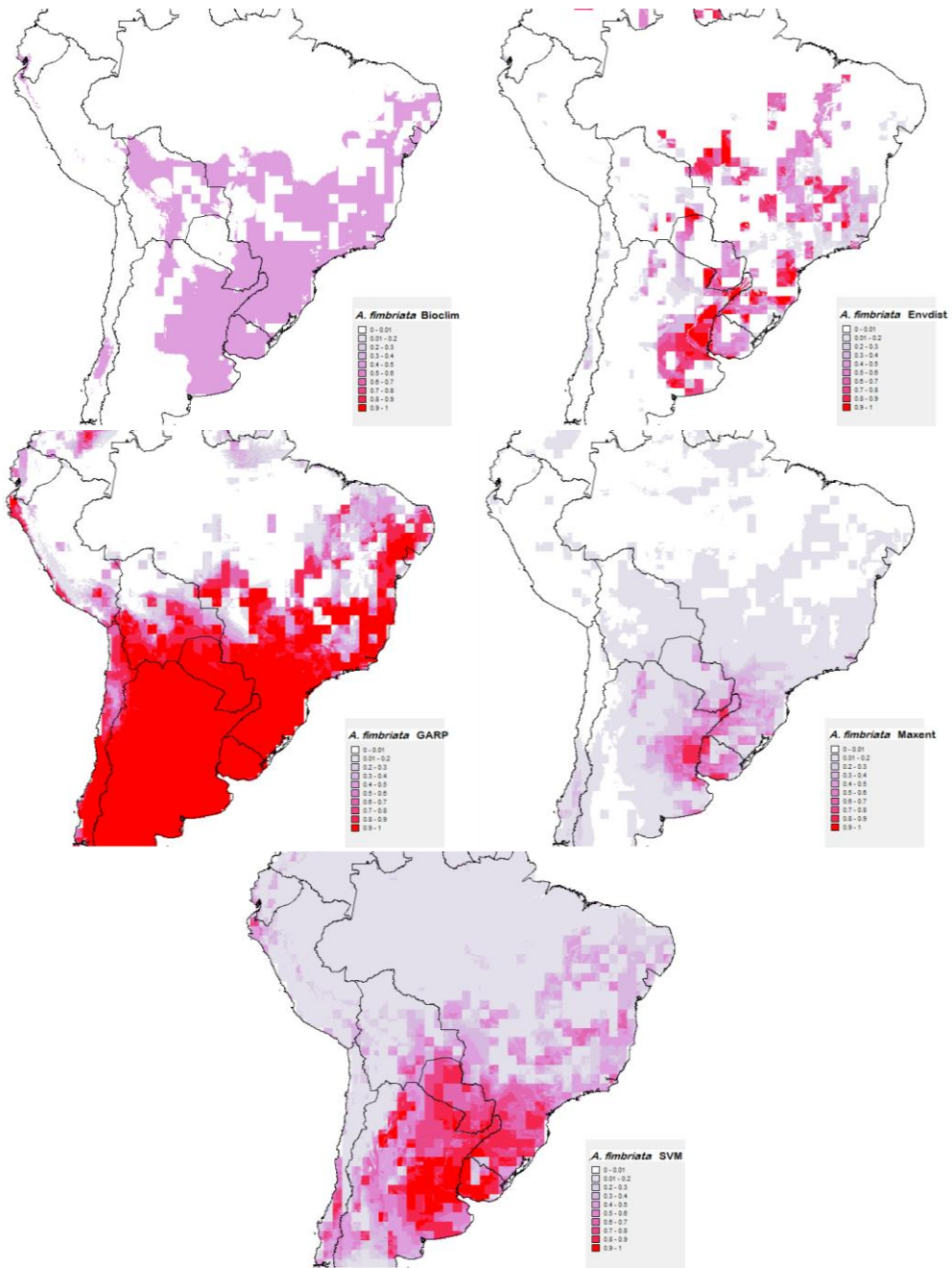
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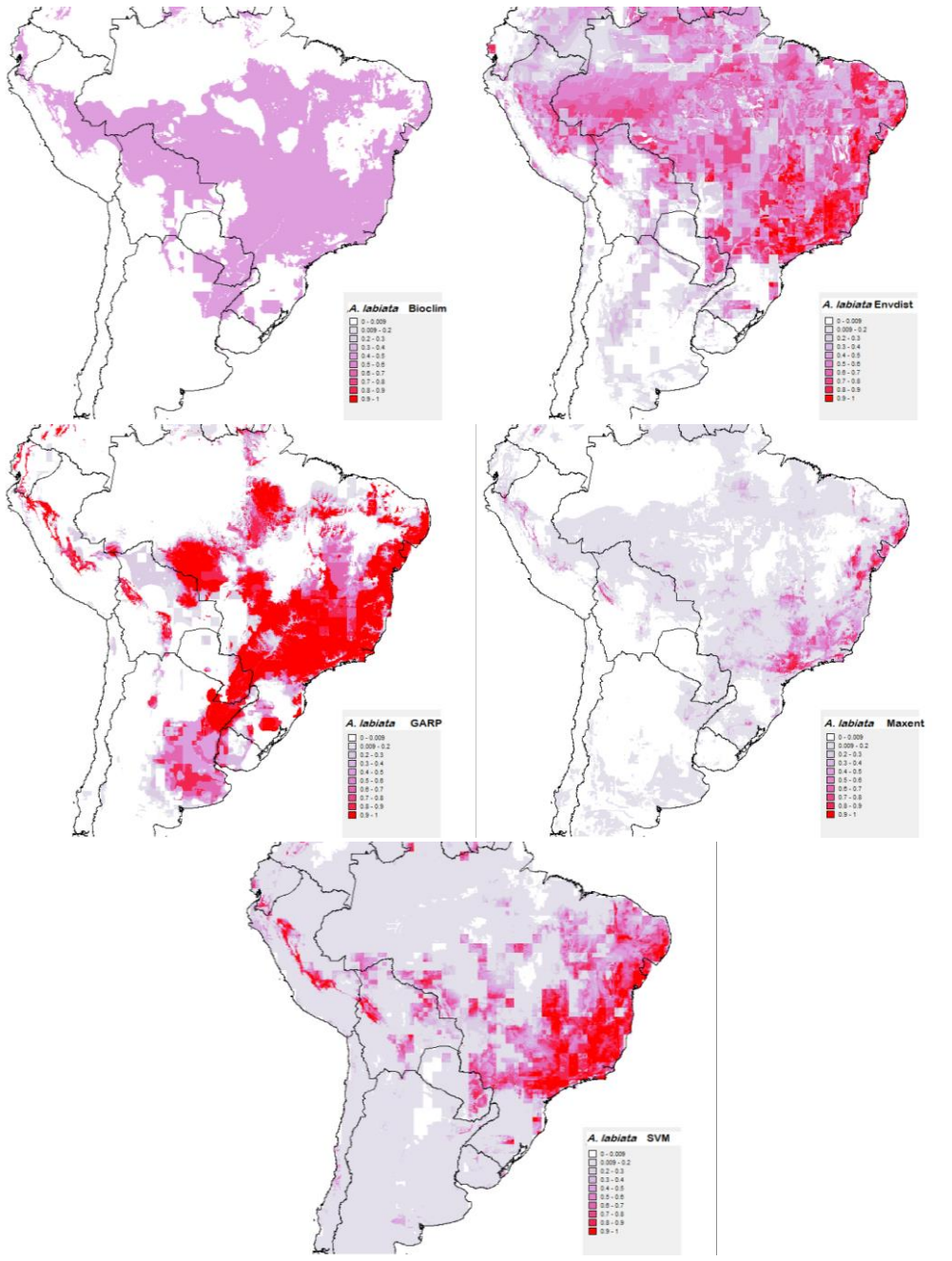
Modelos de distribuição potencial gerados para cada uma das espécies analisadas com os cinco algoritmos utilizados.
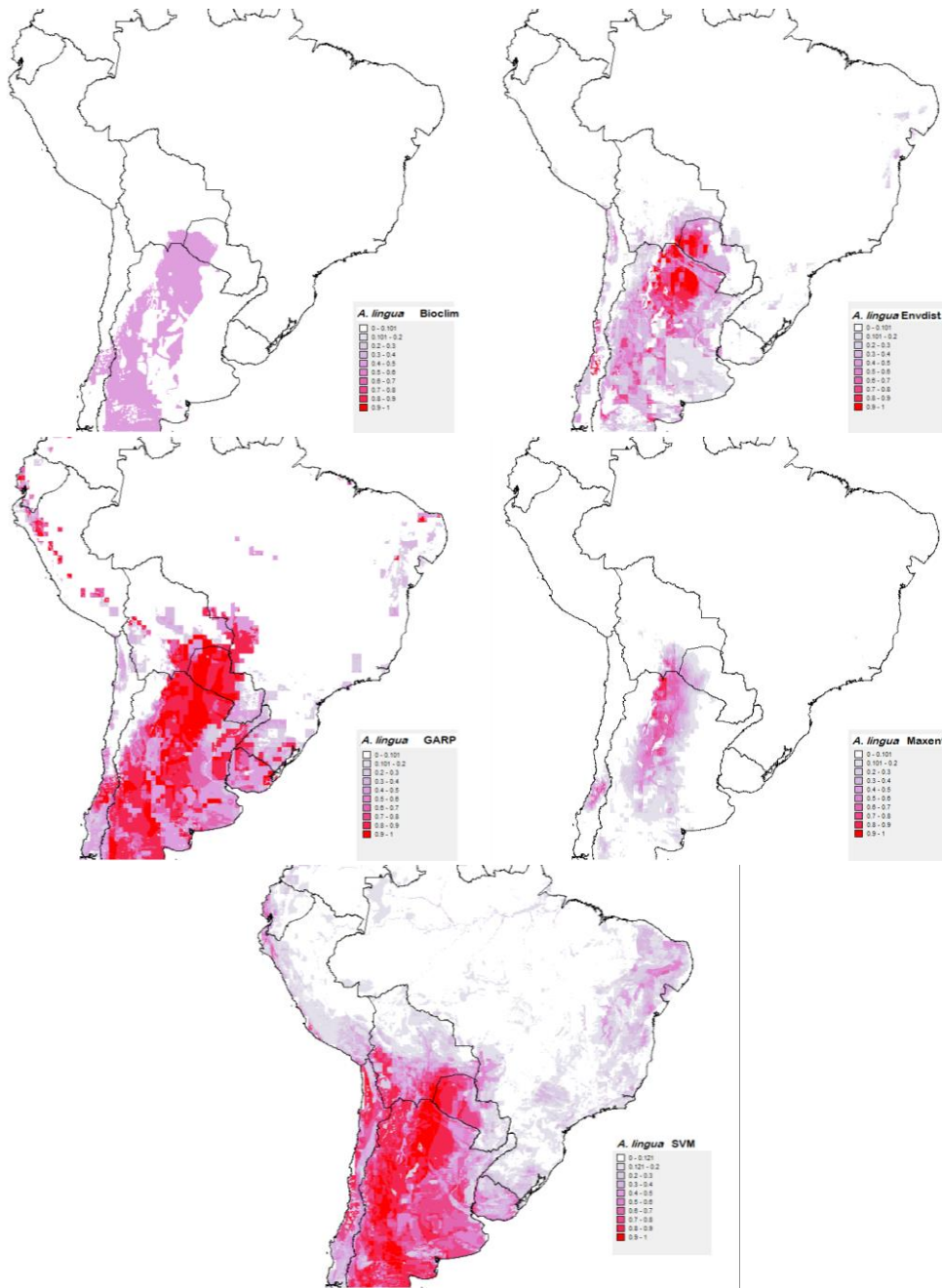
E. corethrus BioClim

E. corethrus EnvDist

E. corethrus GARP

E. corethrus Maxent

E. corethrus SVM

E. duponchelii Bioclim

E. duponchelii Envdist

E. duponchelii GARP

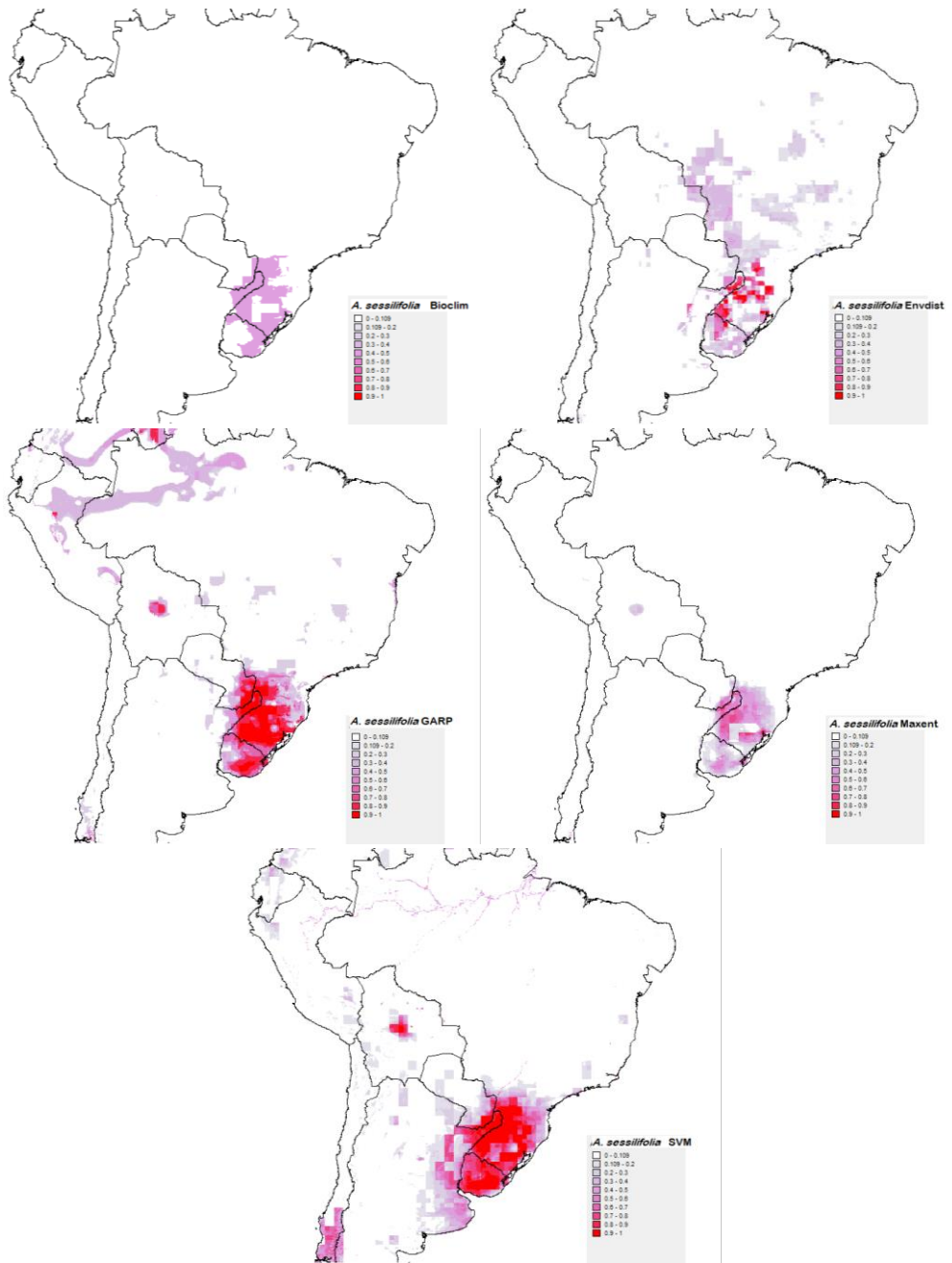E. duponchelii Maxent

E. duponchelii SVM

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5. Manuscripts must have been read and edited by someone whose first language is English.

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Prentice, I.C., Guiot, J., Huntley, B., Jolly, D. & Cheddadi, R. (1996) Reconstructing biomes from palaeoecological data; a general method and its application to European pollen data at 0 and 6 ka. *Climate Dynamics*, **12,** 185-194.
Cox, C. B. & Moore, P. D. (1999) *Biogeography: an ecological and evolutionary approach*, 6th edn. Blackwell Science Ltd, Oxford.
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