UNIVERSIDADE ESTADUAL DO SUDOESTE DA BAHIA
PROGRAMA DE PÓS-GRADUAÇÃO STRICTO SENSU EM CIÊNCIAS AMBIENTAIS

COMPOSIÇÃO E SIMILARIDADE FLORÍSTICA ENTRE AFLORAMENTOS ROCHOSOS NAS UNIDADES DE CONSERVAÇÃO DE BOA NOVA, BAHIA, BRASIL

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Itapetinga, Bahia
Julho – 2021

UNIVERSIDADE ESTADUAL DO SUDOESTE DA BAHIA PROGRAMA DE PÓS-GRADUAÇÃO STRICTO SENSU EM CIÊNCIAS AMBIENTAIS

Composição E Similaridade Florística Entre Afloramentos Rochosos Nas Unidades De Conservação De Boa Nova, Bahia, Brasil

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"Dissertação apresentada, como parte das exigências para obtenção do título de MESTRE EM CIÊNCIAS AMBIENTAIS, no Programa de Pós-Graduação Stricto Sensu em Ciências Ambientais da Universidade Estadual do Sudoeste da Bahia - Área de concentração: Meio Ambiente e Desenvolvimento"

Itapetinga, Bahia
Julho – 2021

581.7 B199c

Barbosa, Morgana Maria do Carmo.

Composição e similaridade florística entre afloramentos rochosos nas Unidades de Conservação de Boa Nova, Bahia, Brasil / Morgana Maria do Carmo Barbosa. – Itapetinga-BA: Universidade Estadual do Sudoeste da Bahia, 2021.

109fl.

Dissertação apresentada, como parte das exigências para obtenção do título de MESTRE EM CIÊNCIAS AMBIENTAIS, no Programa de Pós-Graduação Stricto Sensu em Ciências Ambientais da Universidade Estadual do Sudoeste da Bahia - Área de concentração: Meio Ambiente e Desenvolvimento. Sob a orientação da Profª. D. Sc. Michele Martins Corrêa e coorientação do Prof. D. Sc. Anderson Ferreira Pinto Machado e Profª. D. Sc. Andrea Karla Almeida dos Santos.

1. Florística - Bahia, Brasil. 2. Afloramentos rochosos. 3. Flora – Semiárido – Bahia - Brasil. I. Universidade Estadual do Sudoeste da Bahia - Programa de Pós-Graduação em Ciências Ambientais. II. Corrêa, Michele Martins. III. Machado, Anderson Ferreira Pinto. IV. Santos, Andrea Karla Almeida dos. V. Título.

CDD(21): **581.7**

Catalogação na fonte:
Adalice Gustavo da Silva – CRB/5-535
Bibliotecária – UESB – Campus de Itapetinga-BA

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1. Unidades de Conservação de Boa Nova – Bahia - Brasil
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4. Semiárido

GOVERNO DO ESTADO DA BAHIA
Universidade Estadual do Sudoeste da Bahia
Programa Pós-Graduação em Ciências Ambientais - UESB/RTR/PPG/PPGCA

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"COMPOSIÇÃO E SIMILARIDADE FLORÍSTICA ENTRE AFLORAMENTOS ROCHOSOS NAS UNIDADES DE CONSERVAÇÃO DE BOA NOVA, BAHIA, BRASIL"

Dissertação apresentada ao Programa de Pós-Graduação em Ciências Ambientais da Universidade Estadual do Sudoeste da Bahia, *Campus* de Itapetinga, BA. Área de Concentração: Meio Ambiente e Desenvolvimento.

Aprovada em: 21/07/2021

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Documento assinado eletronicamente por **Michele Martins Corrêa**, **Professor Pleno**, em 22/09/2021, às 13:41, conforme horário oficial de Brasília, com fundamento no art. 13º, Incisos I e II, do Decreto nº 15.805, de 30 de dezembro de 2014.

Documento assinado eletronicamente por **Jomar Gomes Jardim**, **Usuário Externo**, em 23/09/2021, às 15:09, conforme horário oficial de Brasília, com fundamento no art. 13º, Incisos I e II, do Decreto nº 15.805, de 30 de dezembro de 2014.

Documento assinado eletronicamente por **FLAVIO FRANCA**, **Professor Pleno**, em 27/09/2021, às 09:55, conforme horário oficial de Brasília, com fundamento no art. 13º, Incisos I e II, do Decreto nº 15.805, de 30 de dezembro de 2014.

A autenticidade deste documento pode ser conferida no site https://seibahia.ba.gov.br/sei/controlador_externo.php?

Referência: Processo nº 072.4199.2021.0027815-14

SEI nº 00035978971

AGRADECIMENTOS

A Deus, autor da minha vida.

A minha orientadora, Prof.ª Dra. Michele Corrêa, por ter me recebido tão bem, sempre tão gentil e compreensível. Obrigada pelos ensinamentos, confiança e incentivo durante a realização desse trabalho.

Aos meus coorientadores, o Prof. Dr. Anderson Ferreira Pinto Machado e a Profª Dra. Andrea Karla Almeida dos Santos, pelo apoio e amizade ao longo desses anos. Obrigada pelo incentivo, conselhos e colaboração no decorrer desse trabalho.

Ao Prof. Dr. Raymundo José de Sá Neto pelas sugestões e auxílio durante as análises estatísticas.

A Mateus Lopes, pela parceria durante a coletas e identificação do material.

A Vinícius Pimentel, meu namorado, agradeço pelo seu amor, carinho, incentivo e companheirismo durante a reta final do mestrado.

A Universidade Estadual do Sudoeste da Bahia (UESB) e ao Programa de Pós-Graduação em Ciências Ambientais (PPGCA), por todo incentivo a pesquisa e pela oportunidade de cursar o mestrado.

A Universidade Federal da Bahia (UFBA) e ao Herbário Mongoyós (HVC) por todo suporte logístico durante o processamento e análise do material.

A Coordenação de Aperfeiçoamento Pessoal de Nível Superior (CAPES) pela bolsa concedida e ao Programa de Apoio à Pós-Graduação (PROAP) pelo auxílio financeiro disponibilizado para coleta dos dados.

Ao Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), em especial a Johan Pereira, biólogo gestor das Unidades de Conservação de Boa Nova, pelo apoio a pesquisa e aos brigadistas do ICMBio de Boa Nova por todo suporte durante as coletas dos materiais.

Aos membros da banca examinadora pela disposição e por todas as contribuições que estão por vir.

Por fim, agradeço a todos os meus familiares e amigos que estão contribuindo de forma direta ou indireta para a realização desse trabalho.

Muito obrigada a todos!

SUMÁRIO

RESUMO

O município de Boa Nova, no sudoeste da Bahia, está situado em uma importante área de transição entre a Caatinga e a Mata Atlântica. Entre as fisionomias da região destacam-se áreas de afloramentos rochosos, conhecidos como "lajedos". Devido a singularidade desses ambientes e a relevância dos estudos florísticos e ecológicos para conservação, esse trabalho teve como objetivo conhecer e comparar a dissimilaridade florística de quatro lajedos em diferentes fitofisionomias de Boa Nova. Para a análise de dissimilaridade foi utilizado o índice de Jaccard. Além disso, buscou-se avaliar a composição de 90 ilhas de vegetação localizadas nessas áreas e estudar as interações mais frequentes entre as espécies através da análise de modularidade. A lista florística obtida é composta por 162 espécies, distribuídas em 111 gêneros e 50 famílias. As famílias Fabaceae (17 espécies), Malvaceae (13 spp.), Bromeliaceae (10 spp.), Euphorbiaceae (10 spp.) e Orchidaceae (10 spp.) encontram-se entre as mais diversas. Os afloramentos de Boa Nova possuem composição e estrutura semelhante aos afloramentos do semiárido, assim como espécies endêmicas das fitofisionomias de contato. Apesar de próximos o índice de Jaccard revelou uma dissimilaridade florística entre as áreas. Foram registradas nove novas ocorrências para região e cinco espécies sofrem alguma ameaça de extinção e outras 43 são comuns em áreas antropizadas, o que reforça a importância das ações voltadas para a conservação dessas áreas. Durante o estudo das ilhas de vegetação, a análise de modularidade agrupou seis módulos através de interações mais frequentes entre as espécies. Dentre as variáveis observadas, a forma das ilhas e a vegetação do entorno estão contribuindo para formação e diferenciação dos módulos.

Palavras-chave: ecótono, flora, afloramentos rochosos, semiárido e similaridade.

ABSTRACT

The municipality of Boa Nova, in the southwest of Bahia, is located in an important transition area between the Caatinga and the Atlantic Forest. Among the physiognomies of the region are areas of rocky outcroppings, known as "lajedos". Due to the uniqueness of these environments and the relevance of floristic and ecological studies for conservation, this work aimed to know and compare the floristic dissimilarity of four slabs in different phytophysiognomies of Boa Nova. For the dissimilarity analysis Jaccard's index was used. In addition, we sought to evaluate the composition of 90 vegetation islands located in these areas and to study the most frequent interactions between species through modularity analysis. The floristic list obtained is composed of 162 species, distributed in 111 genera and 50 families. The families Fabaceae (17 species), Malvaceae (13 spp.), Bromeliaceae (10 spp.), Euphorbiaceae (10 spp.) and Orchidaceae (10 spp.) are among the most diverse. The Boa Nova outcrops have similar composition and structure to the semi-arid outcrops, as well as endemic species of the contact phytophysiognomies. Despite their proximity, Jaccard's index revealed floristic dissimilarity between the areas. Nine new occurrences were registered for the region and five species are threatened with extinction and another 43 are common in anthropized areas, which reinforces the importance of actions aimed at the conservation of these areas. During the study of vegetation islands, the modularity analysis grouped six modules through more frequent interactions between species. Among the variables observed, the shape of the islands and the surrounding vegetation are contributing to the formation and differentiation of the modules.

Keywords: ecotone, flora, rocky outcrops, semiarid, similarity.

1. INTRODUÇÃO GERAL

A região de Boa Nova (BA), encontra-se entre as áreas prioritárias para conservação e uso sustentável da biodiversidade no país (MMA, 2007), localizada em uma zona de ecótono entre os domínios da Caatinga e Mata Atlântica. Neste local foram criadas em 2010 duas Unidades de Conservação (UC), o Parque Nacional de Boa Nova (PARNA) e o Refúgio de Vida Silvestre (REVIS), somando mais de 27.000 hectares de áreas protegidas (BRASIL, 2010).

As duas UC representam uma das áreas mais importantes das Américas para conservação das aves, atraindo pesquisadores desde a década de 90. Com mais de 450 espécies registradas, ficou conhecida como "Paraíso das Aves", entre elas a *Rhopornis ardesiacus* (Wied, 1831), o gravatazeiro, símbolo da região, e endêmica da Mata de Cipó (SAVE BRASIL, 2017).

Ecótono é uma zona de transição entre diferentes tipos de vegetação, formando um conjunto homogêneo e uniforme (IBGE, 2012). São ambientes com elevada biodiversidade de organismos, podem possuir representantes das fitofisionomias de contato, assim como espécies exclusivas do próprio ecótono (MILAN & MORO, 2016). Em Boa Nova, a Floresta Estacional Semidecidual Submontana, corresponde a fitofisionomia de transição, uma formação florestal de porte relativamente baixo, regionalmente conhecida como Mata de Cipó, com muitas espécies de cipós e lianas (SANTOS *et al*., 2007).

Em alguns locais, nas áreas mais altas das UC (geralmente acima dos 600 metros), ocorrem áreas de afloramentos rochosos, também denominados "lajedos" (J. Sampaio 2019, comunicação pessoal). São áreas extensas de rocha exposta, que se destacam em meio das formações da Caatinga e Mata Atlântica, com muitos representantes de cactos, bromélias e orquídeas (Observação pessoal).

A beleza cênica desses lugares atrai a atenção de turistas, moradores da região e de vários visitantes florais, em especial, espécies de beija-flores que se alimentam nas flores dos *Melocactus ernestii Vaupel* (Cactaceae). No passado, antes da implementação das UC, esses locais foram utilizados por uma mineradora para extração de granito (J. Sampaio 2019, comunicação pessoal). Apesar da criação das UC, ainda é notável a interferência humana nesses ambientes, boa parte dos afloramentos estão situados próximos a estradas, em terrenos privados com atividades de agricultura e pecuária (Observação pessoal).

Pesquisas botânicas na região se intensificaram nos últimos anos (SIMÕES *et al*., 2013; BRANDÃO, 2014; VITÓRIO, 2016; RÊGO & AZEVEDO, 2017; BARBOSA, 2018; FONSECA *et al.*, 2020), divulgando dados interessantes para ciência. Dentre estes, a descrição de novas espécies, por exemplo, a *Physeterostemon gomesii* Amorim & R. Goldenb. (Melastomataceae) (AMORIM *et al*., 2014); *Calyptranthes boanova* Sobral, *Myrcia alatiramea* Sobral & E.Lucas (Myrtaceae) (SOBRAL *et al*., 2012; SOBRAL *et al*., 2015); *Pouzolzia saxophila* Friis, Wilmot-Dear & A. K. Monro. (Urticaceae) (WILMOT-DEAR *et al*., 2014).

Dois trabalhos realizados em Boa Nova, oriundos das monografias de Vitório (2016) e Barbosa (2018) contribuíram para o conhecimento da flora dos lajedos. Vitório (2016) realizou o inventário florístico nas diferentes fitofisionomias da região, entre elas a vegetação rupícola enquanto que Barbosa (2018) estudou três áreas de afloramentos rochosos.

Como resultado, o estudo florístico realizado por Barbosa (2018), revelou a elevada riqueza de espécies nos lajedos, com um total de 217 espécies registradas. Ao comparar as áreas estudadas, apesar de apresentarem espécies em comum, cada lajedo apresentou espécies exclusivas (mais de 70% do total de espécies), entre elas estão espécies endêmicas da Caatinga e da Mata Atlântica. Além disso, foram registradas 21 novas ocorrências para o município de Boa Nova e seis espécies correm alguma ameaça de extinção, o que reforça a necessidade dos estudos e conservação da flora dos lajedos.

Os dados obtidos em estudos florísticos revelam informações que permitem avaliar o seu estado de conservação da flora e servem de base para o avanço de diversos estudos (CARDOSO *et al*., 2009). As atividades de pesquisa dentro das UC auxiliam com dados para a elaboração do plano de manejo das mesmas, incluindo as ações sobre o uso, proteção e educação ambiental nessas áreas destinadas à conservação.

Sendo assim, o objetivo principal desse trabalho foi ampliar os estudos florísticos em áreas de afloramentos rochosos em diferentes fitofisionomias (Caatinga e Floresta Estacional) das Unidades de Conservação de Boa Nova. Além disto, pretende-se contribuir para o conhecimento da flora desses ambientes em áreas de ecótono entre a Caatinga e Mata Atlântica no semiárido e fornecer informações importantes que possam auxiliar na elaboração do plano de manejo das UC.

No primeiro capítulo da dissertação consta a composição florística de quatro áreas de afloramentos rochosos, a avaliação da flora estudada de acordo a distribuição geográfica, padrões de endemismos e ameaça da extinção. Além disso, foi realizado o teste de similaridade florística entre as quatro áreas e foram assinalados os fatores que podem estar colaborando para dissimilaridade entre elas.

O segundo capítulo contém a composição florística de 90 ilhas de vegetação. Para investigar a associação entre as espécies foi realizada a análise de modularidade. Além disso, foram investigadas três importantes variáveis (tamanho da ilha, forma e vegetação do entorno) que possam estar influenciando na formação dos módulos.

O terceiro capítulo contém um guia ilustrado com a flora dos lajedos de Boa Nova, cujo objetivo é colaborar com as Unidades de Conservação através de um produto de divulgação científica da área, sendo de fácil acesso para os gestores das UC, população local e turistas.

2. REVISÃO BIBLIOGRÁFICA

2.1 Afloramentos rochosos: características principais

Afloramentos rochosos são exposições da rocha que se sobressaem na paisagem circundante, oriundos de processos erosivos e elevações tectônicas que culminaram na remoção do solo (MICHAEL & LINDENMAYER, 2018). Apesar de apresentarem ampla distribuição global, estando presentes em várias zonas climáticas e domínios vegetacionais, são mais comuns nas regiões tropicais (POREMBSKI, 2007). Podem ocorrer como afloramentos isolados ou agrupados em formas montanhosas, variando em forma, tamanho e constituição mineral (BREMER & SANDER, 2000; PRADO, 2003; SCARANO, 2007). De acordo o estágio de erosão da rocha, são caracterizados como *inselbergs*, serras ou chapadas (AB'SABER, 2003; PRADO, 2003).

Esses ambientes apresentam condições ambientais com altas taxas de temperatura e evapotranspiração, escassez hídrica e de nutrientes. Fatores estes relacionados com a falta de cobertura do solo, restrito apenas a alguns locais e o elevado escoamento superficial, que facilitam o superaquecimento da superfície rochosa e dificulta a retenção da umidade por períodos prolongados (SZARZYNSKI, 2000; POREMBSKI, 2007).

As condições ambientais levaram ao estabelecimento de uma flora especializada que geralmente difere da matriz circundante. Entre essas espécies se destacam as tolerantes a dessecação e as suculentas. Espécies tolerantes à dessecação conseguem sobreviver a perda de até 95% do teor de água de suas células, algumas Cyperaceae, Poaceae e Velloziaceae fazem parte desse grupo. Outro grupo é formado pelas suculentas, que armazenam água e nutrientes em diferentes partes da planta, característica presente nas Bromeliaceae, Cactaceae e Orchidaceae, por exemplo, e por isso conseguem resistir a longos períodos de secas (POREMBSKI & BARTHLOTT, 2000; POREMBSKI, 2007).

Apesar de compartilharem condições ecológicas semelhantes e possuírem muitas características estruturais em comum, os afloramentos podem apresentar distinções florísticas mesmo entre afloramentos geograficamente próximos, quando analisados a nível de espécie

(GOMES & ALVES, 2010). Essas mudanças podem ocorrer em diferentes escalas espaciais, variando de um local para o outro ou entre microhábitats de um mesmo local (WISER *et al*., 1996).

A localização geográfica, as variações climáticas e microclimáticas (SPEZIALE & EZCURRA, 2012), alterações no relevo, constituição mineral, profundidade do solo, altitude, e vegetação circundante (POREMBSKI *et al*., 1996; 1998; GOMES & ALVES, 2010; MESSIAS *et al*., 2012; CAMPOS *et al*., 2018), são possíveis determinantes para as diferenças florísticas e os padrões de endemismo de cada local.

Os afloramentos rochosos, são ambientes heterogêneos, com uma grande variedade de habitats e isso implica no estabelecimento de diferentes espécies vegetais adaptadas as condições edafoclimáticas locais (BURKE, 2003). Porembski *et al*. (2000) descreveram os habitats típicos de *inselbergs* que ocorrem sobre a superfície rochosa e são comuns em várias partes do mundo. Nota-se que a maioria dos habitats mencionados são semelhantes aos encontrados em trabalhos realizados em áreas de afloramentos em geral (FRANÇA *et al*., 1997; CONCEIÇÃO *et al*., 2007; JACOBI *et al*., 2007; OLIVEIRA & GODOY, 2007; COSTA *et al*., 2011; PAULA *et al*., 2017; PAULINO *et al*., 2018).

Levando em consideração o trabalho de Porembski *et al*. (2000), podemos sinalizar os seguintes habitats: **vegetação de superfícies de rocha**; formada pelas criptogâmicas, onde se destacam os líquens e cianobactérias responsáveis pela coloração escura da rocha e pela vegetação epilítica, formada principalmente por plantas suculentas e/ou xerófitas que se fixam diretamente sobre a rocha; **vegetação sobre fendas da rocha** – as fendas são locais onde ocorrem o acúmulo maior do substrato, levando ao estabelecimento de arbustos e árvores perenes; **vegetação de depressões** – as depressões ocorrem em áreas geralmente planas e variam de tamanho e profundidade, sendo possível a formação de piscinas sazonais ou lagoas permanentes. Fornecem substrato para várias formas de vida vegetal, que dependem exclusivamente da profundidade do substrato e da retenção da umidade para se estabelecerem; **vegetação úmida efêmera** – ocorrem na base de encostas íngremes ou nas bordas dos tapetes de monocotiledôneas, sendo predominantes na estação chuvosa. Formada principalmente por Cyperaceae, Eriocaulaceae, Droseraceae, Poaceae e Xyridaceae; **ilhas florestais** – o desenvolvimento florestal é formado em condições climáticas úmidas, cujo o solo é mais profundo (> 30cm de profundidade). Normalmente, não são espécies típicas de áreas rochosas, entretanto podem estar presentes na vegetação do entorno. Devido a umidade, muitas espécies epífitas se estabelecem. Em alguns lugares, essa vegetação lenhosa forma cinturões nos arredores devido a umidade provocada pelo escoamento superficial e podem ocorrer sobre a encosta de afloramentos menos inclinados.

Outro ambiente descrito por Porembski *et al*. (2000), são as esteiras **de monocotiledôneas**, característicos desses locais, formado por espécies que se fixam diretamente na rocha, e que se espalham horizontalmente por meio de propagação vegetativa, formando os tapetes (agrupamento), que ocorrem como manchas isoladas, cercadas pela rocha exposta (POREMBSKI, 2007), cujo substrato é formado pelo seu próprio material vegetal em decomposição. Os tapetes de monocotiledôneas também são conhecidos como **ilhas de vegetação** (FRANÇA *et al*., 2005), formadas por uma ou mais espécies de plantas, fixadas diretamente na rocha ou em solo raso (CONCEIÇÃO *et al*., 2007). No Brasil, essas formações podem ser representadas por espécies de Eudicotiledôneas (FRANÇA & MELO, 2014). Geralmente espécies tolerantes a dessecação ocorre nos arredores das ilhas, enquanto espécies não tolerantes se distribuem nos centros (POREMBSKI & BARTHLOTT, 2000).

Dentre as famílias mais comuns na composição das ilhas em afloramentos da brasileiros estão: Arecaceae (*Syagrus* spp.), Asphodelaceae, Bromeliaceae (por exemplo, *Aechmea* spp., *Alcantarea* spp., *Deuterocohnia* sp., *Dyckia* spp., *Encholirium* spp., *Orthophytum* spp., *Pitcairnia* sp., *Tillandsia* spp., *Vriesea* spp.), Cactaceae (*Coleocephalocereus* spp., *Pilosocereus* spp., *Melocactus* spp.), Crassulaceae, Cyperaceae (*Trilepis* spp.), Euphorbiaceae (*Euphorbia* spp.), Melastomataceae (*Pleroma* sp.), Orchidaceae (*Encyclia* spp.), Poaceae (*Melinis* spp.), Velloziaceae (*Vellozia* spp.) e algumas pteridófitas (por exemplo, *Selaginella* sp.) (POREMBSKI *et al*., 1998; POREMBSKI *et al*., 2000; FRANÇA *et al*., 2005; POREMBSKI, 2007; FRANÇA & MELO, 2014). Orquídeas epífitas do gênero *Pseudolaelia* spp. aparecem restritas as ilhas crescendo sobre os caules de *Vellozia* sp. (Porembski *et al*., 1998).

As ilhas são os ambientes mais característicos dos afloramentos rochosos, por isso, são objeto de estudos florísticos e fitossociológicos que buscam compreender os processos de adaptação e colonização desses ambientes (POREMBSKI *et al*., 1998; MEIRELLES *et al*., 1999; FRANÇA *et al*., 2005; CONCEIÇÃO *et al*., 2007; RIBEIRO *et al*., 2007; GOMES & ALVES, 2010; SOUZA *et al*., 2011).

2.2 Distribuição dos estudos florísticos em áreas de afloramentos no Brasil: enfoque no semiárido

Os afloramentos rochosos ocorrem nos principais domínios fitogeográficos brasileiros, porém são melhores representados em algumas regiões (SCARANO, 2007). Segundo Silva (2016) pesquisas em ambientes rochosos se intensificaram nos últimos anos após a publicação de Scarano (2007), principalmente em áreas de Caatinga, Mata Atlântica e Cerrado. As fanerógamas seguem como o grupo vegetal mais estudado e a florística lidera as linhas de pesquisa desses estudos, em seguida estão os trabalhos de caráter ecológico e conservacionista.

Na Mata Atlântica se destacam os estudos realizados em afloramentos graníticos-gnáissicos da região Sudeste (MEIRELLES *et al*., 1999; ESGARIO *et al.,* 2009; SANTOS *et al*., 2010; PENA & ALVES-ARAÚJO, 2017), que incluem os *inselbergs* e campos de altitude (CAIAFA & SILVA, 2007; SOUZA *et al*., 2011; PAULA *et al*., 2015; COUTO *et al*., 2017; PAULA *et al*., 2017; PINTO-JUNIOR, 2017).

Os campos de altitude, ocorrem em elevações acima dos 1.500 metros, compõem as fitofisionomias das Serras do Mar, da Mantiqueira e do Brigadeiro (RIBEIRO *et al*., 2007; VASCONCELOS, 2011). Os *inselbergs* são formações montanhosas que resistiram ao processo de pediplanação e possuem como principal característica o topo em formato de cúpula (BURKE, 2003; PRADO, 2003; POREMBSKI, 2007).

Sobre o domínio da Caatinga, foram realizados estudos florísticos em áreas de afloramentos graníticos no semiárido em áreas do sertão e agreste nordestino, que incluem fitofisionomias da Caatinga, florestas estacionais e floresta úmida (brejos de altitude) (GOMES & ALVES, 2010; FRANÇA & MELO, 2014; CORDEIRO *et al*., 2018). Entre as formações se destacam os *inselbergs* e os lajedos (PRADO, 2003). Os lajedos são relevos residuais que ocorrem geralmente em baixas altitudes, sobre solo pouco desenvolvido em superfícies aplainadas (LAGES *et al*., 2013; BARBOSA *et al*., 2018; PEREIRA *et al*., 2018).

No domínio da Caatinga cearense, Araújo *et al*. (2008) estudaram a flora, o espectro biológico e as síndromes de dispersão das espécies de um *inselberg* no município de Quixadá. Paulino *et al*. (2018) fizeram o inventário de dois *inselbergs* no mesmo município visando o conhecimento da composição florística, síndromes de dispersão, forma de crescimento e forma de vida das espécies em diferentes microhábitats e como estes influenciam os parâmetros estudados. Pereira *et al*. (2018) estudaram a composição florística e a caracterização fitossociológica de cinco afloramentos localizados na zona norte do Estado.

No Planalto da Borborema, dentro dos limites do Estado de Pernambuco, Gomes & Alves (2009) realizaram o inventário da flora de um *inselberg*, com propósito de comparar a semelhança florística da área de estudo com a vegetação circundante e com outras áreas de afloramentos rochosos. Gomes & Alves (2010) estudaram a composição e estrutura da vegetação de dois afloramentos, com enfoque nas ilhas de vegetação e similaridade entre as áreas. Gomes *et al*. (2011) realizaram o inventário da flora do afloramento da Pedra Furada, inserido no Parque Municipal da Pedra Furada.

Pessoa & Alves (2014) realizaram o estudo taxonômico da família Orchidaceae de 13 afloramentos rochosos no Estado de Pernambuco. Lucena *et al*. (2017) fizeram o inventário de plantas trepadeiras e de sua distribuição em duas áreas de afloramentos, nos municípios de Bezerros e Triunfo.

Na Paraíba, Almeida *et al*. (2007a) realizaram a análise florística e estrutural das comunidades de Orchidaceae, e a relação dessas espécies com os microhábitats em três *inselbergs*, pertencentes aos municípios de Esperança, Serraria e Fagundes. Almeida *et al*. (2007b) realizaram o inventário da família Fabaceae e das formas de vida em cinco *inselbergs* localizados em Araruna, Pocinhos, Esperança, Fagundes e Serraria.

Porto *et al*. (2008) realizaram o levantamento da flora de um *inselberg* no Município de Esperança. Tolke *et al*. (2011) e Sales-Rodrigues *et al*. (2014) fizeram o inventário da flora de *inselbergs* no município de Puxinanã, ambos pertencentes a Unidade Geoambiental da Borborema. Costa *et al*. (2015) analisaram a riqueza e a síndrome de dispersão de espécies de um afloramento no Parque das Pedras, com intuito de comparar a similaridade entre a área estudada e afloramentos de Caatinga.

No município de Patos, Lucena *et al.* (2015) estudaram a flora de um *inselberg* denominado Espinho Branco, cujo objetivo foi identificar a flora em diferentes gradientes altitudinais. No mesmo município, Lopes-Silva *et al*. (2017) realizaram o levantamento das espécies exóticas em nove *inselbergs* e Lopes-Silva *et al*. (2019) estudaram a composição florística de um *inselberg* conhecido como Morro do Carioca e de sua estrutura arbórea em diferentes níveis de altitude.

Cordeiro *et al*. (2018), realizaram o inventário da flora de um afloramento pertencente ao Piemonte da Borborema, cujo objetivo foi avaliar as similaridades florística com outros *inselbergs* do Nordeste brasileiro. No complexo da Borborema, Pereira *et al*. (2019), realizaram a análise da composição, frequência e diversidade da flora em três áreas de afloramentos no município de Esperança e Félix *et al*. (2019) fizeram o guia de identificação da flora da Serra do Jatobá.

Na Bahia, estudos em afloramentos graníticos foram desenvolvidos por Queiroz *et al*. (1996) na Serra da Jibóia. Na mesma localidade, a monografia de Cruz (2010) retratou a fisionomia, estrutura e diversidade das ilhas de vegetação do mesmo afloramento.

Trabalhos em *inselbergs* no semiárido baiano foram desenvolvidos por França *et al*. (1997), que realizaram o inventário florístico, a caracterização da vegetação e dos habitats encontrados em dois *inselbergs* (Morro das Tocas e Morro do Agenor) no município de Itatim. França *et al*. (2005) realizaram um estudo florístico, ecológico em um *inselberg* na Fazenda da Jibóia, próximo a Feira de Santana, tendo como um dos objetivos a caracterização das ilhas de vegetação. Carneiro *et al*. (2002) realizaram o estudo da família Euphorbiaceae dos *inselbergs* da região de Milagres. França *et al*. (2006) estudaram a diversidade florística no Morro do Agenor. Moraes *et al.* (2009) realizaram o estudo taxonômico da família Solanaceae em 16 *inselbergs* do semiárido baiano. A lista florística resultante dos trabalhos realizados por França *et al.* nos *inselbergs* do semiárido encontra-se disponível no livro intitulado: "*Flora de Inselbergues no Semiárido da Bahia: Região de Milagres e Adjacências*", onde é possível encontrar descrições taxonômicas e distribuição geográfica das espécies, ao todo foram inventariados 20 *inselbergs* da região (FRANÇA & MELO, 2014).

Lajedos graníticos fizeram parte do objeto de estudo das monografias de Vitório (2016) e Barbosa (2018) nas UC de Boa Nova (BRASIL, 2010). Vitório (2016), realizou o inventário da flora do Parque Nacional de Boa Nova, em diferentes fitofisionomias do PARNA, entre elas a vegetação rupícola. O objetivo do trabalho de Barbosa (2018) foi realizar o inventário florístico de duas áreas de afloramentos rochosos nas UC, inseridos em áreas de Caatinga e Floresta Estacional Semidecidual.

Nas zonas de transição entre o Cerrado, Caatinga e Mata Atlântica, ocorrem os campos rupestres, um tipo vegetacional que está associado a topos de montanhas de quartzito-arenito acima dos 900 metros, sendo predominante ao longo da Cadeia do Espinhaço e nas formações do Brasil Central (CONCEIÇÃO *et al*., 2007; NEVES & CONCEIÇÃO, 2007; COSTA *et al*., 2011; VASCONCELOS, 2011). No Quadrilátero Ferrífero (Minas Gerais), os afloramentos de campo rupestre com elevadas concentrações de ferro são conhecidos como afloramentos de cangas, ocorrendo em áreas de ecótono entre o Cerrado e a Mata Atlântica (JACOBI *et al*., 2007; MESSIAS *et al*., 2012; CARMO & JACOBI, 2013).

Nota-se a ausência de trabalhos em áreas de ecótono, entre a Caatinga e a Mata Atlântica (VITÓRIO, 2016; BARBOSA, 2018). Alguns estudos foram realizados no Agreste Nordestino (ALMEIDA, 2007a-b; LUCENA *et al*., 2017; PESSOA & ALVES, 2014; COSTA *et al*., 2015; CORDEIRO *et al*., 2018), considerado uma zona de transição entre o sertão e a zona da mata, apresentando disjunções vegetacionais com a ocorrência de florestas estacionais e refúgios florestais (brejos de altitudes) (IBGE, 2012).

Na Bahia, os trabalhos de França & Melo (2014) e Cruz (2010) apontam a ocorrência da floresta semidecídua e da floresta ombrófila em uma das faces de alguns dos afloramentos estudados, mas não caracterizam essas áreas como zonas de ecótono. Entretanto, são áreas que apresentam tipos vegetacionais que diferem da vegetação predominante do entorno (caatinga) e estão localizados próximas aos limites do semiárido.

2.3 Conservação

Os afloramentos apresentam características únicas, segundo Meirelles *et al*. (1999), a raridade, singularidade e fragilidade desses ambientes são critérios suficientes para justificar a proteção dessas áreas. São ambientes de grande diversidade e endemismo, e estão em constante ameaça devido as ações antropogênicas que colaboram para a perda de hábitat e com ele sua diversidade local, levando a extinção de espécies endêmicas (JACOBI *et al*., 2007; POREMBSKI, 2007).

Martinelli (2007), pontuou os principais problemas ambientais em diferentes ecossistemas montanhosos, entre eles estão: erosão e instabilidade do solo; remoção da vegetação do entorno; espécies invasoras; queimadas; extração de espécies raras e endêmicas; mineração; expansão urbana; agricultura de altitude; pisoteio por animais; turismo; mudanças climáticas e dificuldades em relação à aplicação da lei e proteção, monitoramento, restauração e conservação *ex-situ*.

Muitas abordagens estão relacionadas à Conservação das cangas, os afloramentos de cangas estão localizados sobre minérios de ferro de grande importância econômica no Quadrilátero Ferrífero (Sudeste do Brasil), sendo a ameaça mais devastadora para comunidade vegetal dessas áreas, principalmente para as espécies metalófitas, porém não é a única, por estarem próximas a centros urbanos, essas áreas estão sujeitas a incêndios, retirada ilegal de espécies para comercialização (dentro das Unidades de Conservação), estabelecimento de espécies invasoras devido as atividades relacionadas ao turismo (JACOBI *et al*., 2007; JACOBI *et al*., 2008; CARMO & JACOBI, 2013).

As queimadas podem causar a redução de populações de espécies não resistentes ao fogo, espécies aparentemente resistentes estão tendo seu ciclo de vida alterado e o estabelecimento de mudas inibido (POREMBSKI & BARTHLOTT, 2000). De acordo com o levantamento das informações realizadas por AXIMOFF *et al*. (2016), a maioria das ocorrências dos incêndios em afloramentos litorâneos fluminenses são de origem desconhecida, mas a soltura de balões, práticas religiosas e queima de lixo estão entre as principais causas detectadas. As espécies invasoras *Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L.Jacobs e *Melinis minutiflora* P.Beauv., também foram identificadas nesses locais, são espécies bem adaptadas as queimadas. A *M. multiflora*, também foi encontrada em áreas com histórico de atividades de garimpo na Chapada Diamantina (BA), o que merece uma atenção especial nas práticas de manejo dentro das UC (CONCEIÇÃO *et al.* 2015).

De acordo Porembski (2000), espécies invasoras podem competir com a flora endêmica, cuja capacidade competitiva é relativamente baixa e trazer sérias consequências para a regeneração e sobrevivência dessas espécies. Trabalhos recentes continuam corroborando com a importância da conservação dessas áreas e do seu entorno (PAULINO *et al*., 2018), visto que a introdução de espécies exóticas muitas vezes é oriunda das perturbações nas áreas circundantes, que abrem caminho para o estabelecimento de espécies ruderais (FRANÇA *et al*., 1997; LOPES-SILVA *et al*., 2017).

Apesar do crescimento dos estudos em áreas de afloramentos rochosos, existem lacunas que precisam ser preenchidas em todos os campos de pesquisa (SILVA, 2016). O conhecimento da flora dessas áreas, por meio dos estudos florísticos, é de extrema importância para identificação de áreas prioritárias para conservação, mediante a constatação de espécies endêmicas e ameaçadas (RAPINI *et al*., 2008; PAULA *et al*., 2017). Além disso, os dados obtidos podem auxiliar na implementação de medidas, práticas de conservação e uso sustentável de acordo a necessidade de cada local, que incluem a criação de Unidades de Conservação, planos de restauração, manejo sustentável, pesquisas científicas e educação ambiental (FITZSIMONS & MICHAEL, 2016; MARTINELLI, 2007; SILVA, 2016)

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O trabalho a seguir foi elaborado segundo as normas da Revista Acta Botanica Brasilica

ISSN - 0102-3306 (versão impressa) / ISSN: 1677-941X (versão eletrônica)

4. CAPÍTULO 1

Original Article

Species richness and floristic similarity in four areas of rock outcrops in Boa Nova, Bahia, Brazil

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Abstract

The municipality of Boa Nova, in southwest Bahia and Northeast Brazil, is located in an important transition area between Caatinga and the Atlantic Forest. Among the physiognomies of the region are areas of rocky outcrops, known as "slabs". Due to the singularity of these environments and the relevance of floristic studies for conservation, this work aimed to know and compare the floristic similarity of the slabs in different phytopharmacies of Boa Nova. Flower surveys were carried out at the Porangaba, Lagoa Danta, Fazenda Alvorada and Belo Campo slabs. All collected material is deposited in the Mongoyós Herbarium (HVC) collection. The floristic list obtained is composed by 162 species, distributed in 111 genera and 50 families. The Boa Nova outcrops have a composition and structure similar to the semiarid outcrops, as well as endemic species of contact phytophysiomies. Despite the close ones, the Jaccard similarity index revealed a floristic dissimilarity between the areas. Nine new occurrences were registered for the region, five species are threatened with extinction (*Aosa gilgiana*, *Ficus cyclophylla*, *Pleroma caatingae*, *Tocantinia stigmovittata* and *Trixis pruskii*) and another 43 are common in anthropized areas, which reinforces the importance of actions aimed at the conservation of these areas.

Keywords: ecotone, flora, rocky outcrops, semiarid and similarity.

Introduction

Reminiscent of pediplanation erosive processes, the rocky outcrops are important components of the semiarid physiognomy, among which inselbergs, slabs and boulders stand out (Ab'Saber 2003; Prado 2003). The environmental severity provided by high temperature rates, soil scarcity and water deficit led to the establishment of an adapted flora that generally differs from the surrounding matrix (Porembski 2007). In these formations, vegetation develops in a variety of microhabitats on the rock, which contribute to local diversity (Paulino *et al*. 2018). Among the most common habitats are: rock fissures and depressions, seasonal pools and vegetation islands (França *et al*. 1997; Porembski *et al*. 2000).

Although they share similar ecological and structural conditions, the uniqueness of rock outcrops comes from a set of factors, such as geographic location, microclimatic conditions, soil depth, elevation, lithology and surrounding vegetation, which influence the composition of species, including between geographically close areas (Porembski *et al*. 1996; 1998; Gomes & Alves 2010; Speziale & Ezcurra 2012; Messias *et al*. 2012; Campos *et al*. 2018; Paulino *et al*. 2018).

They are places with high species richness and endemism (Pena & Alves-Araújo 2017), as well as sources of new discoveries for science, with the description of new species (Couto *et al*. 2017). Despite their importance for biodiversity, these ecosystems suffer from human interference from mining, gold-digging, livestock, tourism, among others (Martinelli 2007), which can lead to the loss of habitats and with them their diversity, leading to species extinction (Jacob *et al*. 2007). Therefore, floristic inventories are one of the main strategic actions for the conservation of these areas, serving as support for management and restoration plans (Fitzsimons & Michael 2016).

In Brazil, floristic studies in rocky environments have grown in recent years, especially in the semiarid region (Silva 2016). In Bahia, most studies are concentrated on granitic-gneissic outcrops of Serra da Jiboia (Queiroz *et al*. 1996), in the inselbergs of the Milagres region and surrounding cities (França *et al*. 1997; 2005; 2006; França & Melo 2014) and in outcrops of rupestrian fields in Chapada Diamantina (Conceição & Pirani 2007; Neves & Conceição 2007; Conceição *et al*. 2007; Conceição *et al*. 2015).

Additionally, the slabs of the Conservation Units (UC) of Boa Nova, a region considered an important transition area between the phytogeographic domains of the Caatinga and the Atlantic Forest (Brazil 2010), were the object of study in two monographs (Vitório 2016; Barbosa 2018), in which the results showed the relevance of these environments for conservation, due to the occurrence of endemic and endangered species, the floristic particularities of each location (Barbosa 2018), and the discovery of a new species, *Pouzolzia saxophila* (Urticaceae) (Wilmot-Dear *et al*. 2014).

Despite the increased scientific interest in rocky outcrop areas, studies in ecotonal regions between the Caatinga and the Atlantic Forest are still few, being more common in the transition between the Cerrado and the Atlantic Forest (Silva 2016). The objective was to know the floristic diversity in slab areas in the different phytophysiognomies of Boa Nova, southwestern Bahia, Brazil, as well as to compare the composition of the studied areas and discuss the factors that are contributing to a possible floristic dissimilarity occurring between them. In addition, we sought to compare the floristic list with other areas of semi-arid outcrops. These data will also help in the construction of the management plan for the UC in Boa Nova.

Material and Methods

Study area

Four slabs of the UC of Boa Nova were analyzed – the National Park (PARNA) and the Wildlife Refuge (REVIS) (14°23'16.2"S 40°09'38.0"W) (Fig. 1) – located in the Vitória da Conquista microregion, in Bahia (SEI 2018), covering areas in the municipalities of Boa Nova, Dário Meira and Manoel Vitorino (BRASIL 2010).

The territory is cut by a chain of mountains known as Serra da Ouricana, with elevation that vary between 440 and 1,111m. The relief and rainfall in the region determine the different phytophysiognomies observed in the west-east direction: Caatinga, Semideciduous Forest (Cipó Forest) and Ombrophilous Forest (Atlantic Forest) (BRASIL 2020). The climate is semi-arid and sub-humid tropical (SEI 2014), temperatures between 14°C and 26°C and rainfall of 1,300mm per year (BRASIL 2020).

The studied slabs are locally called Lajedo Lagoa D’anta (Area 01), Lajedo Porangaba (Area 02), Lajedo Belo Campo (Area 03) and Lajedo Alvorada (Area 04). Lajedo Lagoa D’anta (14°21’12.26”S 40°15’54.80”W) has an area of 0.59 ha, with an elevation of around 697m. It is located in a transition area between the Caatinga and the Seasonal Forest, under the greatest influence of the Caatinga (Fig. 1 and 2).

Lajedo Porangaba (14°19’19.00”S 40°15’07.10”W) is composed of three plateaus of exposed rock, totaling 11.5 ha, with elevation ranging from 820-935m. Located inside the PARNA (Figs. 1 and 3) in the transition between the Caatinga and the Seasonal Forest, it has been widely used for granite extraction.

The Lajedo Belo Campo (14°18'45.80”S 40°12'18.38”W) and Lajedo da Fazenda Alvorada (14°19'56.61”S 40°12'38.40”W) are inserted within the limits of REVIS (Fig. 1, 4 and 5), surrounded by the Seasonal Forest. Lajedo Belo Campo has approximately 5.9 ha and 855m of elevation, located inside a private property (Fazenda Encantada), with cattle raising activities. The Lajedo da Fazenda Alvorada has approximately 0.80 ha and 805m of elevation, being sectioned by a public road (Fig. 5A).

Data collect

Data analysis was based on material collected in the field and analysis of exsiccates available in physical herbaria or in the online databases of SpeciesLink (CRIA 2021) and JBRJ for the outcrop areas in Boa Nova. It took place in 11 expeditions to selected slabs to collect botanical material between 2016 and 2019. Sampling was carried out through walks along the entire length of the slabs, which included the entire rocky surface up to the edge limits. All angiosperm species found were collected and the material was pressed and herborized according to Peixoto & Maia (2013) and deposited in the Mongoyós Herbarium (HVC) collection.

Identifications were made based on specialized literature, consultations with specialists (when necessary), comparison with materials deposited at the HVC and online herbarium collections. Popular names were only considered when informed by a member of the local population during fieldwork.

The species were categorized according to habit, geographic distribution, phytogeographic domain and threat risk. The habits considered were: arboreal, shrubby, mistletoe, herbaceous, subshrubby and climbing (Judd *et al*. 2009). The floristic list was organized in alphabetical family order, using the APG IV (2016) classification system as a basis. The species names are according to the Flora do Brasil species list (Flora do Brasil 2020).

For the geographic distribution and phytogeographic domain, information contained in the REFLORA database (Flora do Brasil 2020) was used. For the taxon that had not been updated recently, information from the collection of materials deposited in SpeciesLink (CRIA 2021) and JBRJ or recent taxonomic review papers were utilized. To assess the conservation status of threatened species, information available at CNCFlora (Martinelli & Moraes 2013), list of threatened species from SEMA-BA ordinance Nº 40 (08/2017) or original article on recently described species were used (Freitas *et al*. 2013; Wilmot-Dear *et al*. 2014; Büneker *et al*. 2016).

Data analysis

The floristic dissimilarity between the slabs was compared using the Jaccard index, calculated with the aid of the "vegan" package (Oksanen *et al*. 2019) on the R platform (R Core Team 2020).

Results and Discussion

Floristic

162 species/morphospecies of vascular plants were found, distributed in 111 genera and 50 families. Comparing the studied areas, 43 species were listed for Area 01 (being 18 exclusive), 99 for Area 02 (being 20 exclusive), 76 for Area 03 (being six exclusive), 100 for Area 04 (being 15 exclusive) and both have nine species in common (Fig. 6) (Tab. 1).

The outcrops in Boa Nova have a species-rich composition, similar to those found in granitic outcrops in the semiarid region for which we have reference (Queiroz *et al*. 1996; Araújo *et al*. 2008; Porto *et al*. 2008; Gomes & Alves 2010; Tölke *et al*. 2011; Costa *et al*. 2015; Cordeiro *et al*. 2018; Lopes-Silva *et al*. 2019). Lajedo Lagoa Danta (Area 01) contains a lower richness in number of species when compared to the other outcrop areas in Boa Nova, similar richness was found by França *et al*. (2005) in the semiarid region of Bahia, being higher than the numbers found by Pereira *et al*. (2019) in the countryside of Paraíba.

The 11 most representative families were Fabaceae (17 species), Malvaceae (13 spp.), Bromeliaceae (10 spp.), Euphorbiaceae (10 spp.), Orchidaceae (10 spp.), Cactaceae (8 spp.), Apocynaceae (7 spp.), Asteraceae (7 spp.), Convolvulaceae (5 spp.), Rubiaceae (5 spp.) and Verbenaceae (5 spp.), representing 56.79% of the total cataloged species.

The most representative genera were *Mandevilla* (Apocynaceae), *Portulaca* (Portulacaceae), *Sida* (Malvaceae), *Solanum* (Solanaceae) with four species each, *Euphorbia* (Euphorbiaceae) and *Tillandsia* (Bromeliaceae) with three species each. Another 21 genera are represented by two species each and 84 genera by a single species.

Among the most representative families in the studied outcrops (Fabaceae, Orchidaceae, Asteraceae, Rubiaceae, Bromeliaceae, Euphorbiaceae and Malvaceae), some of them are admittedly very well represented in the Brazilian flora, being among the 10 richest families in species in Brazil, noting that Fabaceae is the richest family in number of species in the Caatinga and Orchidaceae in the Atlantic Forest (BFG 2015). It is worth noting that the most diverse families in this study also appear among the richest in number of species in other studies carried out in areas of outcrops in the semiarid region, whose predominant vegetation in the surroundings is Caatinga and/or Seasonal Forest (França *et al*. 2005; Araújo *et al*. 2008; Porto *et al*. 2008; Gomes & Alves, 2010; Tölke *et al*. 2011; Sales-Rodrigues *et al*. 2014; Paulino *et al*. 2018; Lopes-Silva *et al*. 2019).

Regarding the habit, the vegetation is composed of 45 species of herbs, 40 shrubs, 39 sub-shrubs, 20 vines, 15 trees and three mistletoes (Tab. 1). In general, the studied outcrops have herbaceous-shrub vegetation, with sparse small trees where there is a greater accumulation of sediment. At the edge's limits, where the rocks are fragmented and there is a predominance of shallow soil, the predominant vegetation becomes shrub-tree, becoming increasingly dense as it comes into contact with the surrounding vegetation (Observation staff) (Fig. 5C).

The tree species occurred on the slabs only in areas with greater accumulation of sediment, in accordance with those made by Lopes-Silva *et al*. (2019), since the absence of substrate and nutrients limits the growth of large species on the rocky surface.

Herbaceous substrate species such as *Melinis repens*, *Mollugo verticillata*, *Pilea microphylla* and *Portulaca* spp., occurred together with some species of lichen and seedless embryophytes ("bryophytes" and "pteridophytes"). Other herbaceous species were observed being very representative on the rock, for example, *Aosa gilgiana*, *Euphorbia heterodoxa*, *Maranta zingiberina*, *Peperomia blanda* and *Pouzolzia saxophila*.

Climbing species were more frequent in number in relation to the arboreal stratum. The high number of vines was verified by Tölke *et al*. (2011) and Sales-Rodrigues *et al*. (2014) in Agreste Paraibano. This habit stands out from others because it has adaptations to water stress that allow it to develop during the drought (Schnitzer 2005). Another factor would be the form of dispersion (Araújo 2014), many species of vines of the families have anemochoric dispersion, which would facilitate their entry and establishment in open environments in the Caatinga, justifying their occurrence in areas of rocky outcrops (Lucena *et al*. 2017).

The studied outcrops have phytophysiognomies similar to the environments described by Porembski *et al*. (2000) in granitic-gneissic tropical inselbergs and by França *et al*. (1997; 2005) in inselbergs of the semiarid region of Bahia, although they do not present the typical forms of domes characteristic of inselbergs. Plants grow scattered over the rocky surface, shallow depressions, small fissures, seasonal pools or form islands of vegetation (Personal observation) (Figs. 2B; 2D; 3A; 3D; 4A).

The formation of vegetation islands are characteristic habitats of these places, defined as the grouping of one or more species of plants fixed directly on the rock or in shallow soil, delimited by the rocky surface (Conceição *et al*. 2007; Porembski 2007). The species forming vegetation islands observed during collections in Boa Nova were: *Marsdenia caatingae*, *Aechmea patentissima*, *Dyckia dissitiflora*, *Hohenbergia catingae*, *Tillandsia* spp., *Vriesea* spp., *Melocactus ernestii*, *Tacinga werneri*, *Clusia dardanoi*, *Cnidoscolus bahianus*, *Aosa gilgiana*, *Maranta zingiberina*, *Pleroma caatingae*, *Cyrtopodium flavum*, *Encyclia jenischiana*, *Gomesa flexuosa*, *Pseudolaelia vellozicola* and *Vellozia plicata*.

The families Bromeliaceae, Orchidaceae, Cactaceae, Euphorbiaceae and Velloziaceae appear as the main groups that form vegetation islands in Boa Nova and in the semiarid region of Bahia (França & Melo 2014). Likewise, Bromeliaceae, Velloziaceae and Cactaceae appear as pioneers in the formation of islands in inselbergs of the Atlantic Forest (Porembski *et al*. 1998). These groups have adaptive strategies, such as succulence and desiccation tolerance, to survive the extreme environmental conditions that rock environments provide, so there is a higher incidence of these families growing on the exposed rock (Porembski & Barthlott 2000; Porembski 2007).

The work carried out by Barbosa (2018) inventoried three areas of outcrops in Boa Nova, sampling a total of 217 plant species, and two of the collection sites were also part of this study (Lajedo Porangaba and Lajedo Alvorada). Compared to the work by Barbosa (2018), more than 58 species were recorded for the study areas, 28 from new collected areas (Lajedo Lagoa D'anta and Lajedo Belo Campo). Likewise, some species from Barbosa's list (2018) were not found during the field activities, others were exclusive to Lajedo dos Beija-flores (not inventoried), for example, *Aechmea froesii*, *Hippeastrum glaucescens*, *Monteverdia patens*, *Sparattosperma catingae*, or were found in the surrounding vegetation and therefore were not included in the list, since the work was focused only on rupicolous vegetation.

Comparing the floristic list with the flora of inselbergs from the Milagres region in Bahia (França & Melo 2014), the existence of 82 species in common was verified. These areas have great floristic affinity, and even share species in the composition of the islands: *Aechmea patentissima*, *Dyckia dissitiflora*, *Melocactus ernestii*, *Euphorbia phosphorea* and *Vellozia plicata*.

Comparing our data with other studies on outcrops in the Northeast region, located in the Caatinga, Seasonal Forest and Atlantic Forest (Gomes & Alves 2009; Gomes & Sobral-Leite 2013; Costa *et al*. 2015; Cordeiro *et al*. 2018; Lopes-Silva *et al*. 2019), there is a decrease in the number of shared species ranging from 11 to 30, while the number of genera is between 37 and 56. The greatest similarity (with 30 shared species and 56 genera) was with the work de Costa *et al*. (2015), in the agreste region of Paraíba, on the influence of deciduous and semideciduous forests.

Note that the outcrops in Boa Nova share species with other outcrops in the Northeast region, mainly with those in Milagres (BA). Despite being in the semi-arid limits, under the influence of Caatinga and/or Seasonal Forest, geographical proximity is probably contributing to the floristic similarity between them. According to Gomes & Alves (2009), geographic proximity is a determining factor in the composition of inselberg species in the Northeast.

Floristic Similarity

Jaccard's similarity analysis revealed the existence of a floristic dissimilarity between the analyzed areas. The greatest dissimilarity found was between Area 01 and the other Areas, showing an index of 0.88. The greatest similarity was observed between Areas 03 and 04, presenting an index of 0.51, since that the closer to 1, the lower the similarity between the areas (Fig. 7).

The slabs of Boa Nova show differences in floristic composition, despite being geographically very close. A similar result was obtained by Gomes & Alves (2010) when they analyzed the floristic similarity between two outcrops on the Borborema Plateau, only 2 km apart.

The slab in Area 01 was the outcrop that showed the greatest difference in species composition in relation to the other areas. Although these areas are located in the same region, the Lagoa D'anta slab is at a lower elevation and was under drier environmental conditions during the collection of the material, being strongly influenced by Caatinga. On the other hand, the outcrops of Areas 03 and 04 were located in the Seasonal Forest, at higher elevation under wetter environmental conditions (Personal observation).

The variables elevation and precipitation were identified as responsible for the increase in vegetation cover and species diversity in studies carried out in the Southeast (Pinto-Junior *et al*. 2020a) and Northeast (Gomes & Alves 2010; Pessoa & Alves 2014) regions, thus, may be contributing to the diversity of areas located in the Seasonal Forest, since water availability is usually scarce in these locations (Pinto-Junior *et al*. 2020b).

Another relevant factor would be the matrix vegetation in the surrounding areas. During the analysis of the floristic list, it was observed that common species from the Caatinga were collected only in Area 01, among them are: *Spondias tuberosa*; *Neoglaziovia variegate*; *Commiphora leptophloeos* and *Mimosa tenuiflora*. Likewise, *Ficus cyclophylla*, an endemic species of the Atlantic Forest, was collected only in Area 04.

Boa Nova's slabs, despite having slopes on one side, are flat areas that connect with the surrounding areas. Thus, the relief would allow the establishment of species from the surrounding vegetation on the outcrops, due to the greater accumulation of substrate in these places and, consequently, the retention of moisture (Cordeiro *et al*. 2018). Therefore, outcrops are seen as potential sources for matrix regeneration (Gomes & Alves 2010).

Of the eight species shared between the four areas in Boa Nova, three are widely distributed, *Commelina erecta*, *Stylosanthes viscosa* and *Melinis repens* (Flora do Brasil 2020). The other species are highly adapted to the semiarid, such as the palm *Syagrus coronata*, popularly known as licuri and the cansanção *Cnidoscolus urnigerus* (Melo & Sales 2008; Noblick 2017). *Euphorbia phosphorea*, *Melocactus ernestii* and *Stillingia trapezoidea*, are rupicolous species that are widespread in outcrop areas of the Caatinga (Carneiro-Torres *et al*. 2017; Félix 2019; Flora do Brasil 2020) and Atlantic Forest (Romão *et al*. 2007).

Distribution of taxa by phytogeographic domains

Of the 130 taxa identified at species level, 16 occur only in the Caatinga and Atlantic Forest domains, another 19 are endemic to the Caatinga and six to the Atlantic Forest. In addition, the existence of a species, *Trixis pruskii*, restricted to the Cerrado was found. The other species are widely distributed or are within the limits of the Caatinga and Cerrado (Flora do Brasil 2020) (Tab. 1).

Comparing the species list with the work by Moro *et al*. (2014), for the Caatinga domains, it was verified the existence of 72 species in common, 56 with occurrences in inselbergs. For Atlantic Forest, 38 species were shared with the list by Stehmann *et al*. (2009), where 13 have records in rocky outcrop areas and 32 in Seasonal Forest.

The only floristic inventory that covers the different phytophysiognomies of Boa Nova was carried out by Vitório (2016). Comparing our data, we have 58 species in common. According to the author, 43 were inventoried in areas of the Cipó Forest in the region, 25 of which were exclusive (Vitório 2016). The number of species found in the Cipó Forest may be related to the vegetation surrounding the slabs.

For rupicolous vegetation, Vitório (2016) inventoried 65 species, a greater richness (162 species) was found in our work for this type of vegetation in the region. Analyzing the labels of the material inventoried by Vitório (2016), of the species in common, it was observed that 23 had information that was collected in areas of slabs in the Cipó Forest and were not referred to in the work for rupicolous vegetation, which may be influencing the results of the richness of rupicolous species.

Although the outcrops in Boa Nova have species adapted to these environments, the influence of the surrounding vegetation on the species composition can be noted. It is also noticed that endemic species of the Atlantic Forest, such as *Aechmea patentissima* and *Gomesa flexuosa* were found in the Lagoa Danta slab, under greater influence of the Caatinga. As well as endemic species of the Caatinga, for example: *Pereskia bahiensis*, *Cnidoscolus urnigerus*, *Pleroma caatingae* and *Ficus caatingae*, were also located on the slabs in the Seasonal Forest. Possibly, because it is an ecotone area, many species are shared between these areas.

Geographic Distribution

The occurrence of 68 species endemic to Brazil was verified (Tab. 1), being 20 with restricted distribution to the Northeast region and 10 species endemic to Bahia (Flora do Brasil 2020). *Pouzolzia saxophila* is endemic to Boa Nova, growing on shallow soil, in areas of rocky outcrops (Wilmot-Dear *et al*. 2014; Flora do Brasil 2020).

This work revealed nine new records for the Boa Nova: *Skytanthus hancorniifolius*, *Cyperus uncinulatus*, *Euphorbia insulana*, *Jatropha ribifolia*, *Sida spinosa*, *Mollugo verticillata*, *Vanilla bahiana*, *Solanum gardneri* and *Cissus bahiensis* (CRIA 2021; JBRJ).

Three exotic species were catalogued, namely: *Lantana camara*, *Melinis repens* and *Pilea microphylla*. *Melinis repens* was present in the four study areas. Another 43 species are found in anthropogenic environments (Flora do Brasil 2020). The anthropogenic actions observed in Boa Nova contribute to the occurrence of these species, as they are local, inserted in private areas, within the limits of farms, with tourist activities, farming, urban expansion and, in the past, were used by mining companies to extract granite (Personal observation).

Endangered species in the areas

Among the species that occur on rocky outcrops, 17 have some sort of classification according to the IUCN threat criteria (IUCN 2012). Of these, 12 species were classified as Least Concern (LC). *Aosa gilgiana* and *Ficus cyclophylla* were classified as vulnerable (VU) (Martinelli & Moraes 2013; SEMA 2017), *Trixis pruskii* as near threatened (NT) (Martinelli & Moraes 2013), *Pleroma caatingae* as endangered (EN) (Freitas *et al*. 2013) and *Tocantinia stigmovittata* as Critically Endangered (CR) (Büneker *et al*. 2016).

With regard to endangered species, only *Ficus cyclophylla* is not endemic to Bahia. As previously mentioned, *F. cyclophylla* is an endemic tree of the Atlantic Forest, distributed in the eastern range of Brazil (Pederneiras *et al*. 2011), its occurrence in Boa Nova is associated with contact phytophysiognomy of the slabs.

Aosa gilgiana is a rupicolous species, restricted to rocky outcrops in the semiarid region (Cortes *et al*. 2010; Flora do Brasil 2020) and *Pleroma caatingae* is found in association with species of Cactaceae and Bromeliaceae in areas of rocky soils in the Caatinga (Freitas *et al*. 2013). *Trixis pruskii* has been described in the Chapada Diamantina region, occurring in areas of cerradão, riparian forest and rocky fields (Hind 2000). In Bahia, it can also be found in outcrop areas with the occurrence of Seasonal Forest and Caatinga (CRIA 2021; Staudt *et al*. 2017). *Tocantinia stigmovittata* is an herbaceous species, so far it had only been recorded in two localities (municipalities of Lagoa Real and Caetité), growing in shallow soil in areas of Caatinga and Cerrado (Büneker *et al*. 2016).

In general, the outcrops in Boa Nova have high species richness, contributing to the region's floristic diversity. They have a composition and structure similar to the semi-arid outcrops, mainly in the region of Milagres - BA. Despite the short distance between them, they are distinct environments, which are influenced by contact physiognomies. The registration of endemic, endangered and exotic species reinforces the need for conservation of these environments, with the creation of the management plan for the UC of Boa Nova.

Acknowledgment

We thank the CAPES for the scholarship granted to the first author; the UESB and the PROAP for the financial assistance provided for data collection; the team from the Mongoyós Herbarium (HVC) and the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). To research A. Stadnik (Myrtaceae), C. Caires (Loranthaceae), D. Cardoso, L. Queiroz e J. Costa (Leguminosa), G. Costa (Lytraceae), H. Huaylla (Amarylidaceae), J. Jardim (Rubiaceae), e R. F. de Almeida (Malpighiaceae) by helping to identify the material.

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Figures e Tables

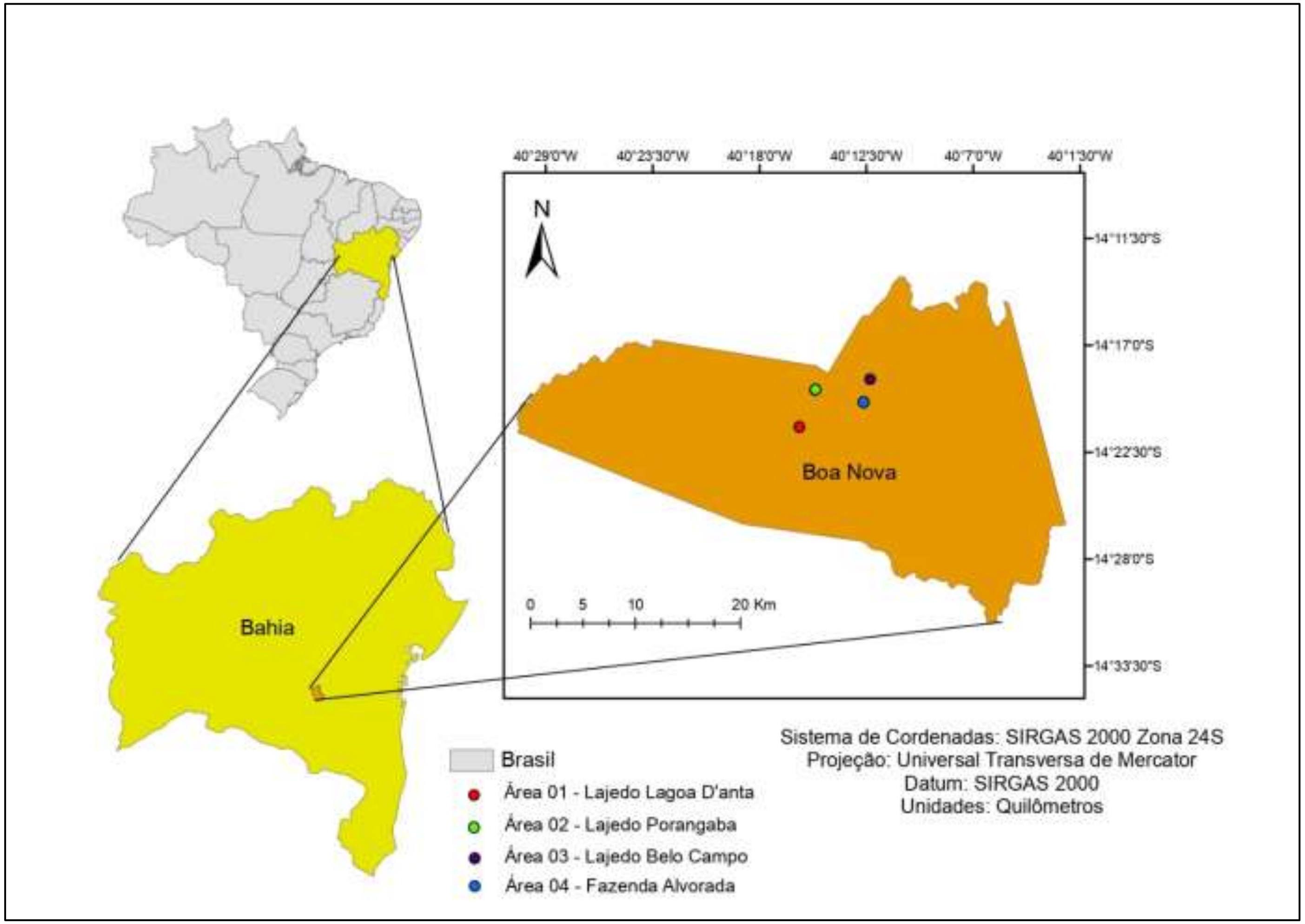

Figure 1. Location of the four study areas inserted in the municipality of Boa Nova. Study areas: Area 01 = Lajedo Lagoa Danta, Area 02 = Lajedo Porangaba, Area 03 = Lajedo Belo Campo, Area 04 = Lajedo Fazenda Alvorada.

Figure 2. Phytophysiognomies of rocky outcrops of Boa Nova, Bahia, Brazil: a-d. phytophysiognomies of Lajedo Lagoa Danta. a = exposed rock, b = vegetation island formed by *Euphorbia phosporea* and *Melocactus ernestii*, c = great depression in the rock e d = seasonal puddle.

Figure 3. Phytophysiognomies of rock outcrops in Boa Nova, Bahia, Brazil: a-d. physiognomies of Lajedo Porangaba. a = vegetation spread over the rocky surface, b = island of vegetation formed by *Clusia dardanoi*, *Hohenbergia catingae* and *Vellozia plicata*, c-d = vegetation growing in shallow soil.

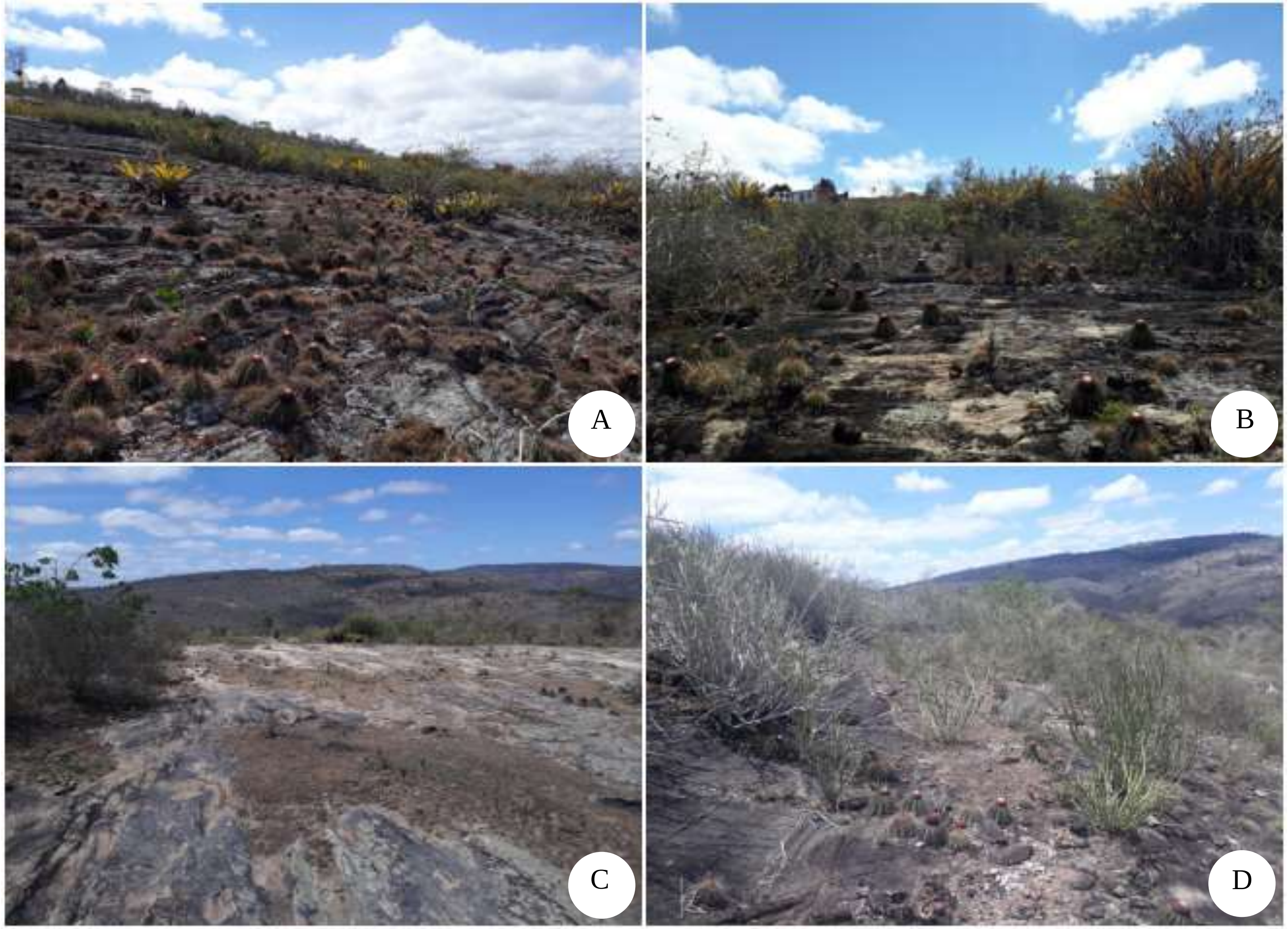

Figure 4. Phytophysiognomies of rock outcrops in Boa Nova, Bahia, Brazil; a-d. physiognomies of Lajedo Belo Campo. a = vegetation spread over the rocky surface, formed mainly by *Melocactus ernestii* and deeper associations between Bromeliaceae, Euphorbiaceae, Loasaceae e Orchidaceae, among others, b = associations between *Pleroma caatingae* and *Hohenbergia catingae*, c = exposed rock with thin layer of soil, d = cluster of *Euphorbia phosphorea*.

Figure 5. Phytophysiognomies of rocky outcrops of Boa Nova, Bahia, Brazil; a-d. physiognomies of Lajedo Alvorada. a = road of public way, b-c = vegetation developing in places with poorly developed soil, d = rock with lichens and cyanobacteria.

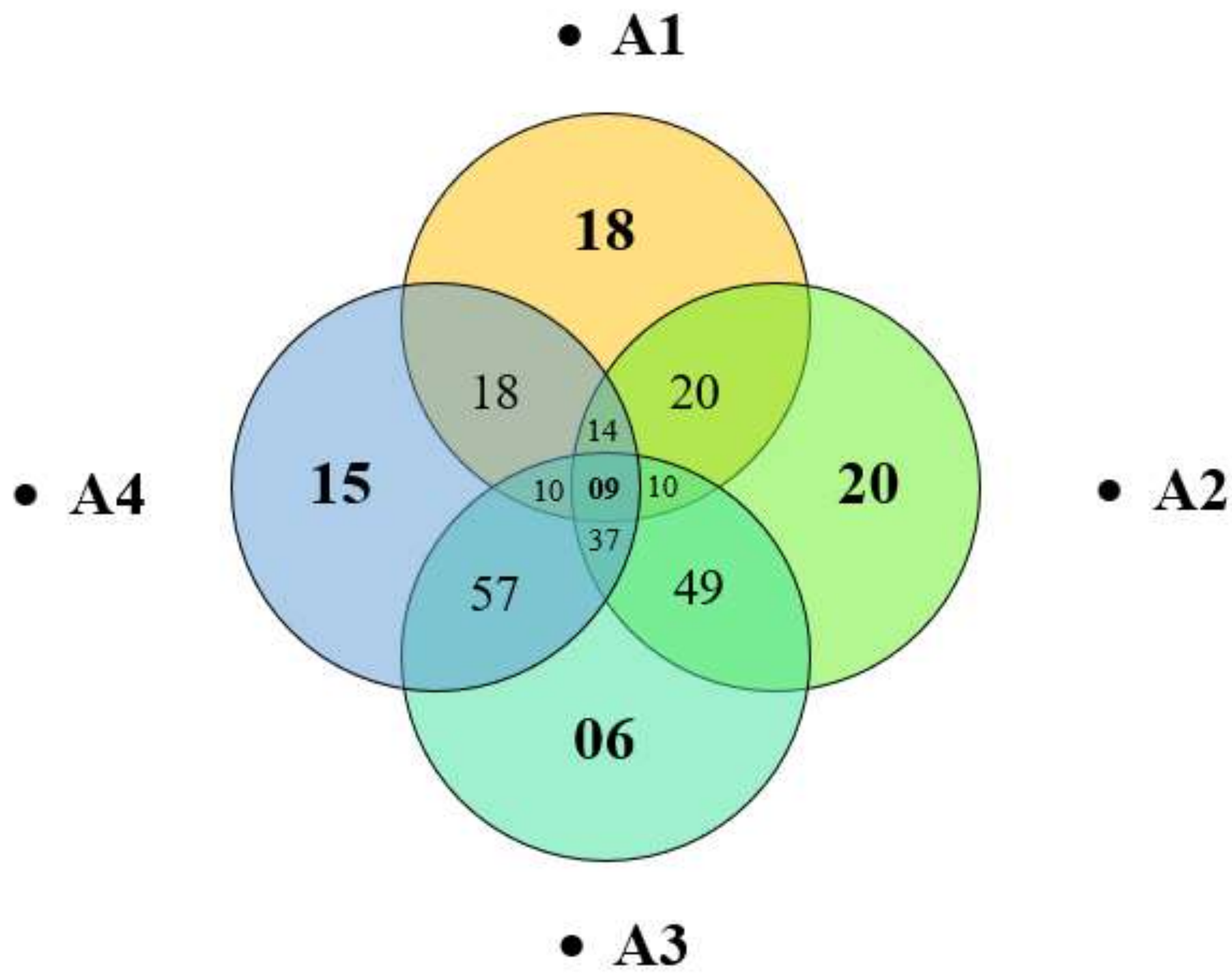

Figure 6. Venn diagram representing the shared and unique species of the four study areas. A1 = Lajedo Lagoa Danta, A2 = Lajedo da Porangaba, A3 = Lajedo Belo Campo, A4 = Lajedo Alvorada.

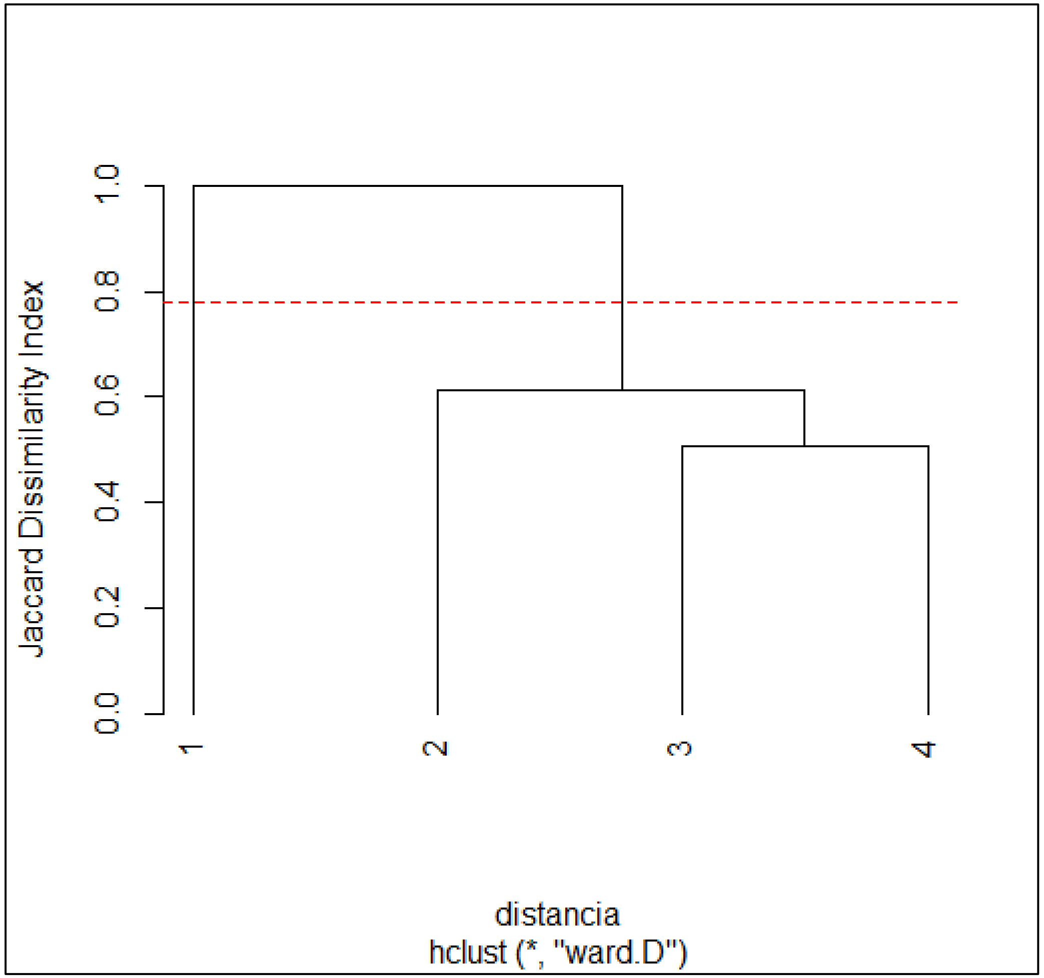

Figure 7. Dendrogram of dissimilarity among the studied outcrops obtained through the Jaccard Index. Area: 1 = Lajedo Lagoa Danta, 2 = Lajedo da Porangaba, 3 = Lajedo Belo Campo, 4 = Lajedo Alvorada.

Table 1. Floristic list of species found in rocky outcrop areas in Boa Nova, Bahia, Brazil. Location within Boa Nova National Park and Wildlife Refuge: A1 = Lajedo Lagoa Danta, A2 = Lajedo Porangaba, A3 = Lajedo belo campo, A4 = Lajedo Alvorada. Endemic to Brazil = *, Endemic to Bahia = **, Naturalized = °. Phytogeographic domain: CA= Caatinga, AF= Atlantic Forest, CE = Cerrado, AM = Amazon, PP = Pampa, PA = Pantanal.

Family/Species	Habit	Voucher	Location				Phytogeographic Domain
			A1	A2	A3	A4	
Acanthaceae							
Justicia sp.	Arb.	M. Carmo 495		x		x	
Ruellia bahiensis (Nees) Morong*	Subarb.	A.M.M. França 03; M. Carmo 484; M. Lopes 84		x	x	x	CA, MA
Amaranthaceae							
Alternanthera brasiliana (L.) Kuntze	Subarb.	D.C. Pereira 13; M. Lopes 48			x	x	AM, CA, CE, MA, PA, PP
Alternanthera multicaulis Kuntze**	Subarb.	A.M.M. França 18; M. Carmo 437		x	x		CA
sp1	Subarb.	M. Carmo 470				x	
Amaryllidaceae							
Tocantinia stigmovittata Büneker, R.E.Bastian & C.M.Costa**	Herb.	L.S. Pereira 31				x	CA, CE
Zephyranthes cearensis (Herb.) Baker*	Herb.	M. Carmo 627; R.A. Leoni 35		x	x		CA, CE
Anacardiaceae							
Spondias tuberosa Arruda*	Arbo.	M. Carmo 642	x				CA, CE
Apocynaceae							
Ditassa capillaris E.Fourn.*	Trep.	J.C.B. Souza 33		x			CA, CE
Mandevilla microphylla (Stadelm.) M.F.Sales & Kin.-Gouv.*	Trep.	D. C. Pereira 22; J.S. Anjos 04; M. Carmo 616		x	x	x	CA, CE, MA
Mandevilla moricandiana (A.DC.) Woodson*	Trep.	R.A. Leoni 03		x			CA, CE, MA
Mandevilla sancta (Stadelm.) Woodson**	Subarb.	M. Carmo 394		x			CA, CE, MA
Mandevilla tenuifolia (J.C.Mikan) Woodson	Herb.	E.O. Souza 20; HUEFS 193355		x		x	AM, CA, CE, MA

Marsdenia caatingae Morillo*	Arb.	A.T.T.S. Dourado 85; HUEFS 193352; M. Carmo 624		x	x	x	CA, MA
Skytanthus hancorniifolius (A.DC.) Miers*	Trep.	M. Carmo 603		x			CA, MA
Araceae							
Anthurium affine Schott*	Herb.	M. Carmo 413; Registro fotográfico	x	x			CA, CE, MA
Arecaceae							
Syagrus coronata (Mart.) Becc.*	Arbo.	Registro fotográfico	x	x	x	x	CA, CE
Syagrus sp.	Arb.	Registro fotográfico	x				
Asteraceae							
Blanchetia heterotricha DC.*	Arb.	G.L. Sampaio 12; HURB 6743		x		x	CA, MA
Conocliniopsis prasiifolia (DC.) R.M.King & H.Rob.	Subarb.	A.C.S. Torres 04; D.C. Pereira 20; M. Carmo 435		x	x	x	CA, CE, MA
Lepidaploa cotoneaster (Willd. ex Spreng.) H.Rob.	Arb.	M. Carmo 482; RB 576038		x	x	x	CA, CE, MA
Trixis antimenorrhoea (Schrank) Kuntze	Arb.	A.S. Soares 15; M. Carmo 497		x		x	CE, MA
Trixis pruskii D.J.N.Hind**	Arb.	A.S. Soares 26		x			CE
Verbesina macrophylla (Cass.) S.F.Blake	Arb.	E.O. Souza 31		x			CA, MA
sp1	Subarb.	A.M.M. França 21; M. Lopes 66		x	x		
Bignoniaceae							
Pyrostegia venusta (Ker Gawl.) Miers	Trep.	J.C.B. Souza 27		x			AM, CA, CE, MA, PA, PP
Boraginaceae							
Heliotropium angiospermum Murray	Arb.	D.C. Pereira 08				x	CA, MA
Varronia curassavica Jacq.	Arb.	M. Carmo 394; M. Carmo 491; M. Lopes 45		x	x	x	AM, CA, CE, MA, PP
Bromeliaceae							
Aechmea aquilega (Salisb.) Griseb.*	Herb.	M. Carmo 411	x				AM, CA, CE, MA
Aechmea patentissima (Mart. ex Schult. & Schult.f.) Baker	Herb.	L.S. Pereira 14; M. Carmo 410; R.A. Leoni 33	x	x		x	MA
Bromelia sp.	Herb.	Registro fotográfico	x	x	x	x	
Dyckia dissitiflora Schult. & Schult. f. *	Herb.	A.S. Soares 12; M. Carmo 395		x		x	CA, CE

Hohenbergia catingae Ule*	Herb.	L.S. Pereira 13		x	x	x	CA, CE, MA
Neoglaziovia variegata (Arruda) Mez*	Herb.	M. Carmo 408	x				CA
Tillandsia gardneri Lindl.	Herb.	M. Carmo 612		x		x	CA, CE, MA, PP
Tillandsia recurvata (L.) L.	Herb.	R.A. Leoni 17		x			CA, CE, MA, PP
Tillandsia sp.	Herb.	M. Carmo 606		x			
Vriesea sp.	Herb.	M. Carmo 609		x			
Burseraceae							
Commiphora leptophloeos (Mart.) J.B.Gillett	Arbo.	Registro fotográfico	x				AM, CA, CE
Cactaceae							
Arrojadoa penicillata (Gürke) Britton & Rose*	Arb.	M. Carmo 419	x				CA
Brasilicereus phaeacanthus (Gürke) Backeb.*	Arb.	C.S. Silva 07; M.S. Oliveira 47	x	x		x	CA
Melocactus ernestii Vaupel*	Subarb.	A.K.A. Santos 1523	x	x	x	x	CA, MA
Pereskia aculeata Mill.	Trep.	M. Carmo 434; RB 580631			x	x	CA, CE, MA, PP
Pereskia bahiensis Gürke**	Arb.	RB 578821	x			x	CA
Pilosocereus catingicola (Gürke) Byles & Rowley subsp. *Catingicola***	Arbo.	Registro fotográfico	x			x	CA
Pilosocereus pentaedrophorus (Cels) Byles & Rowley*	Arb.	RB 579385		x			CA, MA
Tacinga werneri (Eggli) N.P.Taylor & Stuppy*	Arb.	A.K.A. Santos 1524; M. Carmo 416	x	x			CA
Cannabaceae							
Celtis brasiliensis (Gardner) Planch.	Arb.	M. Carmo 440; R.A. Leoni 04		x	x		CA, CE, MA
Clusiaceae							
Clusia dardanoi G.Mariz & Maguire*	Arbo.	L.S. Pereira 12; R.A. Leoni 06		x		x	CA
Commelinaceae							
Callisia repens (Jacq.) L.	Herb.	M. Carmo 468		x	x	x	CA, MA, PP
Commelina erecta L.	Herb.	D.C. Pereira 15; M. Carmo 428; M. Carmo 477; M. Lopes 58	x	x	x	x	AM, CA, CE, MA, PA, PP
Convolvulaceae							

Evolvulus glomeratus Nees & Mart.	Herb.	A.T.T.S. Dourado 87; D.C. Pereira 02;		x	x	x	AM, CA, CE, MA, PP
Ipomoea ramosissima (Poir.) Choisy	Trep.	A.M.M. França 16; M. Carmo 469		x	x	x	AM, CA, CE, MA, PA
Ipomoea sp.	Trep.	M. Lopes 47			x		
Jacquemontia bracteosa Meisn.*	Trep.	M. Carmo 439; M. Carmo 481; RB 585930		x	x	x	CA, CE, MA
Jacquemontia nodiflora (Desr.) G.Don	Trep.	M. Carmo 604		x			CA, CE, MA
Cucurbitaceae							
Doyerea emetocathartica Grosourdy	Trep.	E.P. Amorim 06; M. Carmo 472; M. Carmo 406	x	x		x	CA
Cyperaceae							
Bulbostylis scabra (J.Presl & C.Presl) C.B.Clarke	Herb.	M. Carmo 446; RB 578504		x	x		AM, CA, CE, MA, PP
Cyperus uncinulatus Schrad. ex Nees	Herb.	M. Carmo 445			x	x	AM, CA, CE, PP
Cyperus sp.	Herb.	A.B.B. Cunha 01		x			
Dioscoreaceae							
Dioscorea campestris Griseb.	Trep.	J.C.B. Souza 31; M. Carmo 458		x		x	CA, CE, MA, PP
Erythroxylaceae							
Erythroxylum loefgrenii Diogo*	Arb.	M. Carmo 605		x			CA
Erythroxylum sp.	Arb.	M. Carmo 635				x	
Euphorbiaceae							
Cnidoscolus bahianus (Ule) Pax & K.Hoffm.*	Arb.	D.C. Pereira 26; M. Carmo 425	x	x		x	CA, CE
Cnidoscolus urnigerus (Pax) Pax	Arb.	M. Silva 07	x	x	x	x	CA
Croton heliotropiifolius Kunth	Arb.	A.S. Soares 02; M. Carmo 614			x	x	CA, CE, MA
Croton tetradenius Baill.*	Arb.	J.C.B. Souza 10; M.S. Oliveira 36		x		x	CA, CE, MA
Euphorbia heterodoxa Müll.Arg.*	Herb.	M. Carmo 441; M. Carmo 464; M. Lopes 49			x	x	CA
Euphorbia insulana Vell.	Subarb.	M. Carmo 632				x	CA, MA
Euphorbia phosphorea Mart.*	Arb.	M. Carmo 397; M. Carmo 638; RB 579447	x	x	x	x	CA
Jatropha ribifolia (Pohl) Baill.*	Arb.	M. Carmo 422	x				CA, CE, PA, PP

Stillingia trapezoidea Ule*	Arb.	M. Carmo 494; M. Lopes 72	x	x	x	x	CA
sp1	Subarb.	M. Carmo 461				x	
Fabaceae							
Centrosema arenarium Benth.*	Trep.	M. Carmo 607		x			CA, CE, MA
Centrosema cf. virginianum (L.) Benth.	Trep.	M. Lopes 67			x		AM, CA, CE, MA, PA, PP
Chamaecrista nictitans (L.) Moench	Subarb.	L.S. Pereira 26; M. Carmo 430; M. Carmo 459; M. Carmo 622		x	x	x	AM, CA, CE, MA, PA, PP
Chamaecrista rotundifolia var. grandiflora (Benth.) H.S.Irwin & Barneby	Subarb.	M. Carmo 398		x			CA, CE, MA
Chloroleucon dumosum (Benth.) G.P.Lewis *	Arbo.	HURB 6449	x				CA, CE, MA
Crotalaria incana L.	Subarb.	M. Carmo 455; M. Carmo 492; RB 579188		x	x	x	AM, CA, CE, MA, PA, PP
Galactia sp.1	Trep.	M. Carmo 433; M. Carmo 634			x	x	
Galactia sp.2	Trep.	M. Carmo 454; M. Carmo 486; M. Lopes 46			x	x	
Indigofera suffruticosa Mill.	Subarb.	A.B.B. Cunha 32; M. Carmo 623		x	x		AM, CA, CE, MA, PP
Mimosa tenuiflora (Willd.) Poir.	Arbo.	Comunicação pessoal	x				CA, CE
Mimosa sp.	Arb.	M. Lopes 83			x		
Poecilanthe ulei (Harms) Arroyo & Rudd*	Arb.	M. Carmo 641	x				CA, MA
Senna macranthera (DC. ex Collad.) H.S.Irwin & Barneby	Arb.	A.B.B. Cunha 09; M. Carmo 442; M. Carmo 601		x	x	x	CA, CE, MA
Stylosanthes viscosa (L.) Sw.	Subarb.	A.M.A. Santos 11; A.M.M. França 17; M. Carmo 424	x	x	x	x	AM, CA, CE, MA, PA, PP
Zornia sp.	Herb.	M. Carmo 499				x	
sp1	Arbo.	M. Carmo 600				x	
sp2	Arbo.	A.M.A. Santos 23				x	
Hydroleaceae							
Hydrolea spinosa L.	Subarb.	M. Carmo 427	x				AM, CA, CE, MA, PP, PA

Lamiaceae							
sp1	Subarb.	D.C. Pereira 19; M. Carmo 456			x	x	
Loasaceae							
Aosa gilgiana (Urb.) Weigend**	Herb.	R.A. Leoni 29	x	x	x		CA
Loranthaceae							
Psittacanthus cordatus (Hoffmanns.) G.Don	Hemip.	M. Carmo 637	x				AM, CA, CE, MA, PA
Struthanthus polyrhizus (Mart.) Mart.	Hemip.	A.M.M. França 19; A.S. Soares 03; M. Carmo 639	x	x		x	CA, CE, MA
sp1	Hemip.	M. Carmo 640	x				
Lythraceae							
Cuphea sp.	Subarb.	M. Carmo 480; M. Lopes 85			x	x	
Pleurophora anomala (A. St.-Hil.) Koehne*	Subarb.	E.P. Amorim 17; M. Carmo 463		x		x	CA
Malpighiaceae							
sp1	Arbo.	M. Carmo 420	x				
Malvaceae							
Gaya domingensis Urb	Subarb.	L.S. Pereira 15; M. Carmo 474		x		x	CA, CE, MA
Herissantia crispa (L.) Brizicky	Subarb.	M. Carmo 426; M. Carmo 628			x	x	CA, CE
Herissantia tiubae (K.Schum.) Brizicky*	Subarb.	M. Carmo 421; RB 577005	x	x			CA, CE
Pavonia cancellata (L.) Cav.	Subarb.	A.M.M. França 23; D.C. Pereira 06		x		x	AM, CA, CE, MA
Pavonia martii Colla*	Subarb.	A.B.B. Cunha 03; M. Carmo 490; M. Carmo 620		x	x	x	CA, CE
Sida ciliaris L.	Subarb.	M. Carmo 633; M. Lopes 42			x	x	CA, MA
Sida spinosa L.	Subarb.	M. Carmo 475				x	CA, CE, MA
Sida ulei Ulbr.*	Subarb.	M. Carmo 631				x	CA, CE
Sida sp.	Arb.	J.C.B. Souza 18; M.S. Oliveira 12		x		x	
Sidastrum multiflorum (Jacq.) Fryxell	Subarb.	M. Carmo 460; M. Carmo 643; M. Lopes 62		x	x	x	AM, CA, MA
sp1	Arb.	M. Carmo 451; M. Carmo 485			x	x	
sp2	Subarb.	L.S. Pereira 16; M. Carmo 626		x	x		

sp3	Arb.	M. Carmo 465				x	
Maranthaceae							
Maranta zingiberina L.Andersson*	Herb.	M. Carmo 618; RB 579493		x	x	x	CA, MA
Melastomataceae							
Pleroma caatingae (J.G.Freitas) P.J.F.Guim. & Michelang.	Arbo.	M. Lopes 79; M. Carmo 396		x	x	x	CA
Molluginaceae							
Mollugo verticillata L.°	Herb.	M. Carmo 444			x		AM, CA, CE, MA, PP
Moraceae							
Ficus caatingae R.M.Castro*	Arbo.	M. Carmo 636				x	CA
Ficus cyclophylla (Miq.) Miq.*	Arb.	M. Carmo 483				x	MA
Myrtaceae							
Campomanesia sp.	Arbo.	M. Carmo 414	x				
Eugenia cf. pyriformis Cambess.	Arbo.	D.C. Pereira 07; M. Carmo 602		x		x	CE, MA
Psidium schenckianum Kiaersk.*	Arb.	M. Carmo 599; M. Carmo 619; R.A. Leoni 28		x	x	x	CA, MA
Orchidaceae							
Cyrtopodium flavum Link & Otto ex Rchb.f.*	Herb.	M. Lopes 78		x	x	x	MA
Encyclia jenischiana (Rchb.f.) Porto & Brade**	Herb.	M. Carmo 610; RB 570631		x		x	CA
Epidendrum cinnabarinum Salzm.*	Herb.	A.M.M. França 31; L.S. Pereira 02; M. Carmo 450		x	x	x	CA, CE, MA
Epidendrum secundum Jacq.	Herb.	RB 580607		x			AM, CA, CE, MA
Gomesa flexuosa (Lodd.) M.W.Chase & N.H.Williams	Herb.	M. Carmo 611	x	x			MA
Prescottia plantaginifolia Lindl. ex Hook.*	Herb.	M. Carmo 389; M. Carmo 449; R.A. Leoni 15		x	x	x	CE, MA
Pseudolaelia vellozicola (Hoehne) Porto & Brade*	Herb.	M. Carmo 397		x			CE, MA
Rodriguezia rigida (Lindl.) Rchb.f.*	Herb.	M. Lopes 82; M.S. Oliveira 48		x	x		MA
Sacoila lanceolata (Aubl.) Garay	Herb.	E.M.G. Baleeiro 21; M.S. Oliveira 11		x		x	AM, CA, CE, MA, PP
Vanilla bahiana Hoehne*	Trep.	M. Carmo 625			x	x	CA, CE, MA

Passifloraceae							
Passiflora sp.	Trep.	M. Lopes 63; RB580099; RB 580100		x	x	x	AM, CA, CE, MA
Piperaceae							
Peperomia blanda (Jacq.) Kunth	Herb.	M. Lopes 52			x		AM, CE, MA
Plantaginaceae							
Matourea crenata (Ronse & Philcox) Colletta & V.C.Souza*	Subarb.	M. Carmo 448; RB 580062			x	x	CA, CE, MA
Poaceae							
Melinis repens (Willd.) Zizka°	Herb.	M. Carmo 436; M. Silva 01	x	x	x	x	AM, CA, CE, MA, PA, PP
Polygalaceae							
Asemeia sp.	Herb.	M. Carmo 498; M. Lopes 86			x	x	
Polygala fontellana Marques & A.C.A.Aguiar*	Herb.	R.A. Leoni 23		x			CE, MA
Portulacaceae							
Portulaca elatior Mart. ex Rohrb.	Herb.	M. Carmo 418; M. Lopes 57	x		x		CA, CE, MA
Portulaca halimoides L.	Herb.	M. Carmo 630			x	x	AM, CA, CE, MA, PP
Portulaca hirsutissima Cambess.*	Herb.	A.S. Soares 35; M. Carmo 478		x		x	CA, CE, MA
Portulaca umbraticola Kunth	Herb.	M. Carmo 488; M. Carmo 629			x	x	CA, CE, MA, PA
Rubiaceae							
Borreria verticillata (L.) G.Mey.	Subarb.	A.C.S Torres 09; M. Carmo 621		x	x		AM, CA, CE, MA, PA, PP
Emmeorhiza umbellata (Spreng.) K.Schum.	Ar.	E.O. Souza 23		x			AM, CA, CE, MA, PA
Hexasepalum teres (Walter) J.H. Kirkbr.	Subarb.	M. Carmo 447			x	x	AM, CA, CE, MA, PA, PP
Leptoscela ruellioides Hook.f.*	Subarb.	M. Silva 20; M. Carmo 453		x	x		CA, MA
Mitracarpus sp.	Subarb.	A.S. Soares 16; M. Carmo 431		x	x		
Solanaceae							
Solanum agrarium Sendtn.*	Subarb.	A.M.M. França 27; M. Carmo 479		x		x	CA, CE, MA
Solanum gardneri Sendtn.*	Subarb.	M. Carmo 415	x				CA, MA

Solanum megalonyx Sendtn.*	Arb.	D.C. Pereira 09; R.A. Leoni 07		x		x	AM, CA, CE, MA
Solanum sp.	Arb.	M. Carmo 489				x	
Talinaceae							
Talinum paniculatum (Jacq.) Gaertn.	Herb.	A.C.S Torres 07; M. Carmo 452		x	x	x	AM, CA, CE, MA, PA, PP
Turneraceae							
Turnera chamaedrifolia Cambess.*	Arb.	M. Carmo 443			x	x	CA, CE, MA
Urticaceae							
Pilea microphylla (L.) Liebm.	Herb.	M. Lopes 56; RB 589022; RB 589029		x	x	x	AM, CA, CE, MA
Pouzolzia saxophila Friis, Wilmot-Dear & A. K. Monro**	Herb.	M. Carmo 615; RB 589017; RB 589034		x	x	x	MA
Velloziaceae							
Vellozia plicata Mart.*	Arb.	M. Carmo 409; M. Carmo 613	x	x			CA, CE, MA
Verbenaceae							
Lantana camara L.°	Arb.	A.M.M. França 14; M. Carmo 487		x		x	AM, CA, CE, MA, PA, PP
Lantana fucata Lindl.	Subarb.	M. Carmo 429; M. Carmo 432	x		x	x	CA, CE, MA, PP
Lippia thymoides Mart. & Schauer*	Arb.	M. Carmo 391; M. Carmo 466		x	x	x	CA, CE, MA
Priva bahiensis A.DC.*	Subarb.	D.C. Pereira 05; E.P. Amorim 23; M. Lopes 81		x	x	x	CA, MA
sp1	Subarb.	M. Carmo 426; M. Carmo 496	x			x	
Vitaceae							
Cissus bahiensis Lombardi*	Trep.	M. Carmo 423	x				CA, CE
Indet.							
sp1	Arb.	M. Carmo 407	x				
sp2	Arbo.	M. Carmo 617			x		
Total species			43	99	76	100	

O trabalho a seguir foi elaborado segundo as normas da Revista Plant Ecology and Evolution ISSN - 2032-3913 (versão impressa) / ISSN - 2032-3921 (versão eletrônica)

5. CAPÍTULO 2

Effect of the size and shape of vegetation islands on the floristic composition of rocky outcrops in the Conservation Units of Boa Nova, northeastern Brazil

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Background and Objectives - Rocky outcrops are ecosystems with high species richness and endemism. Ecological studies are essential to understand the adaptation and colonization processes of species in these environments. Therefore, the main objective of this work was to know the composition of the vegetation islands of the rocky outcrops of an ecotone area in northeastern Brazil, to assess the most frequent interactions between species and the likely influence of island size, shape and surrounding vegetation in the characterization and formation of the modules.

Methods - To investigate the composition of the vegetation islands, a floristic survey of the islands present in four outcrops in the Conservation Units of Boa Nova, Bahia was carried out. The islands were measured for their largest and smallest diameter. The interactions between species were investigated through the analysis of modularity in the R Studio Platform, as well as the variations in area, shape and surrounding vegetation as a function of the modules.

Main results - 90 islands of vegetation were sampled. The floristic list of these islands comprises 106 species. The modularity analysis grouped six modules through more frequent interactions between species. Among the variables observed, there was no variation in the size of the areas due to the modules formed, however we found variations in the shape of the islands and in the surrounding vegetation.

Conclusion - Our results assume that the shape of the areas and the vegetation of the surrounding matrix are contributing to the formation and differentiation of modules formed through the species present in the vegetation patches.

Key words – Ecology; ecotone; modularity; rocky outcrops; vegetation islands.

INTRODUCTION

Rock outcrops are rock exposures that stand out from the surrounding landscape, arising from erosive processes and tectonic elevations that culminated in soil removal (Michael & Lindenmayer 2018). The environmental severity provided by high temperature rates, soil scarcity and water deficit led to the establishment of an adapted flora that generally differs from the surrounding matrix (Porembski 2007), revealing environments with great diversity of species and endemisms (Porembski & Barthlott 2000; Silva 2016).

Despite the adverse environmental conditions, rock outcrops are heterogeneous environments, with a remarkable variety of habitats (Porembski et al. 2000), among which vegetation islands stand out as the most characteristic habitat of these locations. The islands occur as isolated patches, completely delimited by the exposed rock, they are formed by species that settle directly on the rock or in shallow soil (França et al. 2005; Conceição et al. 2007; Porembski 2007).

Due to their insular characteristics, the islands are object of floristic and phytosociological studies that seek to understand the adaptation and colonization processes of these environments (Porembski et al. 1998; Meirelles et al. 1999; França et al. 2005; Conceição et al. 2007; Ribeiro et al. 2007; Gomes & Alves 2010; Souza et al. 2011). However, ecological studies are still rare (Silva 2016).

In ecology, community detection algorithms are used to identify modules that are more likely to interact with each other. The detection of these modules through modularity analysis has the potential to develop a better understanding of the assembly of ecological communities and to investigate the overlapping or functional specialization of species (Newman 2004; Dormann & Strauss 2014; Beckett 2016).

Therefore, our study had as main objective to know the floristic composition of the vegetation islands present in four areas of rocky outcrops in the city of Boa Nova and to evaluate the most frequent interactions between species through modularity analysis. In addition, we analyzed the contribution of island size, shape, and surrounding vegetation to the formation of modules.

MATERIALS AND METHODS

Sampling

The selected islands belong to four areas of rocky outcrops (slabs) located within the limits of the Conservation Units of Boa Nova (UC) - Boa Nova National Park (PARNA) and Wildlife Refuge (REVIS) - in the caatinga and seasonal forest. The collections took place from September to December 2019. All vegetation islands were sampled, ie the grouping of plant species attached directly to the rock or in shallow soil, being totally delimited by the exposed rock (see Conceição et al. 2007). The islands were measured in terms of their largest and smallest diameter and only those with at least 1 square m² in area were sampled.

Botanical material collection

During data collection, species not identified in loco were collected (with flowers and/or fruits), herborized according to the techniques of Peixoto & Maia (2013) and later deposited in the Mongoyós Herbarium (HVC) (Thiers 2021). Identifications were made using specialized literature (eg identification keys, field guides, etc.) (eg, Freitas et al. 2013; França & Melo 2014; Rêgo & Azevedo 2017; Félix et al. 2019; Souza & Lorenzi 2019; Fonseca et al. 2020; Simões et al. 2020), comparison with materials deposited at the HVC, online databases (CRIA 2021; JBRJ) and consultation with experts when necessary.

Interactions between species (Modularity analysis)

We used modularity analysis (Newman 2004) to assess the most frequent connections between species present in vegetation islands, through the formation of modules (subsets). For this, the presence of species in each sampling unit was considered. Data analysis was performed in R language (R core team 2020) using the "Bipartite" package and computeModules and plotModuleWeb functions (Dormann & Strauss 2014).

Floristic composition and predominant life forms in the modules

The composition of the modules was evaluated according to their life form and fixation substrate (Tables 1-6). For this, we use the information of each taxon as described in Reflora (Flora do Brasil 2020).

Association between variables (Chi-square statistic)

To understand the factors that influence the connections between the vegetation islands and their respective species, we evaluated the physiognomies present in the surrounding vegetation as a function of the formed modules. They were identified as caatinga (caa), seasonal forest (fess) and transition between caatinga and seasonal forest (caafess). The analysis was performed using the chisq.tes function referring to the Chi-Square Test (Agresti 2007) of the R Studio platform (R core team 2020).

Association between variables (ANOVA)

Analysis of Variance (ANOVA) (Chambers et al. 1992) was used to verify if the size of the areas (ellipse) and the shape (ratio) of the vegetation islands are influencing the formation of the modules. The statistical test was performed by the *aov* function in R Studio (R core team 2020).

RESULTS

Floristic composition and predominant habits in the modules

Ninety vegetation islands were evaluated: 21 islands in the Lagoa D'anta slab (14°21'12.26"S 40°15'54.80"W) inserted in the caatinga phytophysionomy, 37 islands in the Porangaba slab (14°19'19.00"S 40°15'07.10"W) inserted in the physiognomy of the transition area, 22 islands in the slab of Belo Campo (14°18'45.80"S 40°12'18.38"W) and 10 islands of vegetation in the slab of Fazenda Alvorada (14°19'56.61"S 40°12'38.40"W), both inserted in the phytophysiognomy of the seasonal forest.

106 species were collected, distributed in 83 genera and 42 families, with Bromeliaceae (10), Fabaceae (10), Euphorbiaceae (8), Cactaceae (7) and Orchidaceae (7) being the five most representative in number of species (Tables 1-6).

Module 1 grouped 14 vegetation islands and 26 species, with the predominant life form being herbaceous (10). Regarding the substrate, most species are terrestrial (14), with only three exclusively rupicolous species, and another four found in both substrates (terricultural/rupicolous) (Table 1).

Module 2 grouped 11 vegetation islands and 20 species. The life forms that stood out were sub-shrubs (8) and herbaceous (7). Most species are terrestrial (16), only three are exclusively rupicolous and another three are found in both substrates (Table 2).

Module 3 added the largest number of islands (43) being composed of 14 species. The predominant life forms were herbaceous (6) and sub-shrub (5). Most species are rupicolous or epiphyte (11). (Table 3).

The modules with the smallest number of islands were 4 and 5, and module 4 grouped three vegetation islands and 11 species. All species in this module are terrestrial, with the sub-shrubby habit as predominant (5) (Table 4). Module 5 added only two islands, comprising seven species. There was a predominance of terrestrial (7) and sub-shrub (4) species (Table 5).

Module 6 grouped 17 islands and the largest number of species represented so far (28). Herbaceous were the predominant way of life (14). All terrestrial species, however, 11 species were also found fixed directly on the rock (Table 6).

Interactions between species

The modularity found was 0.4428, which is higher than expected by chance (Simulation = 0.3422 +/- 0.007/ Nsim=1000; p<0.001). Six modules were generated through more frequent interactions between species (Figure 1).

Association between variables

The Chi-square test showed a significant association between the formed modules and the surrounding vegetation (p = 1.0 x 10(-6)) (Figure 2). Modules 1 and 3 were grouped mostly by islands surrounded by the phytophysiognomies of the caatinga and the transition area. On the other hand, modules 4, 5 and 6 were exclusively for islands surrounded by the seasonal forest.

The average area of the islands was 19.91 +/- 38.65 m² and there was no difference in the average area between the modules (F = 1,105, GL = 5 and 85, p = 0.364) (Figure 3), which denotes that the area of the islands does not influence the formation of modules.

The mean ratio of the diameters of the islands was 3.51 +/- 3.92, however there was a variation in the mean ratio between the modules (F = 4.6, GL = 5 and 83, p = 0.0009390), with differences between the ratio of the islands of module 6 for modules 1 and 3 (Figure 5), which suggests that the variation in the shape of the islands may be contributing to the segregation of the modules.

DISCUSSION

Our analysis did not show a significant variation in the size of the islands due to the formation of the modules (Figure 3). However, larger islands typically harbor more taxa, as they offer greater habitat diversity (e.g., variations in geology, topography, and microclimate) (Hortal et al. 2009). In this way, the size of the island influences not only the composition, but the structure of the community (Villa et al. 2018).

There were differences between the averages of the ratio of module 6 for modules 1 and 3. Modules 1 and 3 have islands with more irregular shapes (elongated/slender), under these conditions two factors may be contributing to a greater association between these species, being they: the edge effect between vegetation and exposed rock, and the presence or absence of fixation substrate linked to the availability of water resources and nutrientes.

The composition of module 3, for example, is formed mainly by rupicolous and epiphyte species (Table 3), both with adaptive strategies (succulent and desiccation tolerance) that allow the establishment and survival of populations in adverse environments. Islands composed exclusively of *Melocactus ernestii* Vaupel (Cactaceae) and *Vellozia plicata* Mart. (Velloziaceae), other islands showed associations between the cited species and Orchidaceae (see *Encyclia jenischiana* (Rchb.f.) Porto & Brade and *Pseudolaelia vellozicola* (Hoehne) Porto & Brade).

The only species with shrubby habit (module 3) was *Clusia dardanoi* G. Mariz & Maguire (Clusiaceae), a possible facilitator species (Ricklefs 1996), whose presence in the site causes microclimatic changes (shading, temperature decrease, nutrient concentration, etc.) and consequently the entry of other species into the community. In loco they were also observed forming islands together with *Hohenbergia catingae* Ule (Bromeliaceae) and *Pleroma caatingae* (J.G.Freitas) P.J.F.Guim. & Michelang. (Melastomataceae).

The study by Conceição et al. (2007) in quartzite-sandstone outcrops, found that larger islands were composed of shrubs and arbors in more shaded places. Species of *Clusia* sp. and *Tibouchina* sp. were observed in the composition of these islands, as well as Bromeliaceae and Rubiaceae. The smaller islands were represented by species responsible for the primary succession (Cyperaceae, Orchidaceae and Velloziaceae), colonizing places of exposed rock where the solar incidence was greater.

Similarly, Conti et al. (2021) observed that the effects of insularity – area size and isolation – affect the patterns of functional characteristics of species in edaphic islands, determining persistence strategies of plants in these environments. For example, insularity was associated with a decline in the proportion of species with clonal abilities, one of the reasons being the limitations in their dispersal and thus a lower probability of reaching more distant islands. In contrast, the high degree of insularity (smaller islands and greater isolation) promotes persistence strategies aimed at keeping these populations viable such as more extensive lateral propagation and deeper buds below ground level.

Species with adaptive traits were also present in the composition of module 1 (Table 1) [e. g. *Aechmea patentissima* (Mart. ex Schult. & Schult.f.) Baker, *Arrojadoa penicillata* (Gürke) Britton & Rose, *Euphorbia phosphorea* Mart., *Gomesa flexuosa* (Lodd.) M.W.Chase & N.H.Williams] however, tree species associated with phytophysiognomy of the caatinga, such as *Spondias tuberosa* Arruda (Anacardiaceae), *Commiphora leptophloeos* (Mart.)

J.B.Gillett (Burseraceae), *Chloroleucon dumosum* (Benth.) G.P.Lewis., *Mimosa tenuiflora* (Willd.) Poir (Fabaceae) and *Pilosocereus catingicola* (Gürkela) Rowley Subsp. *catingicola* were expressive in these formations, different from what was observed in the other modules. Substrate accumulation in small rock depressions likely contributed to these associations.

Module 6 (Table 6) is mainly composed of species from the subshrub herbaceous stratum. The grouped islands belong to the seasonal forest formation and have more regular (circular) shapes. The expressive presence of subshrub species [e. g. *Borreria verticillata* (L.) G.Mey., *Senna macranthera* (DC. ex Collad.) H.S.Irwin & Barneby, *Crotalaria incana* L.] and the geophyte *Zephyranthes cearensis* (Herb.) Baker assumes that these islands retain a thin layer of soil. However, there is a greater dependence on water availability due to the grouping of hydrophilic herbs [e. *Callisia repens* (Jacq.) L., *Commelina erecta* L., *Mollugo verticillata* L., *Pilea microphylla* (L.) Liebm]. Effects of seasonality, that is, changes between a dry and wet environment were responsible for the difference in composition (beta diversity) of herbaceous species in rocky outcrops of the Quadrilátero Ferrífero (Nunes et al. 2020).

CONCLUSION

This was the first study to assess the ecology of vegetation islands in rocky outcrops of the Conservation Units of Boa Nova, Bahia. Here, we describe the floristic composition of the vegetation islands and see that the modularity analysis grouped six main groups through more frequent interactions between species. The shape of the areas and the surrounding vegetation showed significant variations depending on the modules formed, reflecting on the edaphoclimatic conditions of each habitat and supposedly contributing to the differentiation between them.

ACKNOWLEDGMENT

To the Coordination for the Improvement of Higher Education Personnel (CAPES) for the scholarship granted to the first author; to the State University of Southwest Bahia (UESB) and to the Graduate Support Program (PROAP) for financial assistance for data collection; the team from the Mongoyós Herbarium (HVC) and the Chico Mendes Institute for Biodiversity Conservation (ICMBio). To the researchers C. Caires (Loranthaceae), G. Costa (Lytraceae), H. Huaylla (Amarylidaceae), J. Jardim (Rubiaceae), D. Cardoso, J. Costa, L. Queiroz (Leguminosa) and R. F. de Almeida (Malpighiaceae) for helping to identify the material.

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FIGURES AND TABLES

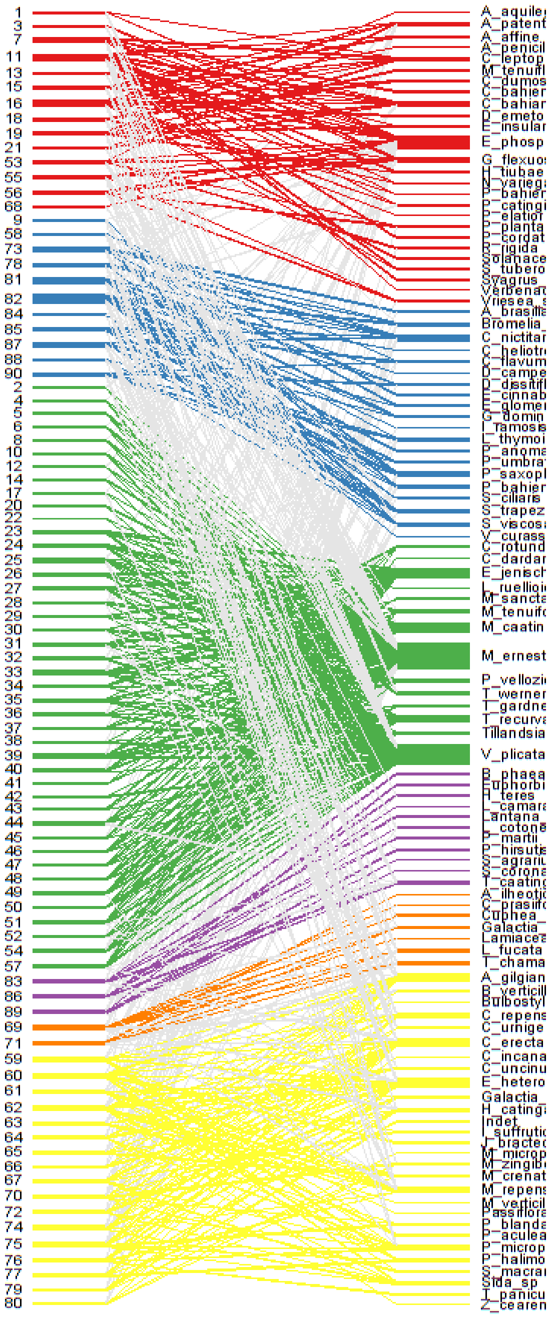

Figure 1. Graph representing the interaction network among the 106 plant species (right side of the graph) present in 90 vegetation islands (left side of the graph) through Modularity Analysis. The formed modules are represented by colors: red (module 1), blue (module 2), green (module 3), purple (module 4), orange (module 5) and yellow (module 6).

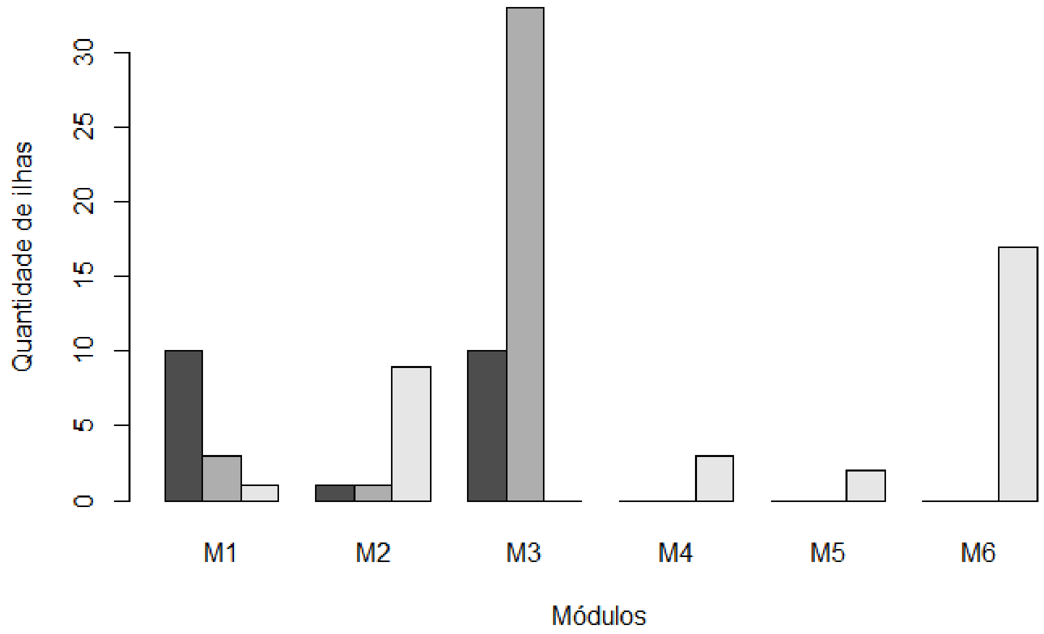

Figure 2. Modules formed taking into account the vegetation surrounding the sampled areas. Result obtained by the Chi-square test. Colors: dark gray (caatinga), gray (transition between caatinga and seasonal forest) and light gray (seasonal forest).

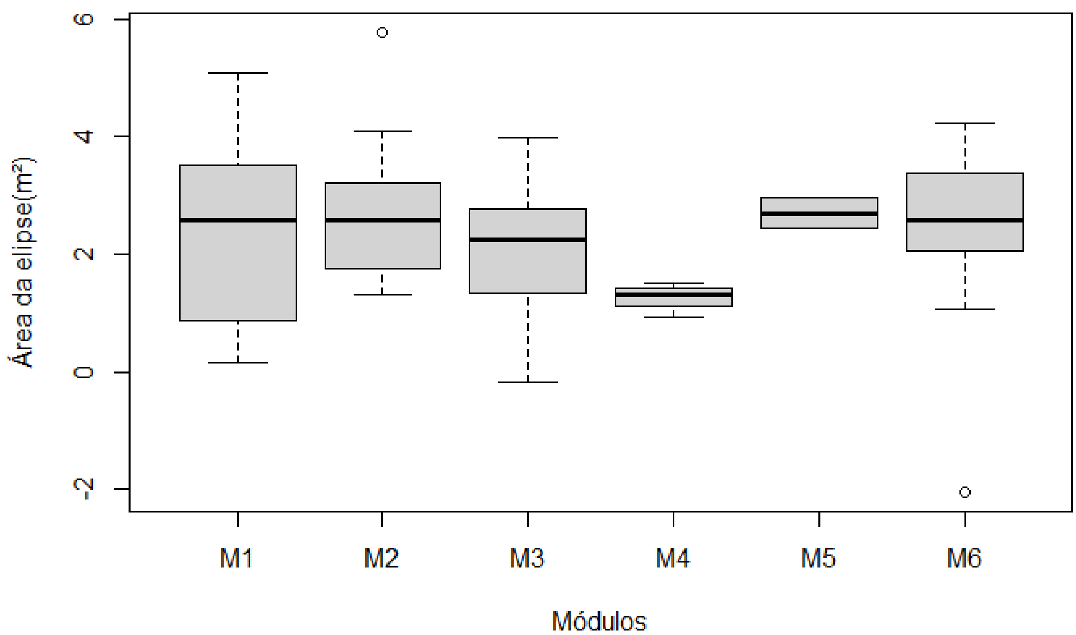

Figure 3. Analysis of variance (ANOVA) of the area (ellipse) of the vegetation islands as a function of the formed modules.

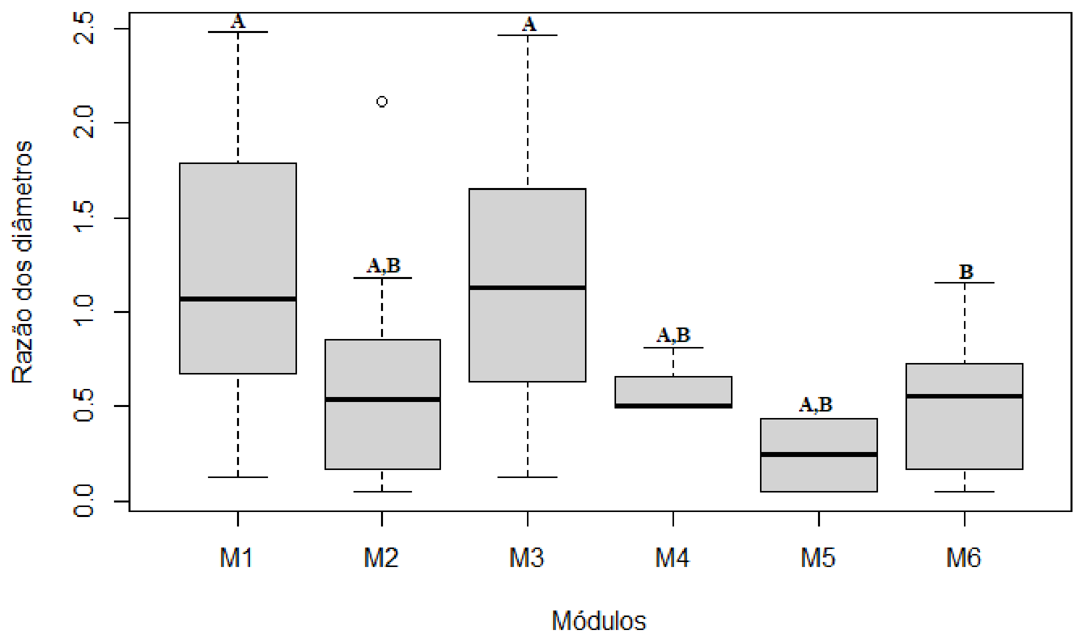

Figure 4. Analysis of variance (ANOVA) graph of the ratio of vegetation islands as a function of the formed modules.

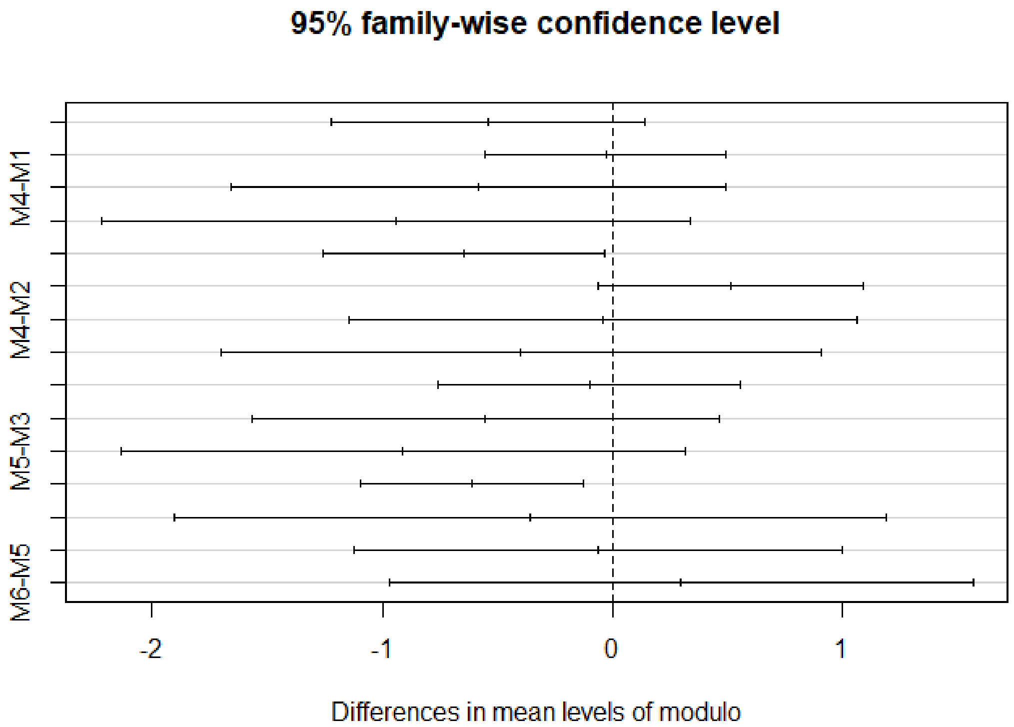

Figure 5. Tukey's test graph for the ratio of vegetation islands as a function of the formed modules.

Table 1 – Floristic composition of module 1 and their respective life forms and substrates.

Module 1				
Islands	**Family**	**Species**	**Life form**	**Substrate**
1	Anacardiaceae	*Spondias tuberosa* Arruda	Tree	Terrestrial
3	Araceae	*Anthurium affine* Schott	Herb	Rupicolous
7	Arecaceae	*Syagrus* sp.	Palm tree	Terrestrial
11	Bromeliaceae	*Aechmea aquilega* (Salisb.) Griseb.	Herb	Rupicolous/Terrestrial
16	Bromeliaceae	*Aechmea patentissima* (Mart. ex Schult. & Schult.f.) Baker	Herb	Epiphyte
18	Bromeliaceae	*Neoglaziovia variegata* (Arruda) Mez	Herb	Terrestrial
19	Bromeliaceae	*Vriesea* sp.	Herb	Rupicolous
13	Burseraceae	*Commiphora leptophloeos* (Mart.) J.B.Gillett	Tree	Terrestrial
53	Cactaceae	*Arrojadoa penicillata* (Gürke) Britton & Rose	Bush	Rupicolous/Terrestrial
21	Cactaceae	*Pereskia bahiensis* Gürke	Bush	Terrestrial
55	Cactaceae	*Pilosocereus catingicola* (Gürke) Byles & Rowley subsp. *catingicola*	Tree	Terrestrial
56	Cucurbitaceae	*Doyerea emetocathartica* Grosourdy	Bindweed	Terrestrial
68	Euphorbiaceae	*Cnidoscolus bahianus* (Ule) Pax & K.Hoffm.	Bush	Terrestrial
15	Euphorbiaceae	*Euphorbia insulana* Vell.	Sub-shrub	Terrestrial
	Euphorbiaceae	*Euphorbia phosphorea* Mart.	Bush	Rupicolous
	Fabaceae	*Mimosa tenuiflora* (Willd.) Poir.	Tree	Terrestrial
	Fabaceae	*Chloroleucon dumosum* (Benth.) G.P.Lewis	Tree	Terrestrial
	Loranthaceae	*Psittacanthus cordatus* (Hoffmanns.) G.Don	Herb	Mistletoe
	Malvaceae	*Herissantia tiubae* (K.Schum.) Brizicky	Sub-shrub	Terrestrial
	Orchidaceae	*Gomesa flexuosa* (Lodd.) M.W.Chase & N.H.Williams	Herb	Epiphyte
	Orchidaceae	*Prescottia plantaginifolia* Lindl. ex Hook.	Herb	Rupicolous/Terrestrial
	Orchidaceae	*Rodriguezia rigida* (Lindl.) Rchb.f.	Herb	Epiphyte
	Portulacaceae	*Portulaca elatior* Mart. ex Rohrb.	Herb	Rupicolous/Terrestrial

	Solanaceae	Solanaceae 01	Sub-shrub	Terrestrial
	Verbenaceae	Verbenaceae 01	Sub-shrub	Terrestrial
	Vitaceae	*Cissus bahiensis* Lombardi	Bindweed	Hemiepiphyte

Table 2 – Floristic composition of module 2 and their respective life forms and substrates.

		Module 2		
Islands	**Family**	**Species**	**Life form**	**Substrate**
9	Amaranthaceae	*Alternanthera brasiliana* (L.) Kuntze	Sub-shrub	Terrestrial
58	Boraginaceae	*Varronia curassavica* Jacq.	Bush	Terrestrial
73	Bromeliaceae	*Bromelia* sp.	Herb	Terrestrial
78	Bromeliaceae	*Dyckia dissitiflora* Schult. & Schult. f.	Herb	Rupicolous
81	Convolvulaceae	*Evolvulus glomeratus* Nees & Mart.	Herb	Terrestrial
82	Convolvulaceae	*Ipomoea ramosissima* (Poir.) Choisy	Bindweed	Terrestrial
84	Dioscoreaceae	*Dioscorea campestris* Griseb.	Bindweed	Rupicolous
85	Euphorbiaceae	*Croton heliotropiifolius* Kunth	Sub-shrub	Terrestrial
87	Euphorbiaceae	*Stillingia trapezoidea* Ule	Bush	Rupicolous/Terrestrial
88	Fabaceae	*Chamaecrista nictitans* (L.) Moench	Sub-shrub	Terrestrial
90	Fabaceae	*Stylosanthes viscosa* (L.) Sw.	Sub-shrub	Terrestrial
	Lythraceae	*Pleurophora anomala* (A. St.-Hil.) Koehne	Sub-shrub	Terrestrial
	Malvaceae	*Gaya domingensis* Urb	Sub-shrub	Terrestrial
	Malvaceae	*Sida ciliaris* L.	Sub-shrub	Terrestrial
	Orchidaceae	*Cyrtopodium flavum* Link & Otto ex Rchb.f.	Herb	Rupicolous/Terrestrial
	Orchidaceae	*Epidendrum cinnabarinum* Salzm.	Herb	Epiphyte/Rupicolous
	Portulacaceae	*Portulaca umbraticola* Kunth	Herb	Rupicolous/Terrestrial
	Urticaceae	*Pouzolzia saxophila* Friis, Wilmot-Dear & A. K. Monro	Herb	Rupicolous

Verbenaceae	*Lippia thymoides* Mart. & Schauer	Bush	Terrestrial
Verbenaceae	*Priva bahiensis* A.DC.	Sub-shrub	Terrestrial

Table 3 – Floristic composition of module 3 and their respective life forms and substrates.

Module 3				
Islands	**Family**	**Species**	**Life form**	**Substrate**
2	Apocynaceae	*Mandevilla sancta* (Stadelm.) Woodson	Sub-shrub	Rupicolous
4	Apocynaceae	*Mandevilla tenuifolia* (J.C.Mikan) Woodson	Herb	Rupicolous
5	Apocynaceae	*Marsdenia caatingae* Morillo	Bush	Rupicolous
6	Bromeliaceae	*Tillandsia gardneri* Lindl.	Herb	Epiphyte/Rupicolous
8	Bromeliaceae	*Tillandsia recurvata* (L.) L.	Herb	Epiphyte/Rupicolous
10	Bromeliaceae	*Tillandsia* sp.	Herb	Epiphyte/Rupicolous
12	Cactaceae	*Melocactus ernestii* Vaupel	Sub-shrub	Rupicolous
14	Cactaceae	*Tacinga werneri* (Eggli) N.P.Taylor & Stuppy	Bush	Rupicolous
17	Clusiaceae	*Clusia dardanoi* G.Mariz & Maguire	Tree	Terrestrial
20	Fabaceae	*Chamaecrista rotundifolia* var. *grandiflora* (Benth.) H.S.Irwin & Barneby	Sub-shrub	Terrestrial
22	Orchidaceae	*Encyclia jenischiana* (Rchb.f.) Porto & Brade	Herb	Rupicolous
23	Orchidaceae	*Pseudolaelia vellozicola* (Hoehne) Porto & Brade	Herb	Epiphyte/Rupicolous
24	Rubiaceae	*Leptoscela ruellioides* Hook.f.	Sub-shrub	Terrestrial
25	Velloziaceae	*Vellozia plicata* Mart.	Sub-shrub	Rupicolous
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Table 4 – Floristic composition of module 4 and their respective life forms and substrates.

Module 4				
Islands	**Family**	**Species**	**Life form**	**Substrate**
83	Arecaceae	*Syagrus coronata* (Mart.) Becc.	Palm tree	Terrestrial
86	Asteraceae	*Lepidaploa cotoneaster* (Willd. ex Spreng.) H.Rob.	Bush	Terrestrial
89	Cactaceae	*Brasilicereus phaeacanthus* (Gürke) Backeb.	Bush	Terrestrial
	Euphorbiaceae	*Euphorbiaceae* sp.	Sub-shrub	Terrestrial
	Malvaceae	*Pavonia martii* Colla	Sub-shrub	Terrestrial
	Melastomataceae	*Pleroma caatingae* (J.G.Freitas) P.J.F.Guim. & Michelang.	Bush	Terrestrial
	Portulacaceae	*Portulaca hirsutissima* Cambess.	Herb	Terrestrial
	Rubiaceae	*Hexasepalum teres* (Walter) J.H. Kirkbr.	Herb	Terrestrial
	Solanaceae	*Solanum agrarium* Sendtn.	Sub-shrub	Terrestrial
	Verbenaceae	*Lantana camara* L.	Sub-shrub	Terrestrial
	Verbenaceae	*Lantana* sp.	Sub-shrub	Terrestrial

Table 5 – Floristic composition of module 5 and their respective forms and substrates.

Module 5				
Islands	**Family**	**Species**	**Life form**	**Substrate**
69	Asteraceae	*Conocliniopsis prasiifolia* (DC.) R.M.King & H.Rob.	Sub-shrub	Terrestrial
71	Fabaceae	*Galactia sp.*	Bindweed	Terrestrial
	Lamiaceae	Lamiaceae 01	Sub-shrub	Terrestrial
	Lythraceae	*Cuphea* sp.	Sub-shrub	Terrestrial
	Polygalaceae	*Asemeia* sp.	Herb	Terrestrial
	Turneraceae	*Turnera chamaedrifolia* Cambess.	Herb	Terrestrial
	Verbenaceae	*Lantana fucata* Lindl.	Sub-shrub	Terrestrial

Table 6 – Floristic composition of module 6 and their respective life forms and substrates.

Module 6				
Islands	**Family**	**Species**	**Life form**	**Substrate**
59	Amaryllidaceae	*Zephyranthes cearensis* (Herb.) Baker	Herb	Terrestrial
60	Apocynaceae	*Mandevilla microphylla* (Stadelm.) M.F.Sales & Kin.-Gouv.	Bindweed	Terrestrial
61	Bromeliaceae	*Hohenbergia catingae* Ule	Herb	Rupicolous/Terrestrial
62	Cactaceae	*Pereskia aculeata* Mill.	Bindweed	Rupicolous /Terrestrial
63	Commelinaceae	*Callisia repens* (Jacq.) L.	Herb	Rupicolous/Terrestrial
64	Commelinaceae	*Commelina erecta* L.	Herb	Rupicolous/Terrestrial
65	Convolvulaceae	*Jacquemontia bracteosa* Meisn.	Bindweed	Terrestrial
66	Cyperaceae	*Bulbostylis scabra* (J.Presl & C.Presl) C.B.Clarke	Herb	Rupicolous/Terrestrial
67	Cyperaceae	*Cyperus uncinulatus* Schrad. ex Nees	Herb	Rupicolous/Terrestrial
70	Euphobiaceae	*Cnidoscolus urnigerus* (Pax) Pax	Bush	Terrestrial
72	Euphobiaceae	*Euphorbia heterodoxa* Müll.Arg.	Herb	Rupicolous/Terrestrial
74	Fabaceae	*Crotalaria incana* L.	Sub-shrub	Terrestrial
75	Fabaceae	*Indigofera suffruticosa* Mill.	Sub-shrub	Terrestrial
76	Fabaceae	*Senna macranthera* (DC. ex Collad.) H.S.Irwin & Barneby	Bush	Terrestrial
77	Indeterminada	Indeterminada	Sub-shrub	Terrestrial
79	Loasaceae	*Aosa gilgiana* (Urb.) Weigend	Sub-shrub	Rupicolous/Terrestrial
80	Malvaceae	*Galactia* sp.	Sub-shrub	Terrestrial
	Malvaceae	*Sida* sp.	Sub-shrub	Terrestrial
	Maranthaceae	*Maranta zingiberina* L.Andersson	Herb	Terrestrial
	Molluginaceae	*Mollugo verticillata* L.	Herb	Terrestrial
	Passifloraceae	*Passiflora sp.*	Bindweed	Terrestrial

Piperaceae	*Peperomia blanda* (Jacq.) Kunth	Herb	Rupicolous/Terrestrial
Plantaginaceae	*Matourea crenata* (Ronse & Philcox) Colletta & V.C.Souza	Sub-shrub	Terrestrial
Poaceae	*Melinis repens* (Willd.) Zizka	Herb	Terrestrial
Portulacaceae	*Portulaca halimoides* L.	Herb	Rupicolous/Terrestrial
Rubiaceae	*Borreria verticillata* (L.) G.Mey.	Sub-shrub	Terrestrial
Talinaceae	*Talinum paniculatum* (Jacq.) Gaertn.	Herb	Rupicolous/Terrestrial
Urticaceae	*Pilea microphylla* (L.) Liebm.	Herb	Terrestrial

5. CAPÍTULO 3

Guia de campo ilustrativo da flora dos afloramentos rochosos de Boa Nova

Boa Nova Conservation Units, Bahia, Brazil

Plants of the rocky outcrops of Boa Nova 1

Morgana Maria do Carmo Barbosa[1], Anderson Ferreira Pinto Machado[1], Andrea Karla Almeida dos Santos[2] & Michele Martins Corrêa[1]

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1 ***Anemia*** sp.
ANEMIACEAE

2 ***Mandevilla*** *sancta*
APOCYNACEAE

3 ***Mandevilla*** *tenuifolia*
APOCYNACEAE

4 ***Marsdenia*** *caatingae*
APOCYNACEAE

5 **Skytanthus** hancorniifolius
APOCYNACEAE

6 ***Syagrus*** *coronata*
ARECACEAE

7 ***Trixis*** *antimenorrhoea*
ASTERACEAE
Photo: Baleeiro, E.M.G

8 ***Varronia*** *curassavica*
BORAGINACEAE

9 ***Aechmea*** *aquilega*
BROMELIACEAE

10 ***Aechmea*** *patentíssima*
BROMELIACEAE

11 ***Bromelia*** sp.
BROMELIACEAE

12 ***Dyckia*** *dissitiflora*
BROMELIACEAE

Boa Nova Conservation Units, Bahia, Brazil

Plants of the rocky outcrops of Boa Nova

2

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13 ***Hohenbergia*** *catingae* BROMELIACEAE

14 ***Hohenbergia*** sp. BROMELIACEAE

15 ***Tillandsia*** *gardneri* BROMELIACEAE

16 ***Tillandsia*** sp. BROMELIACEAE

17 ***Commiphora*** *leptophloeos* BURSERACEAE

18 ***Brasilicereus*** *phaeacanthus* CACTACEAE

19 ***Melocactus*** *ernestii* CACTACEAE

20 ***Pilosocereus*** *catingicola* subsp. *Catingicola* CACTACEAE

21 ***Pilosocereus*** *pentaedrophorus* CACTACEAE

22 ***Tacinga*** *werneri* CACTACEAE

23 ***Clusia*** *dardanoi* CLUSIACEAE

24 ***Commelina*** *erecta* COMMELINACEAE

Boa Nova Conservation Units, Bahia, Brazil

Plants of the rocky outcrops of Boa Nova 3

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25 ***Ipomoea*** sp.
CONVOLVULACEAE

26 ***Doyerea*** *emetocathartica*
CUCURBITACEAE

27 ***Erythroxylum*** sp.
ERYTHROXYLACEAE

28 ***Cnidoscolus*** *bahianus*
EUPHORBIACEAE

29 ***Cnidoscolus*** *urnigerus*
EUPHORBIACEAE

30 ***Croton*** *heliotropiifolius*
EUPHORBIACEAE

31 ***Euphorbia*** *heterodoxa*
EUPHORBIACEAE

32 ***Euphorbia*** *phosphorea*
EUPHORBIACEAE

33 ***Stillingia*** *trapezoidea*
EUPHORBIACEAE

34 ***Chamaecrista*** nictitans
FABACEAE

35 ***Chamaecrista*** *rotundifolia var. grandiflora*
FABACEAE

36 ***Galactia*** sp.
FABACEAE

Boa Nova Conservation Units, Bahia, Brazil

Plants of the rocky outcrops of Boa Nova 4

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37 ***Senna*** *macranthera*
FABACEAE

38 ***Stylosanthes*** *viscosa*
FABACEAE

39 ***Zornia*** sp.
FABACEAE

40 ***Hydrolea*** *spinosa*
HYDROLEACEAE

41 ***Herissantia*** *tiubae*
MALVACEAE

42 ***Pavonia*** *cancellata*
MALVACEAE
Photo: Baleeiro, E.M.G

43 ***Sida*** *ciliaris*
MALVACEAE

44 **MALVACEAE**

45 ***Pleroma*** *caatingae*
MELASTOMATACEAE

46 ***Ficus*** *cyclophylla*
MORACEAE

47 ***Campomanesia*** sp.
MYRTACEAE

48 ***Psidium*** *schenckianum*
MYRTACEAE

Boa Nova Conservation Units, Bahia, Brazil
Plants of the rocky outcrops of Boa Nova 5

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49 ***Cyrtopodium*** *flavum*
ORCHIDACEAE

50 ***Encyclia*** *jenischiana*
ORCHIDACEAE

51 ***Epidendrum*** *cinnabarinum*
ORCHIDACEAE

52 ***Epidendrum*** *secundum*
ORCHIDACEAE

53 ***Gomesa*** *flexuosa*
ORCHIDACEAE

54 ***Rodriguezia*** *rigida*
ORCHIDACEAE

55 ***Sacoila*** *lanceolata*
ORCHIDACEAE

56 ***Vanilla*** *bahiana*
ORCHIDACEAE
Photo: Fábio

57 ***Portulaca*** sp.
PORTULACACEAE

58 ***Portulaca*** sp.
PORTULACACEAE

59 ***Doryopteris*** *collina*
PTERIDACEAE

60 ***Solanum*** sp.
SOLANACEAE

Boa Nova Conservation Units, Bahia, Brazil

Plants of the rocky outcrops of Boa Nova

6

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61 ***Turnera*** *chamaedrifolia*
TURNERACEAE

62 ***Pouzolzia*** *saxophila*
URTICACEAE

63 ***Vellozia*** *plicata*
VELLOZIACEAE

64 ***Lippia*** *thymoides*
VERBENACEAE

65 **Lajedo Lagoa Danta**
Parque Nacional de Boa Nova (PARNA)

66 **Lajedo Porangaba**
Parque Nacional de Boa Nova (PARNA)

67 **Lajedo Alvorada**
Refúgio de Vida Silvestre (REVIS)

68 **Lajedo Belo Campo**
Refúgio de Vida Silvestre (REVIS)

ANEXO

Normas da Acta Botanica Brasilica

Instructions

Language editing

If English is not your first language, it is strongly recommended to have your manuscript edited for language before submission. This is not a mandatory step, but may help to ensure that the academic content of your paper is fully understood by journal editors and reviewers. Language editing does not guarantee that your manuscript will be accepted for publication. Authors are liable for all costs associated with such services.

Types of articles

Original Articles

Reviews

Viewpoints

Methods

Short Communications

Summary of submission processes

Submission management and evaluation of submitted manuscripts will involve the Journal's online manuscript submission system. The manuscript text should be prepared in English (see **Preparing the article file below** for details) and submitted online (http://mc04.manuscriptcentral.com/abb-scielo). Figures, tables and other types of content should be organized into separate files for submission (see **Preparing Tables, Figures and Supplementary** material below for details). If you are using the online submission system for the first time please go to the login page and generate a login name and password after clicking on the "**New user – register here**" link. If you are already registered but need to be reminded of your login name or password please go to the login page and inform your email in "**password help**". Please never create a new account if you are already registered.

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also provide a statement that the authors have the rights to publish all images included in the manuscript.

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(Please consult a last issue of Acta Botanica Brasilica for layout and style)

All manuscripts must follow these guidelines: the text should be in Times New Roman font, size 12, double-spaced throughout and with 25 mm margins; the paper size should be set to A4 (210 x 297 mm). All pages should be numbered sequentially. Each line of the text should also be numbered, with the top line of each page being line 1. For text files .doc, .docx and .rtf are the only acceptable formats. Files in Adobe® PDF format (.pdf files) will not be accepted. When appropriate, the article file should include a list of figure legends and table heads at the end. This article file should not include any illustrations or tables, all of which should be submitted in separate files. Do not include field code either.

The **first page** should state the type of article (Original Article, Review, Viewpoint, Method or Short communication) and provide a concise and informative full title followed by the names of all authors. Each name should be followed by the **Orcid number** and an identifying superscript number (1, 2, 3 etc.) associated with the appropriate institutional address to be entered further down the page. Only one corresponding author should be indicated with an asterisk and should always be the submitting author. The institutional address(es) of each author should be listed next, each address being preceded by the superscript number where appropriate. The address must be synthetic and in English with institution, postal code, city, state and country. Do not translate laboratory, department and university. Titles and positions should not be mentioned. This information is followed by the e-mail address of the corresponding author.

The **second page** should contain a structured **Abstract** not exceeding 200 words in a single paragraph without references. The Abstract should outline the essential content of the manuscript, especially the results and discussion, highlighting the relevance of main findings.

The Abstract should be followed by between five and ten Keywords. Note that essential words in the title should be repeated in the **keywords**.

Original articles should be divided into sections presented in the following order:

Title page
Abstract
Introduction
Materials and methods
Results
Discussion
Acknowledgements
References
Tables and Figures legends
Supplementary Data (if applicable)

Materials and methods and **Results** should be clear and concise. The **Discussion** section should avoid extensive repetition of the results and must finish with some conclusions. This section can be combined with results (**Results and Discussion**), however, we recommend authors consult the Editoral Board for a previous evaluation.

Plant names must be written out in full in the abstract and again in the main text for every organism at first mention but the genus is only needed for the first species in a list within the same genus (e.g. Hymenaea stigonocarpa e H. stilbocarpa). The authority (e.g., L., Mill., Benth.) is required only in Materials and methods section. Use The International Plant Names Index (www.ipni.org) for correct plants names. Cultivars or varieties should be added to the scientific name (e.g. Solanum lycopersicum 'Jumbo'). Authors must include in Materials and methods a reference to voucher specimen(s) and voucher number(s) of the plants or other material examined.

Abbreviations must be avoid except for usual cases (see recent issues) and all terms must be written out in full when used to start a sentence. Non-conventional abbreviations should be spelled out at first mention.

Units of Measurement. *Acta bot. bras.* adopts the *Systéme International d'Unités* (SI). For volume, use the cubic metre (e.g. 1 × 10–5 m3) or the litre (e.g. 5 µL, 5 mL, 5 L). For concentrations, use µM, µmol L–1 or mg L–1. For size and distance use meters (cm, mm, um, etc) and be consistent in the manuscript.

Numbers up to nine should be written out unless they are measurements. All numbers above ten should be in numerals unless they are starting sentences.

Citations in the text should take the form of Silva (2012) or Ribeiro & Furr (1975) or (Mayer & Wu 1987a; b; Gonzalez 2014; Sirano 2014) and be ordered chronologically. Papers by three or more authors, even on first mention, should be abbreviated to the name of the first author followed by et al. (e.g. Simmons *et al*. 2014). If two different authors have the same last name, and the article have the same year of publication, give their initials (e.g. JS Santos 2003). Only refer to papers as 'in press' if they have been accepted for publication in a named journal, otherwise use the terms 'unpubl. res.', giving the initials and last name of the person concerned (e.g., RA Santos unpubl. res.).

References should be arranged alphabetically based on the surname of the author(s). Where the same author(s) has two or more papers listed, these papers should be grouped in year order. Letters 'a', 'b', 'c', etc., should be added to the date of papers with the same citation in the text. Please provide DOI of 'in press' papers whenever possible.

For papers with **six** authors or fewer, please give the names of all the authors. For papers with **seven** authors or more, please give the names of the first three authors only, followed by et al.

Please follow the styles:

Books

Smith GM. 1938. Cryptogamic botany. Vol. II Bryophytes and Pteridophytes. 2nd. edn. New York, McGraw-Hill Book Company.

Chapters in books

Schupp EW, Feener DH. 1991. Phylogeny, lifeform, and habitat dependence of ant-defended plants in a Panamanian forest. In: Huxley CR, Cutler DC. (eds.) Ant-plant interactions. Oxford, Oxford University Press. p. 175-197.

Research papers

Alves MF, Duarte MO, Oliveira PEAM, Sampaio DS. 2013. Self-sterility in the hexaploid Handroanthus serratifolius (Bignoniaceae), the national flower of Brazil. Acta Botanica Brasilica 27: 714-722.

Papers in press (ahead of print)

Alves JJ, Sampaio MTY. 2015. Structure and evolution of flowers. Acta Botanica Brasilica (in press). doi: 10.1590/0102-33062015abb3339.

Online-only journals

Wolkovich EM, Cleland EE. 2014. Phenological niches and the future of invaded ecosystems with climate change. AoB Plants 6: plu013 doi:10.1093/aobpla/plu013

Thesis (citation should be avoided)

Souza D. 2014. Plant growth regulators. PhD or MSc Thesis, University, City.

Websites and other sources (citation should be avoided)

Anonymous. 2011. Title of booklet, leaflet, report, etc. City, Publisher or other source, Country.

References to websites should be structured as: author(s) name author(s) initial(s). year. Full title of article. Full URL. 21 Oct. 2014 (Date of last successful access).

Acknowledgements should be in fewer than 80 words. Be concise: “we thank…” is preferable to “The present authors would like to express their thanks to…”. Funding information should be included in this section.

The following example should be followed:

We acknowledge the Center of Microscopy (UFMG) for providing the equipment and technical support for experiments involving electron microscopy. We also thank J.S. Santos for assistance with the statistical analyses. This work was supported through a research grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq (ID number).

For **SHORT COMMUNICATIONS** note that the editorial guidelines applying to original papers must also applying here. In general, the difference between original papers and short communications is the **lack of subsections in the text** and limited space for illustrations in the latter. Figures and tables can be present, assuming that the overall size of the manuscript does not exceed the five printed page limit (supplementary material can be added). The abstract (as described for original articles) must be followed by a “running text” (a single section, without subheadings), followed by the acknowledgments and references.

Preparing Figures, Tables and Supplementary material

All figures (photographs, maps, drawings, graphs, diagrams, etc.) and tables must be cited in the text, in ascending order. Citations of figures in the text should appear in an abbreviated, capitalized form (e.g., Fig. 1, Fig. 2A-D, Fig. 3A, Figs. 3A, 4C, Tab.1).

The maximum dimensions of individual figures should be 170 × 240 mm. The width of an individual component can be 170 mm or 85 mm, without exception, whereas the height can be ≤ 240 mm. For continuous tone images (e.g., photographs), please supply TIFF files at 300 dpi. More complex drawings, such as detailed botanical illustrations will not be redrawn and should be supplied as 600 dpi TIFF files.

Grouping of related graphics or images into a **single figure** (a plate) is strongly encouraged. When a block of illustrative material consists of several parts, each part should be labelled with sequential capital letters, in the order of their citation in the text (A, B, C, etc.). The letters that identify individual images should be inserted within white circles in the lower right-hand corner. For separate the grouped images, authors should insert white bars (1mm thickness).

Individual images (not grouped as a plate) should be identified with sequential Arabic numerals, in the order of their citation in the text (Fig. 1, Fig. 2, Fig. 3, etc.), presented in the same manner as the letters identifying individual images (described above).

The number that identifies a grouped figure (e.g., Fig. 2) should not be inserted into the plate but should rather be referenced only in the figure caption and the text (e.g., Fig. 2A-C).

Scale bars, when required, should be positioned in the lower right-hand corner of the figure. The scale bar units should be given either at the end of the figure caption or, when a figure contains multiple scale bars with different units, above each bar.
Details within a figure can be indicated with arrows, letters or symbols, as appropriate.

Tables should be preceded by titles, indicated with sequential Arabic numerals (Table 1, 2, 3, etc.; do not abbreviate). Tables should be created using the Table function of Microsoft Word™. Columns and rows should be visible, although no dark lines should be used to separate them. Horizontal rules should be used only at the top (below the title) and bottom (below the final row) of the table. Do not use fills, shading or colors in the tables.

When appropriate, excess (but important) data can be submitted as Supplementary Files, which will be published online and will be made available as links. This might include additional figures, tables, or other materials that are necessary to fully document the research contained in the paper or to facilitate the readers' ability to understand the work.

Supplementary Materials are linked from the main article webpage. They can be cited using the same DOI as the paper.

Supplementary Materials should be presented in appropriate .doc file for text and tables and .tiff file at 300dpi for figures and graphics. The full title of the paper and author names should be included in the header. All supplementary figures and tables should be referred in the manuscript body as "Table S1" and/or "Figure S1".

Acta bot. bras. intends to maintain archives of Supplementary Materials but does not guarantee their permanent availability. Acta bot. bras. reserves the right to remove Supplementary Materials from a published article in the future.

The Review Process

All authors will receive an email acknowledging the submission of the manuscript, with its correspondent reference number. The Editor-in-Chief will evaluate manuscript adherence to instructions, quality and novelty and will decide on the suitability for peer reviewing. Manuscripts failing to adhere to the format will be returned to the authors. Manuscripts are sent to at least two anonymous referees that are given 21 days to return their reports.

Submitting a revised paper

After peer review, go to “click here to submit a revision” and upload the new manuscript version. Remember to delete the documents in duplicate.

Publication and printing process

After acceptance, a PDF proof will be sent to corresponding authors as an e-mail attachment. Corrected proofs should be returned within 72 h. It is the sole responsibility of the corresponding author to check for errors in the proof.

Each article is identified by a unique DOI (Digital Object Identifier), a code used in bibliographic referencing and searching.

The dates of submission and acceptance will be printed on each paper.

The corresponding author will receive a free PDF or URL that gives access to the article online and to a downloadable PDF.

The corresponding author is responsible for distributing this PDF or URL to any co-authors.

Misconduct

Misconduct on submitted manuscripts will lead to immediate rejection. Duplicate publication, plagiarism, figure manipulation, dual-submission, and any other fraudulent method will not be tolerated.

If misconduct is detected after the manuscript publication, the article will be retracted and a retraction note will be published.

Submitted manuscripts can be scanned to detect plagiarism and verify the papers’ originality.

Normas da Revista Plant Ecology and Evolution

Introduction

SCOPE

Plant Ecology and Evolution is a diamond open access journal that publishes papers about ecology, phylogenetics, and systematics of all plant groups (including algae, fungi, and myxomycetes), also covering related fields such as comparative and developmental morphology, conservation biology, evo-lution, phytogeography, pollen and spores, population biology, and vegetation studies. Submissions concerning (sub)tropical Africa are particularly welcome.

EDITORIAL POLICIES

To ensure the publication of high-quality academic content, the editorial team of Plant Ecology and Evolution, the authors, and the external reviewers are expected to fully adhere to the peer review process policy, the journal's publication ethics, and the policy on copyright and open access for the journal's content. Plant Ecology and Evolution is a diamond open access journal, meaning that authors do not have to pay any fees to submit or publish their work and that all papers are open access without embargo.

MANUSCRIPT TYPES

Research article - This is a manuscript reporting the results of original research. For taxonomic manuscripts, more comprehensive work is preferred, and isolated taxonomic novelties should be written in a way that they are attractive and interesting for a wider international audience.

Review - This type of manuscript provides a survey of the current state of a specific topic and summarises previously published studies, rather than reporting new facts or analyses.

LANGUAGE

The journal publishes original scientific research in English (British spelling – Oxford English Dictionary). The authors should make sure that the academic content of the paper can be fully understood and they are encouraged to have their manuscript checked for language.

Submissions in French might be considered in exceptional circumstances. These submissions should be by African researchers and deal with tropical African botany. Ideally, they should also deal with a topic that is of interest to a wider audience. The authors are however encouraged to seek help to publish in English in order to increase the potential impact of their research.

RESEARCH DATA POLICY

For the purpose of reproducibility and to adhere to the FAIR (Findability, Accessibility, Interoperability, and Reusability) data principles, the authors are encouraged to make all newly generated data available and to acknowledge secondary data (i.e. data generated by others).

Authors should deposit newly generated data into domain-specific, data-type repositories that provide open access (e.g. GenBank, ForestPlots, GitHub, Dryad). References to data should be included in the manuscript (e.g. GenBank accession numbers). An overview of domain or type-specific repositories can be found in the Registry of Research Data Repositories. If the data does not fit into a specific domain or type, authors can use more general public repositories (e.g. Zenodo, Figshare). As a final option, authors can provide their data as supplementary files that are published along with the paper. For taxonomic studies, voucher specimens should be deposited in public herbaria, preferably in the country of origin.

When depositing data, pay attention to data quality. Describe the data by adding metadata and make the data comprehensible and accessible by explaining all terms, abbreviations, etc. Also, try to use open protocols, tools, and formats as much as possible.

Whenever possible, authors should cite the data as complete bibliographic references with DOI or URL, or give information on how the data can be accessed.

FIRST SUBMISSION

The email should contain the following files, each file name containing the first author's initials, e.g. "AB":

✓ **Cover letter** – Fill in the cover letter template and convert it to pdf; AB_cover.pdf

✓ **Text file** – the entire text as a separate Word file, without figures and tables; AB_text.doc, AB_text.docx

✓ **Tables** – All tables combined in a single Word file; AB_tables.doc, AB_tables.docx

✓ **Figures** – Each figure as a separate, high-quality file (format: tif, jpeg or pdf): AB_fig1.tif, AB_fig2.jpg, AB_fig3.pdf

✓ **Manuscript pdf** – Combine in a single pdf: the text + tables + figures + tables and figure captions; AB_manuscript.pdf

Supplementary files – Optional. Additional supporting data are provided as separate supplementary files.

Cover illustration – Optional. We welcome photographs that could be featured on the journal cover.

REVISION/RESUBMISSION

In case of revision/resubmission of a previous manuscript, provide the following files (add the number of the revision, e.g. after one round of review: revision1, after 2 rounds of review: revision2):

✓ **Cover letter** – Make a cover letter including the manuscript ID number and indicate what changes have been done to address the comments made by the reviewers and the editor (point by point); AB_cover_revision1.pdf

✓ **Revised text with track changes** – AB_text_revision1_trackchanges.doc

✓ **Revised text with track changes accepted** – AB_text_revision1.doc

Revised tables – If necessary.

Revised figures – If necessary.

✓ **Revised manuscript pdf** – Combine in a single pdf: the revised text with track changes accepted + all (revised) tables and figures + tables and figure captions; AB_manuscript_revision1.pdf

Revised supplementary files – If necessary.

Text file

FORMATTING AND STYLE

General format

Times New Roman, font size 12, left aligned, single line spacing, and continuous line numbering. Pages are numbered sequentially.

Structure and main headings

The IMRAD structure (INTRODUCTION, MATERIAL AND METHODS, RESULTS, DISCUSSION, CONCLUSION, ACKNOWLEDGEMENTS, REFERENCES) is the preferred default structure. Some flexibility is however allowed (e.g. taxonomic manuscripts might also have TAXONOMIC TREATMENT).

Headings

There are maximum three levels of headings. Main headings are in uppercase and centred (e.g. INTRODUCTION). Second level headings are in bold, left aligned, and only the first word is capitalised (e.g. Molecular analyses). Third level headings are in bold, left aligned, only the first word is capitalised, and are directly followed by an en dash and the text (e.g. Morphological characters – Corolla …).

Font styles

Bold is only used for second and third level headings, and for certain elements in captions and the taxonomic treatment. Italic is only used for generic/infrageneric names and in specimen citations, for gene abbreviations, for certain statistical symbols, and for journal titles. Underline is only used to indicate the major organs in a description.

Abbreviations and contractions

If abbreviations are used, they are followed by a full stop (sp., subsp., s.s., s.l., a.s.l., e.g., i.e., d.f., pers. comm., pers. obs.). A full stop is not added for contractions in which letters from the middle of the word are omitted (ca, vs, eds, Mt, Dr).

Numerals

Numbers up to and including ten are spelled out, except when they are measurements (e.g. 6 mm). Numbers at the start of a sentence are always spelled out (e.g. Thirty-two plots …). Numerals are followed by a single space, then by the unit (e.g. 24 cm).

Standard symbols

SI units and SI-derived unit symbols are used for measurements (cm, mol, kg), as well as some non-SI units (s, min, h, d, ha).

Date format

Use day, month abbreviation, and year (e.g. 10 Jan. 2016, 14 Jun.–28 Jul. 2013). Or as alternative use month, year (e.g. data collected in September 2019), or day, month (15 February).

Use of en dash

En dash is used for all ranges (measurements, elevation range, page number range, etc.), without spaces (e.g. 2.5–5 mm, 10–14 stamens). It should not be used when using a range with a preposition: do not write "from 10–15 cm" but write "from 10 to 15 cm". The en dash is also used for an enclosed phrase – such as this one – within a sentence (note the spaces around the en dashes). Finally, en dash is used in third level headings and abstract headings. Em dashes are not used.

Geographical coordinates

The preferred format is degrees minutes seconds. Use the prime symbol ′ for minutes and the double prime symbol ″ for seconds. There is no space between the elements, and a comma between latitude and longitude (e.g. 50°55′41.5″N, 4°19′44.4″E).

CITATION OF TAXON NAMES

Scientific names

Taxon names are written in full (Genus species) in the abstract and again in the main text when mentioning a taxon for the first time. The genus name is only written in full for the first species in a list of congeneric species (e.g. Vangueria infausta, V. pygmaea), or when a sentence begins with a genus name. Only generic and infrageneric names are italicised.

Taxonomic authorities

Author names are added when mentioning a taxon for the first time. Authors are abbreviated following the International Plant Names Index, without spaces (e.g. K.Schum.). Author names can be omitted in the main text when available elsewhere (e.g. table, supplementary file, taxonomic treatment).

Additional formatting for taxonomic treatments

See below in the guidelines for taxonomic manuscripts.

TEXT STRUCTURE

Title page

Running title – Include a short title of max. 75 characters, spaces included.

Full title – The title should be informative and concise. The words are not capitalised (except proper nouns and supra-generic names). Taxonomic authorities are omitted in the title. For taxonomic manuscripts, a higher rank (e.g. family) is indicated in parentheses if the title includes generic or infrageneric names, e.g. "Three new species of Tricalysia (Rubiaceae) from Atlantic Central Africa".

Authors and affiliations – Provide the full names of all authors and their affiliations (i.e. institution, city, country; no full postal address necessary). Each author is followed by a superscript number that is associated with the appropriate affiliation (except when all authors have the same affiliation).

Corresponding author – One of the authors should be designated as the corresponding author by adding a superscript asterisk behind the name. Mention the e-mail address of the corresponding author below the affiliations (only one email address allowed, no phone number).

Abstract

Structured abstract – Each paragraph starts with an appropriate heading in bold followed by an en dash (e.g. Background and aims –, Material and methods –, Key results –, Conclusion –). The abstract should read independently from the manuscript and not include references or abbreviations. New taxa names should be mentioned but no taxonomic authorities. The abstract should not exceed 300 words.

Keywords – The abstract should be followed by up to ten keywords (ordered alphabetically and separated by semicolons).

Manuscripts in French – Include an English translation of the full title, the abstract, and the keywords.

Introduction

The Introduction should provide a literature review that puts the manuscript into context and allows readers outside the field to understand the purpose and significance of the study. It should define knowledge gaps and address why this particular study is important and necessary. If relevant, the appropriate hypotheses about the research should be mentioned. The Introduction should end with the overall aim and specific objectives of the study.

Material and methods

The Materials and methods should provide enough detail to allow other researchers to replicate the study. Acronyms of consulted herbaria can be listed here. Specific information and/or protocols for new methods should be included in detail. If methods are well established, authors may cite the papers where those are described in detail, but the manuscript should include sufficient information to be understood independently.

All equipment, software, data, and code should be cited appropriately. When specialised equipment is mentioned, the manufacturer's details should be given. When referring to software (including R packages), mention the version and cite it as a bibliographic reference (e.g. FigTree v.1.4.4 (Rambaut 2018), R package vegan v.2.5-6 (Oksanen et al. 2019)). Databases, indexes, and datasets should also be cited as bibliographic references (e.g. Index Herbariorum (Thiers continuously updated), International Plant Names Index (IPNI 2020)).

For geographic maps, the use of open-source software and data is encouraged (e.g. QGIS). Copyright requirements are mentioned under Table and figure files.

All newly generated data should be made available and it is recommended to deposit the data in public repositories. Authors are expected to follow our Research data policy.

Results

The Results should only present the findings of the study and citing other literature is usually not appropriate. By default, Results and Discussion are not mixed. Avoid redundancy and do not repeat data in both graphical and tabular form. Make sure to refer to and explain in detail all tables, figures, and supplementary files. Referring to data that is not provided (i.e. data not shown) is strongly discouraged.

Discussion

The Discussion should interpret and describe the significance of the results in light of what was already known, and explain the new insights that emerged. It should not be a repetition of the Results, but instead refer to the literature and demonstrate how the study has changed our knowledge about the research topic. Refer to the objectives mentioned in the Introduction and demonstrate if these were met or not. If you formulate the objectives as questions, you should answer those questions.

Conclusion

An optional summary of the findings in light of the objectives and suggestions for future research. This can also be included as a last paragraph in the Discussion.

Supplementary file captions

When supplementary files are associated with the manuscripts, provide a short caption for each supplementary file (e.g. Supplementary file 1 – Additional phylogenetic trees from the MrBayes analysis.).

Acknowledgements

Acknowledge collaborators who did not meet the criteria for authorship but contributed to the study, including people who supplied photographs or made drawings. Preferably use their full names. Mention funding sources (include grant numbers), provide permit numbers, and give recognition to institutes or organisations that made the work possible.

REFERENCES

Citation in the text

Single author: (Breteler 2018), Breteler (2018)
Two authors: (Köhler & Majure 2020), Köhler & Majure (2020)
Three or more authors: (Droissart et al. 2019), Droissart et al. (2019)

When referring to a specific page: (De Block 2018: 443), De Block (2018: 443)

Multiple references are listed in chronological order and separated by semicolons. Multiple references sharing the same authorship are grouped, years separated by commas, and ordered chronologically (Fisher 2012, 2014; Blackwell et al. 2013, 2017; Adams et al. 2014; Wright & Baker 2017). Letters (a, b, etc.) are added after the date for papers with identical authorship and year (Van de Vijver et al. 2014a, 2014b).

References should be cited as "in press" only if the paper has been accepted for publication. These references are mentioned in the Reference section. Otherwise, the terms "in prep." (in preparation), "unpubl. res." (unpublished results), "pers. obs." (personal observation), or "pers. comm." (personal communication) are used (e.g. Bonaventure Sonké et al. unpubl. res., Erik Smets pers. comm.). Referring to these categories should however be avoided as much as possible. Categories as "submitted" or "in review" are not accepted. None of these other categories should be mentioned in the References.

References

References are listed in alphabetical order, based on the surname of the first author. If two first authors share the same surname, the order is based on the first initial of each author.

References sharing the same first author surname and initial are arranged according to the following order:
1) Single-authored papers are listed first and arranged chronologically.
2) Two-authored papers are then listed, arranged alphabetically based on surname of the second author; when papers share the same authorship in this list, they are arranged chronologically.
3) Three-or-more-authored papers are then listed, arranged chronologically. When three-or-more-authored papers share the same year of publication, they are grouped alphabetically according to surname of second author, surname of third author, etc. In such group, the first reference is identified by letter "a", the second reference by "b", etc.

Italic is only used for generic/infrageneric names and journal titles. Bold and underline are not used. Journal titles are written in full. A DOI should be provided for all references where available.

Journal article

One author

Dormann C.F. 2002. Herbivore-mediated competition between defended and undefended plant species: a model to investigate consequences of climate change. Plant Biology 4(5): 647–654. https://doi.org/10.1055/s-2002-35437

Two authors

Lehndal L. & Ågren J. 2015. Herbivory differentially affects plant fitness in three populations of the perennial herb Lythrum salicaria along a latitudinal gradient. PLOS ONE 10(9): e0135939. https://doi.org/10.1371/journal.pone.0135939

Between 3 and 6 authors

Darbyshire I., Goyder D.J., Wood J.R.I., Banze A. & Burrows J.E. 2020. Further new species and records from the coastal dry forests and woodlands of the Rovuma Centre of Endemism. Plant Ecology and Evolution 153(3): 427–445. https://doi.org/10.5091/plecevo.2020.1727

More than 6 authors

Berg M.P., Kiers E.T., Driessen G., et al. 2010. Adapt or disperse: understanding species persistence in a changing world. Global Change Biology 16(2): 587–598. https://doi.org/10.1111/j.1365-2486.2009.02014.x

Book

Mason R.L., Gunst R.F. & Hess J.L. 2003. Statistical design and analysis of experiments: with applications to engineering and science. Second edition. John Wiley & Sons, Hoboken.

Book chapter

Arcand N.N. & Ranker T.A. 2008. Conservation biology. In: Ranker T.A. & Haufler C.H. (eds) Biology and evolution of ferns and lycophytes: 257–283. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511541827.011

Book in a series (e.g. flora)

Clayton W.D., Phillips S.M. & Renvoize S.A. 1974. Gramineae (Part 2). In: Polhill R.M. (ed.) Flora of Tropical East Africa. A.A. Balkema, Rotterdam.

Clayton W.D. 1989. Gramineae. XXIV. Paniceae. In: Launert E. & Pope G.V. (eds) Flora Zambesiaca: 10(3): 1–192. Flora Zambesiaca Managing Committee, London.

Contribution in proceedings

Cleaver C.M., Schoettle A.W., Burns K.S. & Connor J.J. 2015. Limber pine conservation strategy: recommendations for Rocky Mountain National Park. In: Ramsey A. & Palacios P. (eds) Proceedings of the 63rd Annual Western International Forest Disease Work Conference: 81–82. Washington Department of Natural Resources, Olympia.

Thesis

Bauters K. 2018. Scleria revised: a molecular approach towards a new classification. PhD thesis, Ghent University, Belgium. Available from http://hdl.handle.net/1854/LU-8582443 [accessed 1 Jan. 2021].

Dataset

Mateo-Ramírez L. & Riina R. 2020. Croton calcareus Riina & Mateo-Ram. Plazi.org taxonomic treatments database. Dataset. Available from http://treatment.plazi.org/id/0395F724-FFB8-BC25-FDC7-F96EFCA3B006 [accessed 1 Jan. 2021].

Software

R Core Team 2020. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. Available from https://www.R-project.org [accessed 1 Jan. 2021].

QGIS Development Team 2020. QGIS Geographic Information System. Version 3.16. Open Source Geospatial Foundation. Available from https://qgis.org [accessed 1 Jan. 2021].

Website

IUCN Standards and Petitions Committee 2019. Guidelines for using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Available from http://www.iucnredlist.org/documents/RedListGuidelines.pdf [accessed 1 Jan. 2021].

Thiers B. continuously updated. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available from http://sweetgum.nybg.org/science/ih/ [accessed 1 Jan. 2021].

TABLE AND FIGURE CAPTIONS

Citation in the text

When starting a sentence, use "Figure(s)" or "Table(s)", otherwise use "fig.", "figs", or "table(s)". E.g. "Figure 1 shows …", "The localities are listed in table 1 …", "The petals (fig. 2A–E) and the stipules (figs 3B, 4D) …".

When referring to a figure in another paper, write the word in full (e.g. … (Bitencourt et al. 2020: figure 2).).

Captions

Table and figure captions should be as long as necessary, but as short as possible. Taxonomic authorities should be omitted. A figure composed of several subfigures is treated as a single figure with each subfigure labelled with a capital letter (A, B, etc.).

Table 1 – Taxonomical list of all observed taxa in this study. Unidentified species are given a provisional letter code. C = cosmopolitan, SA = sub-Antarctic region, U = unknown, AMS = Ile Amsterdam, (AMS) = Ile Amsterdam but yet undescribed.

Figure 2 – *Phialiphora valida*. A. Habit. B. Node and stipule, showing the bases of two non-basal leaves and three branches. C. Inflorescence showing the involucrate bracts. D. Higher order bract. E. Ovary, calyx, flower bud. F. Corolla, stamens, style, and stigma. G. Fruit, lateral view. A–G from De Block, Groeninckx & Rakotonasolo 2349 (BR). Drawn by Antonio Fernandez.

Table and figure files

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TABLE FILES

Tables that are part of the main text should be relevant for understanding the results of the study. Carefully consider the number and size of tables: having too many or too long tables is discouraged. Other tables with a more supportive role should be provided as supplementary files (e.g. tables related to the Material and methods, long lists of samples/species, GenBank accession numbers, plot characteristics, environmental variables).

Tables and their captions should be provided in a single document in MS Word format (.doc or .docx) or Rich Text Format (.rtf).

FIGURE FILES

Figures that are part of the main text should be relevant for understanding the results of the study. Carefully consider the number of figures: having too many figures is discouraged. Other figures with a more supportive role should be provided as supplementary files (e.g. additional phylogenetic trees, elaborate maps with sampling locations, experimental design, additional statistics).

Each figure should be provided as a separate file, while the captions are provided separately at the end of the text file. Figures are provided as high-quality images and scale bars are added where necessary.

Composition

Related images should be assembled into a single figure whenever possible. Each subfigure is labelled with a capital letter (A, B, etc.) that is preferably placed in the upper or lower left corner of the subfigure. Letters are in Arial font with an appropriate font size.

Raster images

Used for photographs, maps, etc. The following extensions are accepted: .tif and .jpg.

Vector-based images

Used for line drawings, graphs, phylogenetic trees, etc. These images are preferably provided in pdf format.

Size

Figure width is either a single column (85 mm wide) or a double column (up to 177 mm wide). Figure height is maximum 235 mm (preferably shorter to leave space for the caption).

Resolution and colour

Line drawings and graphs are in black and white with a minimum resolution of 1200 dpi. Greyscale and colour images have a minimum resolution of 450 dpi. When using colour, use an inclusive colour palette.

Manuscript pdf file

Combine the text file with all tables, figures, and their respective captions into a single pdf file. This manuscript pdf file should also be part of the submission.

Supplementary files

Authors are encouraged to deposit their data in public repositories (see Research data policy). Additional supporting data can however also be provided as separate supplementary files. The number of supplementary files is limited to six per paper. Supplementary files will be available online only and will not be copy-edited, so make sure that the data is clearly and succinctly presented, and that the style conforms with the rest of the manuscript. Ideally, the supplementary files should not be platform-specific, and should be viewable using free or widely available tools (e.g. .pdf, .xlsx, .csv).

Taxonomic manuscripts
REQUIREMENTS FOR ALL TAXONOMIC PAPERS

Taxonomic papers need to demonstrate the general relevance of the work. They should present the broader context and additional analyses (e.g. morphology, anatomy, phylogenetics, biogeography, evolution, etc.) are encouraged. Although its scope is global, the journal prioritises publishing taxonomic papers from the (sub)tropics.

Taxonomic manuscripts follow the same guidelines as outlined above under Text file. The IMRAD structure should be followed as close as possible and the addition of the Taxonomic treatment at the end is recommended. Pay special attention to the citation of taxon names. Taxonomic nomenclature follows the rules of the most recent edition of the International Code of Nomenclature for algae, fungi and plants. Nomenclatural types for newly described taxa are deposited in a public herbarium and the acronyms follow the Index Herbariorum. All references cited in the taxonomic treatment (valid publication of a basionym, synonym, etc.) are included in the References. A list of taxonomic novelties is provided at the end of the Text file.

Discussion

The morphological characters, phylogeny, ecology, geography, reproductive biology, etc. of the new taxa, which are the basis for their distinctiveness, should be discussed when available. The discovery of the new taxa should be put in a broader context, rather than simply describing the taxa. If appropriate, consider presenting this information under a separate header (e.g. Bakalin & Vilnet 2020, De Block et al. 2020).

Identifier for fungi

For names of new taxa, new combinations, names at new ranks, or replacement names for organisms treated as fungi (including fossil fungi and lichen-forming fungi), authors are required to cite the identifier for the name issued by a recognised repository (e.g. MycoBank, Index Fungorum) in the protologue.

ADDITIONAL REQUIREMENTS FOR ISOLATED TAXONOMIC NOVELTIES

The journal might consider publishing isolated taxonomic novelties, i.e. a new taxon described outside the framework of a revision or monograph. However, such manuscripts should be written in a way that they are attractive and interesting for a wider international audience.

Introduction

Provide context of the higher taxon to which the novelty belongs, and refer to recent taxonomic literature on the group (e.g. other novelties recently published, taxonomic history). Explain whether the description of the novelty fits in a broader framework (e.g. flora, research line, conservation efforts).

Discussion

In addition to the requirements for a discussion mentioned above, motivate why it is important to describe the new taxon separately. When available, provide additional information about the new taxon (e.g. morphology, phylogenetic placement, conservation assessment) and about the area where the new taxon is found (e.g. climate, soil, level of endemism, conservation efforts, other collecting efforts or other new species recently described). For examples, see Fleischmann et al. 2020, Quintanar et al. 2020.

Illustration

A figure clearly showing the diagnostic characters of the new taxa. This is often a line drawing but can also be pictures, or a combination of both.

Comparison

The new taxa should be compared to related (or sympatric, or similar) taxa in a dichotomous key and/or table.

TAXONOMIC TREATMENT

For emphasis, some terms are in bold in the taxonomic treatment:
- Introduction of a novelty: **sp. nov., gen. nov., var. nov., subsp. nov.**, etc.
- Introduction of a new synonym: **syn. nov**.
- Introduction of a new combination, of a name at new rank: **comb. nov., stat. nov**.
- Introduction of illegitimate or invalid name: **nom. illeg., nom. inval**.
- Designation of a lectotype, neotype, or epitype in the manuscript: **designated here**.

Treatment of a taxon

The treatment of a taxon includes the following elements in the following order. Third level headings are used to introduced the elements 2 to 12. Elements 4 to 12 should be provided as much as possible, depending on the information available.

1) **Name of the taxon** (citation of tables and figures) – Type:
2) **Diagnosis** – A diagnosis in English (or Latin) for new taxa.
3) **Description** – Full description of the taxon with major organs underlined. A diagnosis must be present if there is no description.
4) **Distribution** – With reference to a distribution map, if provided.
5) **Habitat and ecology** –
6) **Phenology** –
7) **Vernacular name** –
8) **Use** –
9) **Etymology** –
10) **IUCN conservation assessment** – First mention the category and the criteria (e.g. "Critically Endangered: CR B1ab(iii)+2ab(iii)"), followed by the rationale. Also encouraged for taxa that are not new.
11) **Additional material examined** –
12) **Notes** –

New taxon

Englerodendron libassum Jongkind & Breteler, sp. nov. (figs 2, 3) – Type: LIBERIA • Margibi county, forest edge at Kpan Town lagoon; 6°11′N, 10°29′W; 7 Mar. 2020; fr.; Jongkind 14290; holotype: BR; isotypes: K, P, WAG.

Diagnosis – This species resembles E. hallei (Aubrév.) Estrella & Ojeda by its unijugate leaves but differs by its 2.7 cm long lateral racemes which are at most 1 cm long in E. hallei, and by the shape of its leaflets that are not caudate as in E. hallei but gradually short acuminate at the apex.

Accepted names

For a previously published name, the taxonomic authority should be followed by the citation of the protologue, with page number. This reference should also be included in the References section.

Crotonogyne giorgii De Wild. (De Wildeman 1914: 381) (figs 1–3; tables 1, 2) – Type: D.R. CONGO • Bonkula; Sep. 1913; De Giorgi 1327; holotype: BR[BR0000008894007].

Synonyms

Homotypic synonyms are mentioned first in a single paragraph, listed in chronological order, with citation of the original publications, and followed by the citation of the type. Heterotypic synonyms are mentioned next in separate paragraphs, listed in chronological order, with citation of the original publications, and followed by the citation of the types. Illegitimate or invalid names are mentioned last, listed in chronological order, with citation of the original publications. En dashes (–) are used as separators within a paragraph.

Crotonogyne caterviflora N.E.Br. (Brown 1905: 114) (fig. 4; table 1) – Neomanniophyton caterviflorum (N.E.Br.) Pax & Hoffm. (Pax & Hoffmann 1912: 118) – Type: LIBERIA • Sinoe Basin; 1904; Whyte s.n.; holotype: K.
Neomanniophyton chevalieri Beille (Beille 1917: 295) – Crotonogyne chevalieri (Beille) Keay (Keay 1955: 139), **syn. nov.** – Type: CÔTE D'IVOIRE • Between Soubré and Yaou (Sanvi); 28 Mar. 1907; Chevalier 17783; holotype: P; isotype: K.

New combination

A new combination includes the basionym with a full and direct reference to its authorship and valid publication. This reference should also be included in the References section.

Cyperus testui (Cherm.) Reynders, **comb. nov.** – Pycreus testui Cherm., Archives de Botanique Tome 4, Mémoire 7: 13. 1931 (Chermezon 1931: 13) – Type: CENTRAL AFRICAN REPUBLIC • Marais du Brini; 21 Jun. 1921; G.M.P.C. Le Testu 2860; lectotype: P[P00573015], designated here; isolectotypes: P[P00573013, P00573014].

Typification

When a lectotype (or neotype, epitype, etc.) is designated in the manuscript itself, add the words "designated here" in bold. E.g. "lectotype: BR, **designated here**". When the lectotype (or neotype, epitype, etc.) was designated before, a citation is needed and no bold is used. E.g. "lectotype: AD, designated by Prescott (1984: 319)".

Specimen citations

Specimen citations are grouped per country (one paragraph per country). Each citation is separated by a bullet point (•), and each element within the citation is separated by a semicolon. If data is missing, list only the available elements (except collector information, see format).

Specimen citations include the following elements in the following order.
1) Country, in uppercase, followed by a bullet point •
2) If specimens are grouped by geopolitical unit(s) within a country (e.g. state, province), use: COUNTRY – **Region** • … • … . – **Region** • … • … .
3) Locality
4) Geographical coordinates (for format, see Formatting and style)
5) Elevation
6) Collection date (for format, see Formatting and style)
7) Phenology (fruits = fr., flowers = fl., flower buds = fb., sterile = st.)
8) Collector name + collection number in italic; if no collector name is available, use "s.col."; if no number is available, use "s.n."; followed by the herbarium acronyms, and if available, add a barcode number between square brackets.

MADAGASCAR – **Mahajanga Province** • Bongolava; 15°36′42.8″S, 47°35′32.7″E; 185 m; 18 Mar. 2010; fl.; De Block, Groeninckx & Rakotonasolo 2339; BR[BR0000005519811], TAN • Bongolava; 15°36′49.2″S, 47°35′21″E; 215 m; 18 Mar. 2010; fl.; De Block, Groeninckx & Rakotonasolo 2342; BR[BR0000005519644], TAN.