

BIOGEOGRAFIA HISTÓRICA

ENFOQUES FUNDAMENTAIS

Dispersialismo – Darwin 1859, Wallace 1876

Biogeografia filogenética – Hennig 1966, Brundin 1966

Áreas ancestrais – Bremer 1992, Ronquist 1994

Panbiogeografia – Croizat 1958, Craw 1988, Page 1987

Biogeografia cladística – Nelson 1974, D. Rosen 1976, Nelson & Platnick 1981

Análise de parcimônia de endemismos (PAE) - B. Rosen 1988, Craw 1988, Morrone 1988

Métodos baseados em eventos – Page 1994, Ronquist 1997

Filogeografia – *Avise et al.* 1987

Biogeografia experimental – Haydon, Tadtkey & Pianka 1994

Biogeografia Integrativa – Donoghue & Moore 2003

ÁREAS DE ENDEMISMO

superposição das distribuições de 2 ou mais táxons

conceito de AE: A.P. De Candolle (1838) - enfoque
descritivo

enfoque analítico: várias definições de AE:

Nelson & Platnick (1981) - área relativamente
pequena que apresenta número significativo de
espécies que não estão presentes em nenhuma
outra área.

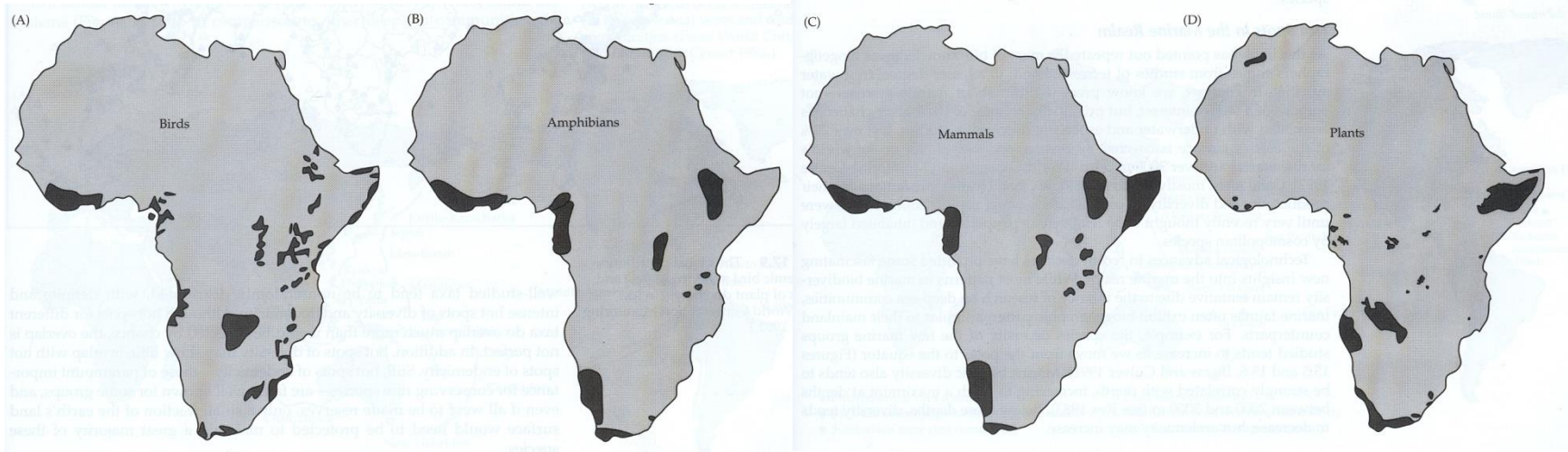
Morrone (1994) - áreas de congruência distribucional não-aleatória de 2 ou mais táxons.

Harold & Mooi (1994) - região que compreende a distribuição de 2 ou mais táxons monofiléticos que exibem congruência filogenética e de distribuição.

AEs: usadas como unidades de análise na maioria dos métodos de Biogeografia Histórica.

Axelius (1991) x Hovenkamp (1997)

Áreas de endemismo na África



Aves

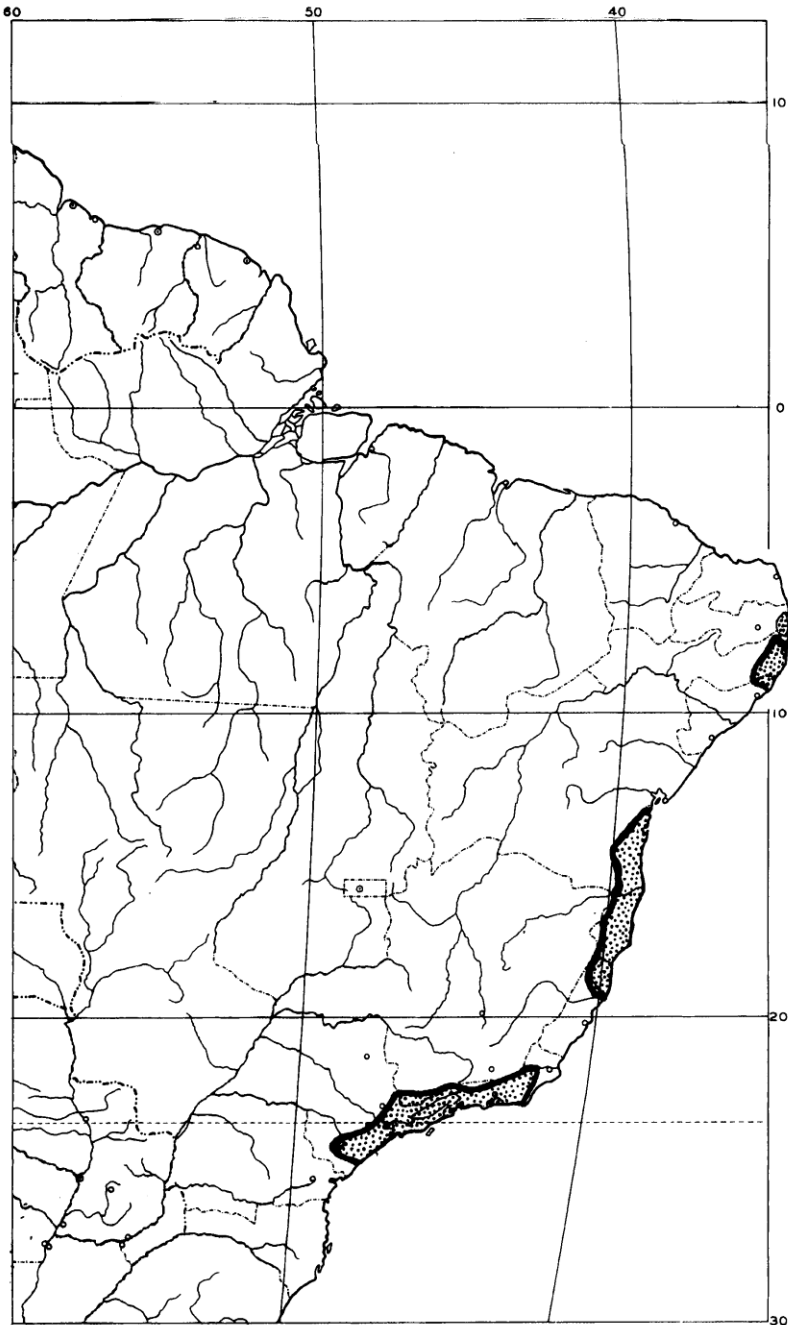
Anfíbios

Mamíferos

Plantas

Overlap of areas of endemism in Africa are quite high for some groups (e.g., amphibians and mammals), but relatively low for others (e.g., plants and mammals). (A-C from Bibby et al. 1992; D from World Conservation Monitoring Centre 1992.)

Brown & Lomolino 1998



The three tropical lowland rain forest centres of endemism in coastal Brazil. From north to south these are: the Pernambuco-Alagoas centre (PE-AL), the southern Bahia-northern Espirito Santo centre (BA-ES), and the Sao Paulo-Rio de Janeiro centre (SP-RJ)

Thomas *et al.* 1998.

Dimensão ideal das Áreas de Endemismo ?

AEs maiores (Austrália, América do Sul) podem constituir unidades adequadas em escala de determinados estudos

AEs menores podem ser reconhecidas dentro das maiores:

Hierarquização das AEs

ANÁLISE DE PARCIMÔNIA DE ENDEMICIDADE (PAE)

permite descobrir padrões naturais de distribuição de organismos
(B. Rosen 1988)

classifica localidades, quadrículas ou áreas (*análogas a táxons*) segundo os táxons compartilhados (*análogos a caracteres*) mediante a solução mais simples (critério de parcimônia).

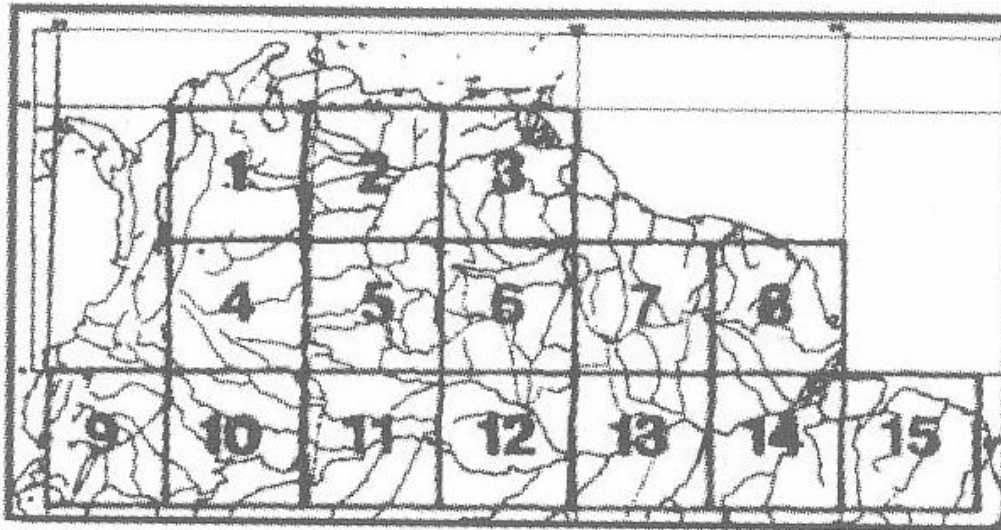
PAE baseado em localidades (B. Rosen 1988) – proposto em paleontologia.

PAE baseado em áreas de endemismo (Craw 1988) - só utiliza táxons monofiléticos + algoritmo de parcimônia.

PAE baseado em quadrículas

(Morrone 1994)

- objetiva delimitar AEs aplicando algoritmo de parcimônia sobre as distribuições



a

		Especies				
		1	2	3	-	n
Cuadrículas	1	1	0	0	-	1
	2	1	0	0	-	1
	3	1	1	0	-	1
	-	-	-	-	-	-
	15	0	0	1	-	0

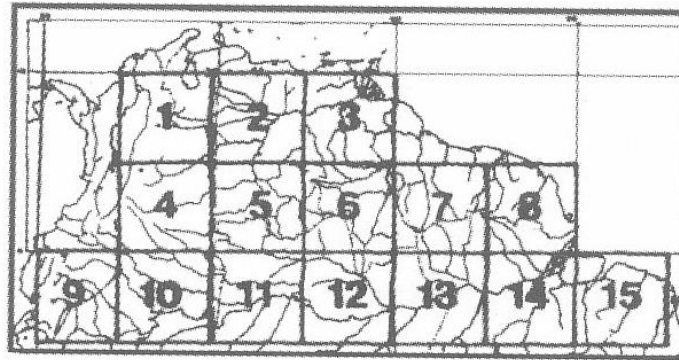
b

PAE baseado em quadrículas (Morrone 1994)

1. Construção de grade quadriculada sobre a área de estudo
2. Obtenção dos dados de distribuição de táxons monofiléticos de qualquer hierarquia, que habitem a área
3. Construção de matriz de quadrículas x táxons (1 presença, 0 ausência). Enraizar cladograma com uma quadrícula hipotética só com ausências.

4. Análise da matriz usando algoritmo de parcimônia (PAUP, Hennig86, NONA)

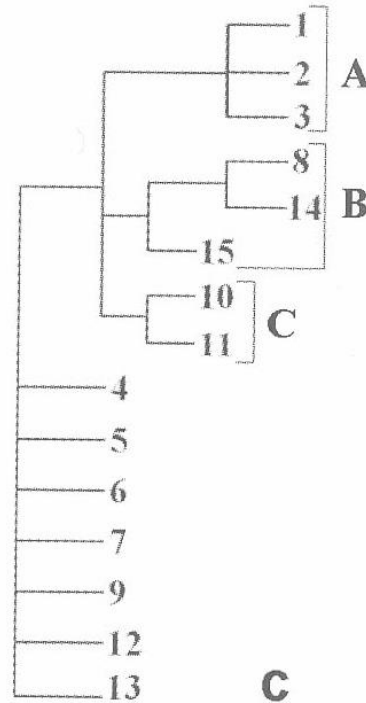
5. Seleção das AEs, considerando **somente as quadrículas que formaram um clado e cuja união esteja sustentada pela presença de mais de 1 táxon.**



a

		Especies				
		1	2	3	-	n
Cuadrículas	1	1	0	0	-	1
	2	1	0	0	-	1
	3	1	1	0	-	1
	-	-	-	-	-	-
	15	0	0	1	-	0

b

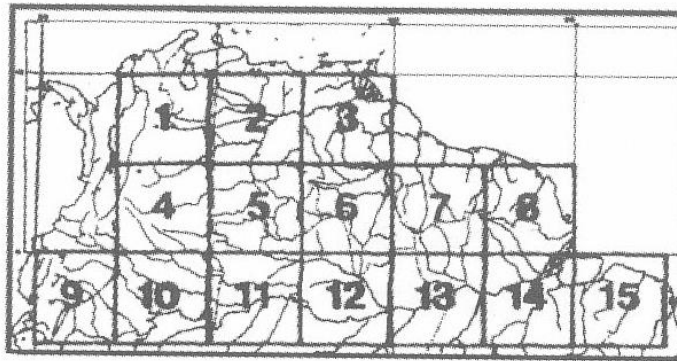


C

4. Análise da matriz usando algoritmo de parcimônia (PAUP, Hennig86, NONA)

5. Seleção das AEs, considerando somente as quadrículas que formaram um clado e cuja união esteja sustentada pela presença de mais de 1 táxon.

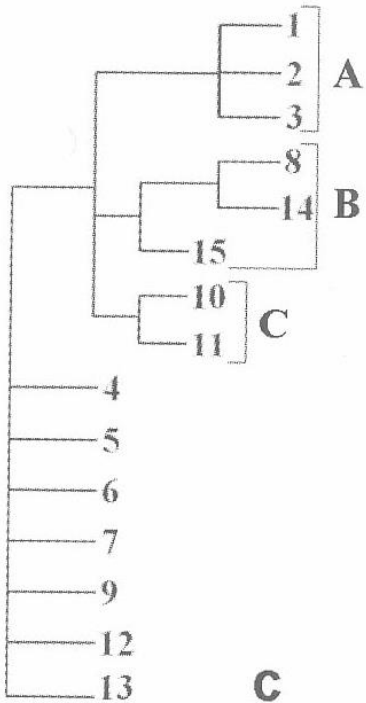
6. Desenham-se as quadr. selecionadas em mapa traçando os limites em função das distr. reais dos táxons que sustentam cada clado.



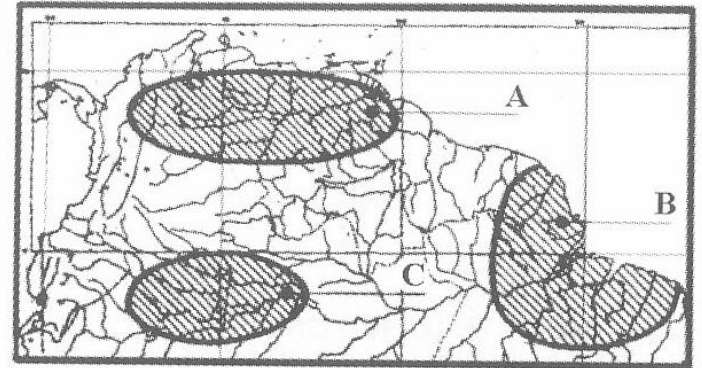
a

		Especies			
		1	2	3	- n
Cuadrículas	1	1	0	0	- 1
	2	1	0	0	- 1
	3	1	1	0	- 1
	-	-	-	-	- -
	15	0	0	1	- 0

b



c

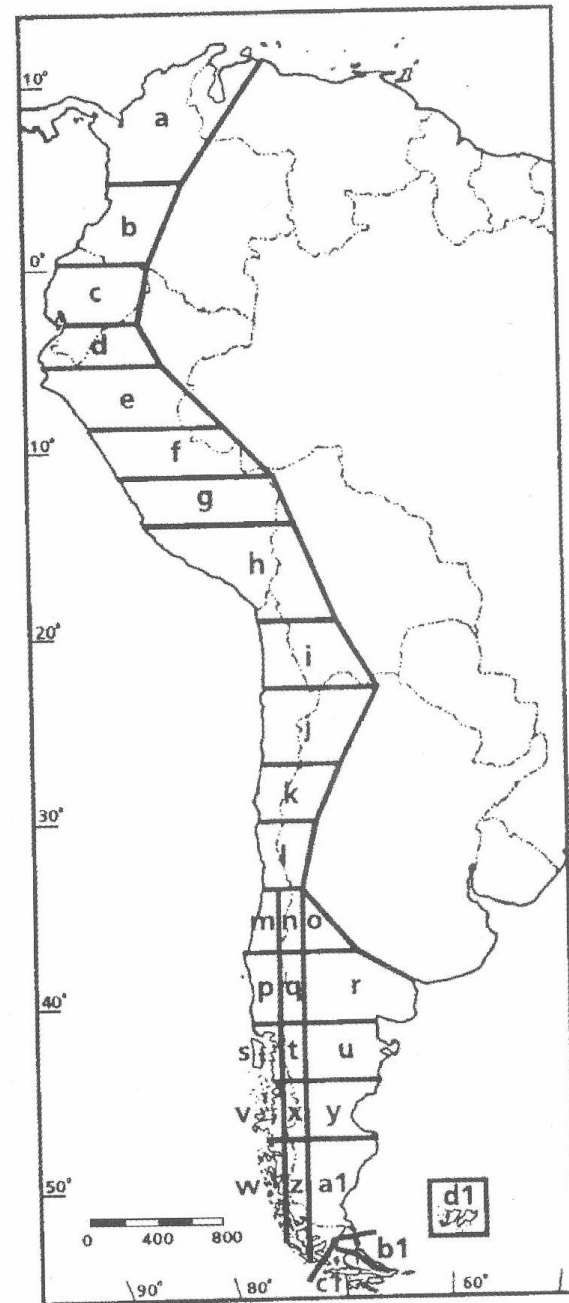


d

Exemplo 1:

Posadas *et al.* 1997
– PAE na subregião
andina,
com dados de 160
spp vegetais.

(30 quadrículas)



Exemplo 1:

Posadas *et al.* 1997

PAE na subregião andina,
com dados de 160 spp. vegetais

(30 quadrículas)

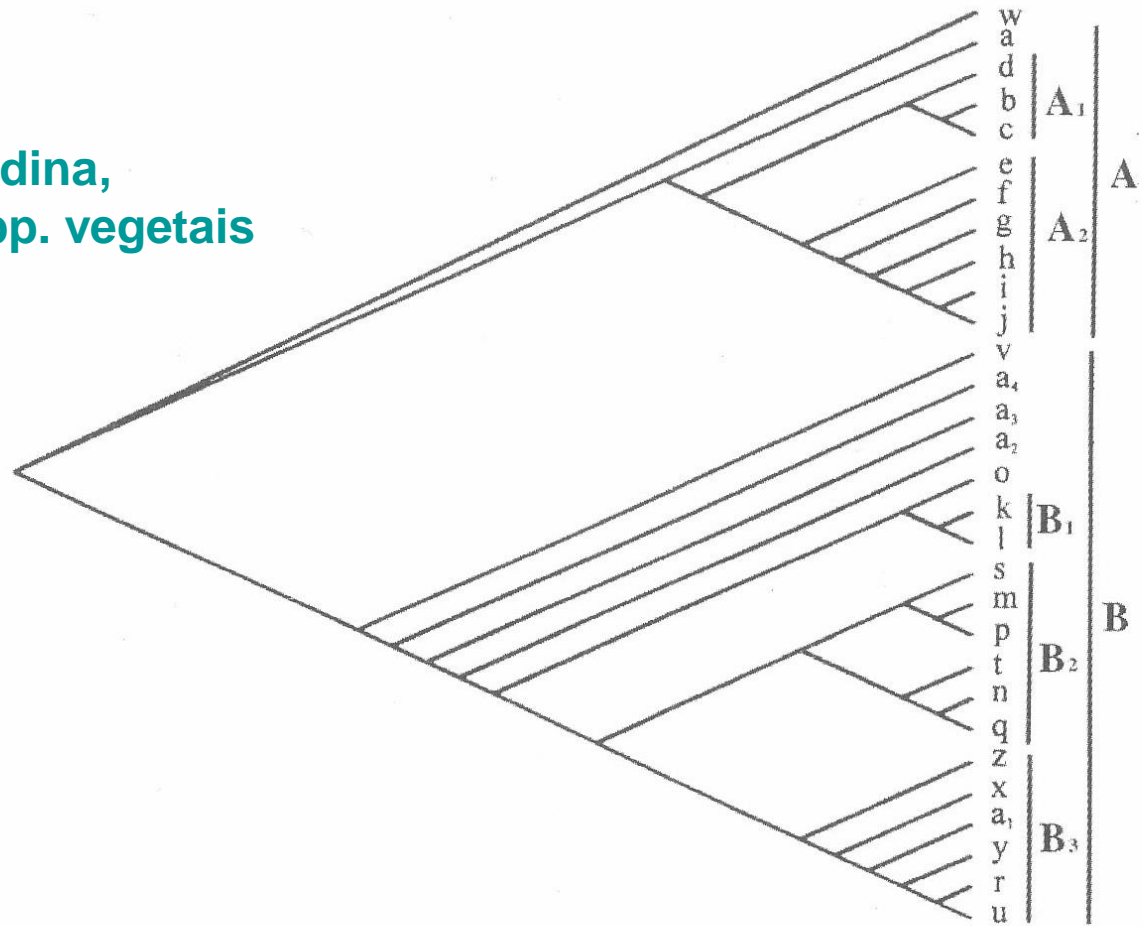


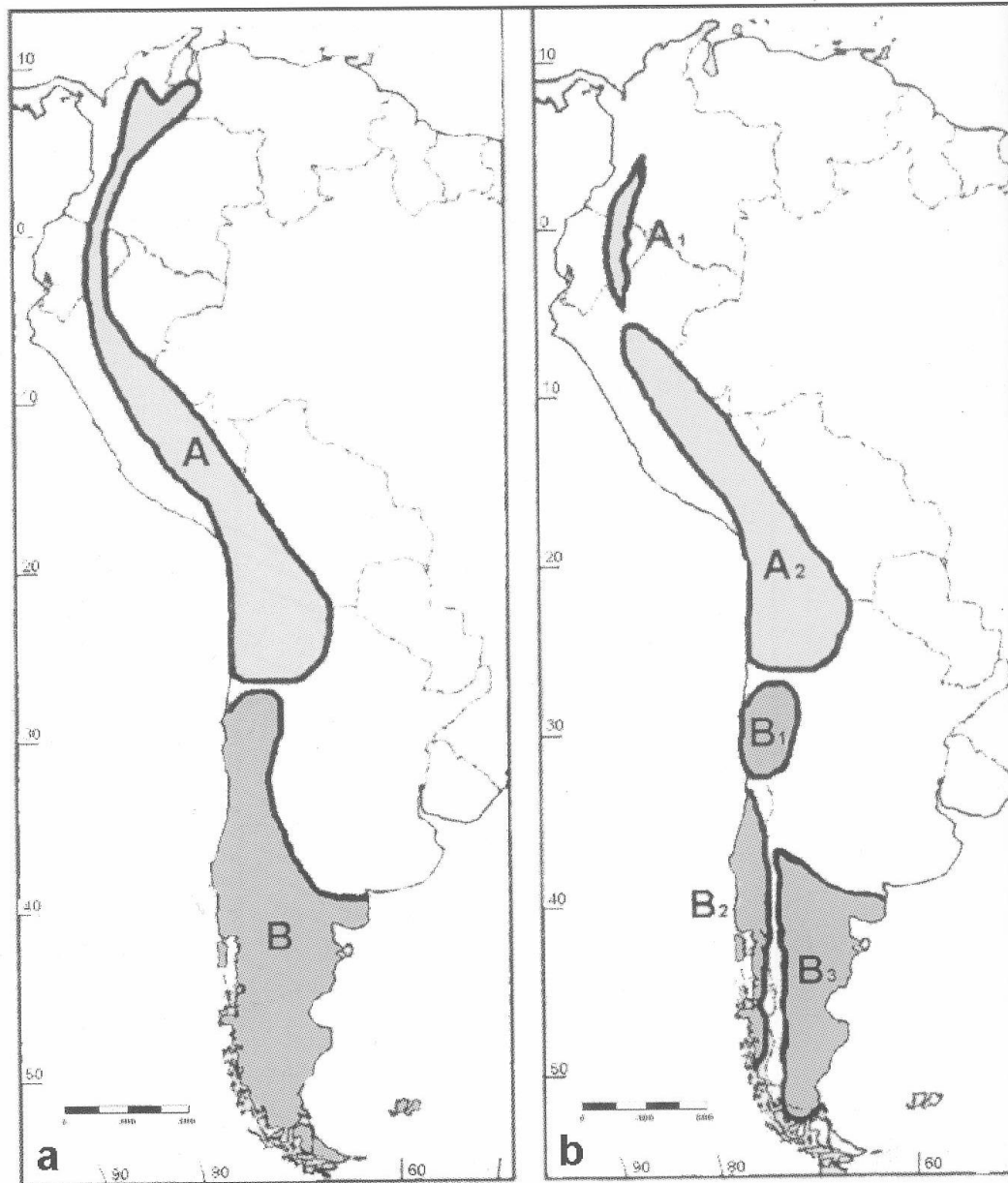
Fig. X-3. Cladograma obtenido a partir de la matriz de cuadrículas por especies; cada terminal representa una cuadrícula. A y B representan respectivamente las áreas de endemismo mayores y A₁, A₂, B₁, B₂ y B₃ las áreas de endemismo menores incluidas dentro de A y B (modificado de Posadas *et al.*, 1997).

Exemplo 1:

Posadas *et al.* 1997

PAE na subregião andina,
160 spp. vegetais

Áreas de endemismo:



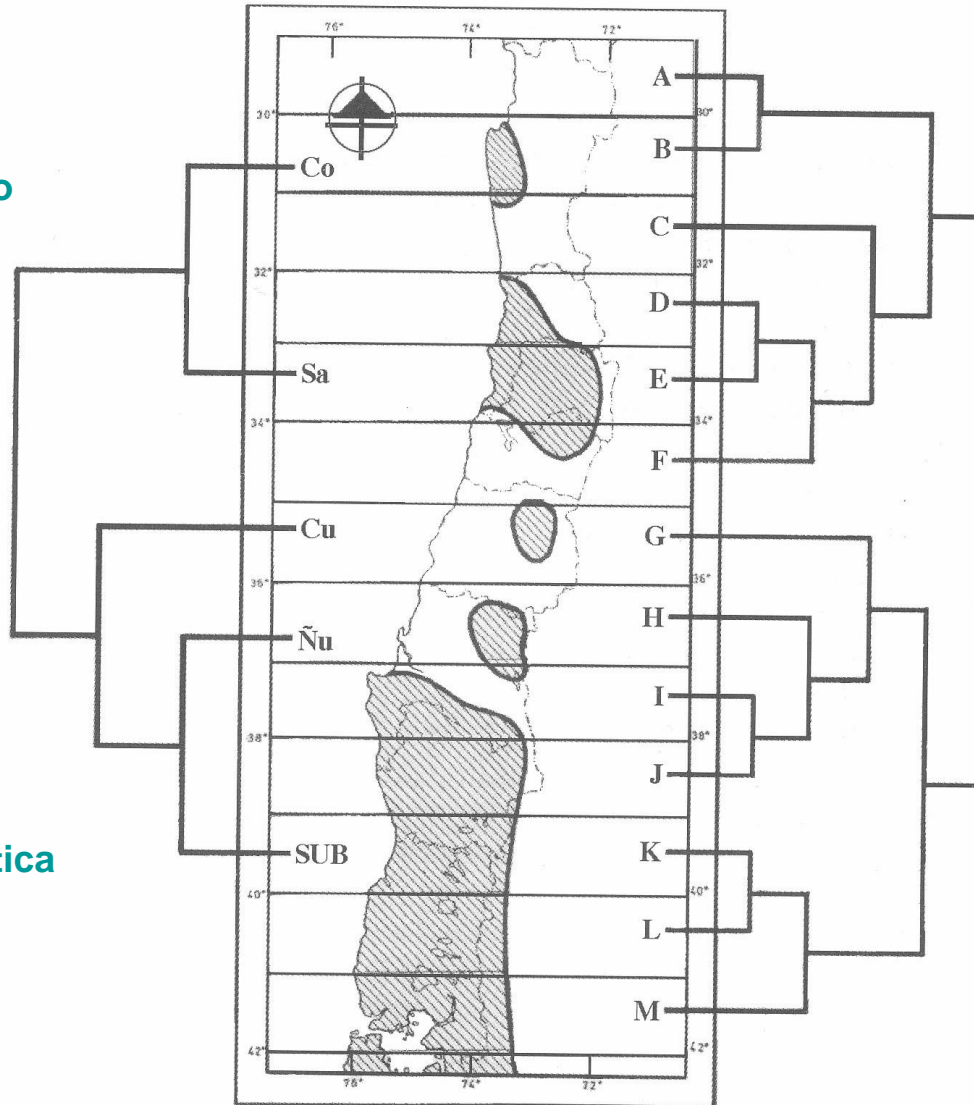
Coquimbo

Santiago

Curicó

Ñuble

Subantártica



Exemplo 2:

Morrone et al. 1997

**—
PAE no Chile
central, com 67
táxons:**

**7 gên. de
Compositae**

**3 gên. de
Curculionidae**

2 gên. de Aranae

Fig. X-5. Mapa de Chile Central mostrando las cuadrículas usadas para la aplicación del PAE (señaladas con las letras A a M), en rayado se observan las áreas de endemismo obtenidas. A la izquierda se muestra el cladograma general de áreas obtenido aplicando técnicas de biogeografía cladística y a la derecha el cladograma resultante del PAE (modificado de Morrone *et al.*, 1997).

Exemplo 3:
Luna-Vega *et al.* 2001
Florestas nebulares
neotropicais
baseado em PAE

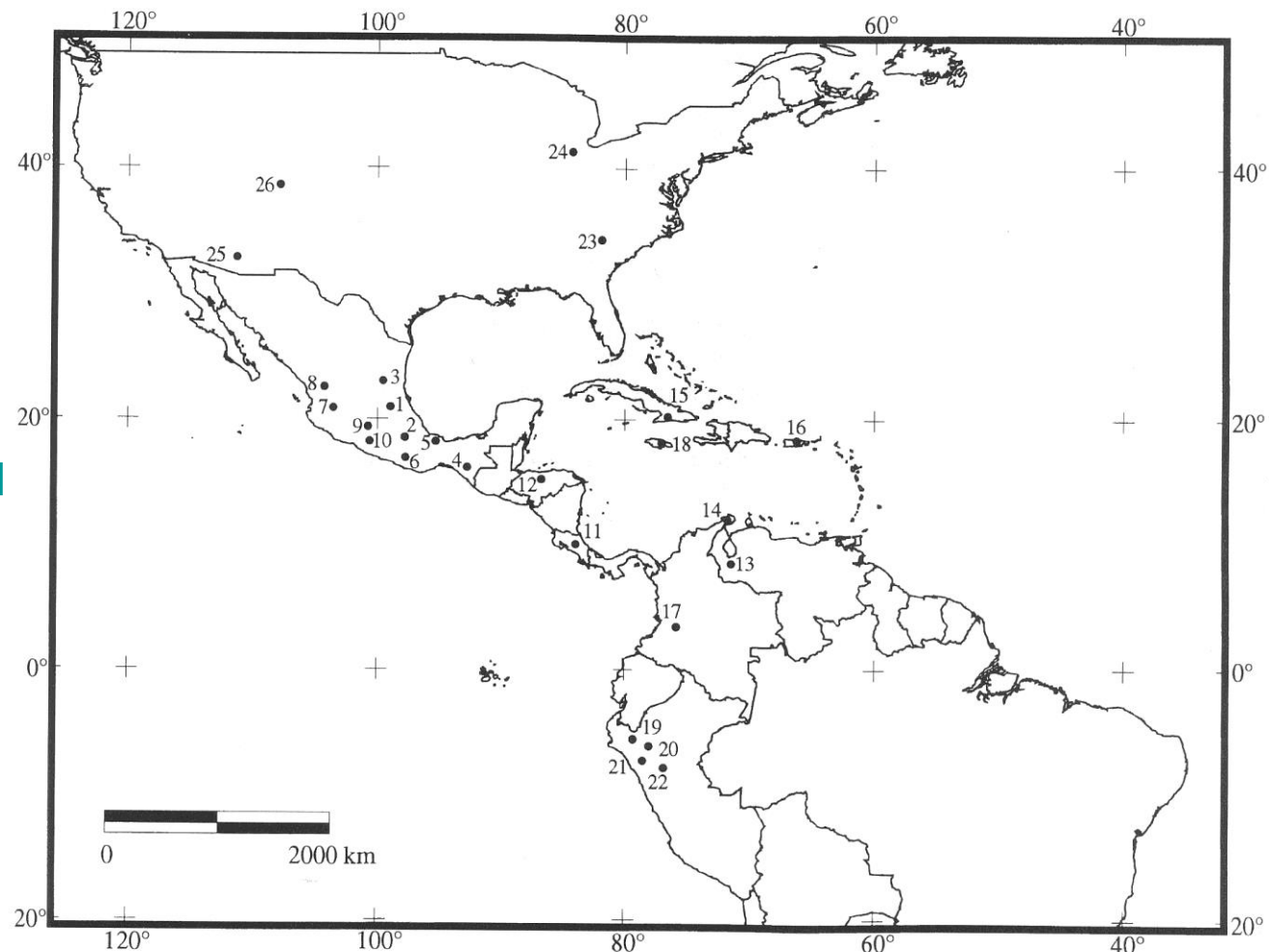


Fig. 1. Cloud forest localities analysed: 1. Tlachinol, Hidalgo, Mexico; 2. Huautla de Jiménez, Oaxaca, Mexico; 3. Gómez Farías, Tamaulipas, Mexico; 4. El Triunfo, Chiapas, Mexico; 5. Volcán San Martín, Veracruz, Mexico; 6. San Jerónimo Coatlán, Oaxaca, Mexico; 7. Sierra de Manantlán, Jalisco and Colima, Mexico; 8. Sierra de San Juan, Nayarit, Mexico; 9. Ocuilan, Morelos-Mexico, Mexico; 10. Omiltemi, Guerrero, Mexico; 11. Monteverde, Costa Rica; 12. San Juancito, Honduras; 13. La Montaña, Venezuela; 14. Serranía de Macuira, Colombia; 15. Turquino, Cuba; 16. Luquillo Mountains, Puerto Rico; 17. Cerro del Torrá, Chocó, Colombia; 18. Blue Mountain, Jamaica; 19. Canchaque, Peru; 20. Parque Nacional de Cutervo, Peru; 21. Bosque Monteseco, Peru; 22. Bosque Cachil, Peru; 23. Great Smoky Mountains, eastern United States; 24. Sandhill Woodlot, Michigan, northeastern United States; 25. Santa Catalina Mountains, western United States; 26. Needle Mountains, southwestern Colorado, western United States

Exemplo 3:

Luna-Vega et al. 2001

**Florestas nebulares
neotropicais**

baseado em PAE

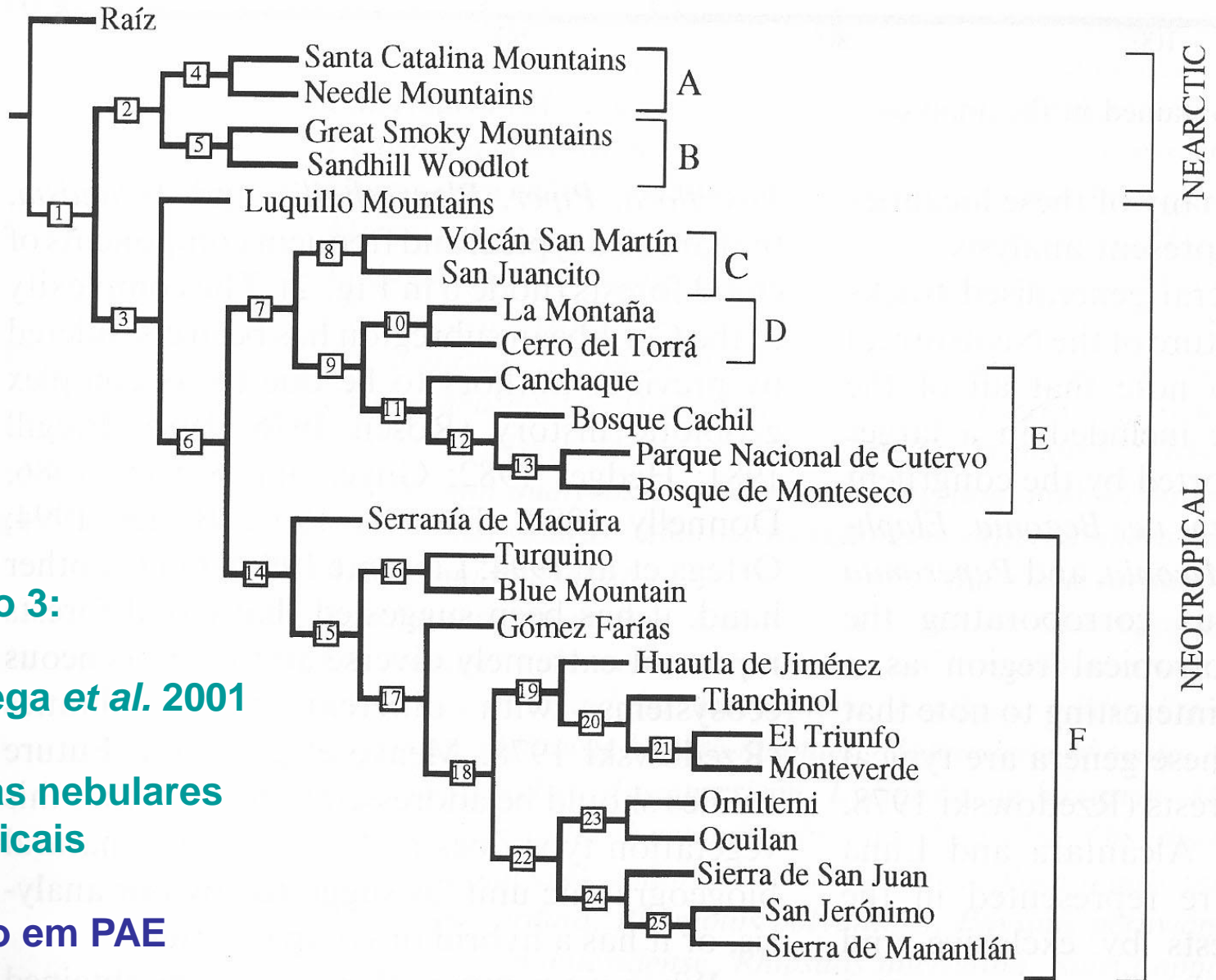


Fig. 2. Cladogram obtained by PAE. Raíz = root

Exemplo 3:

Luna-Vega *et al.* 2001

Florestas nebulares
neotropicais

panbiogeografia

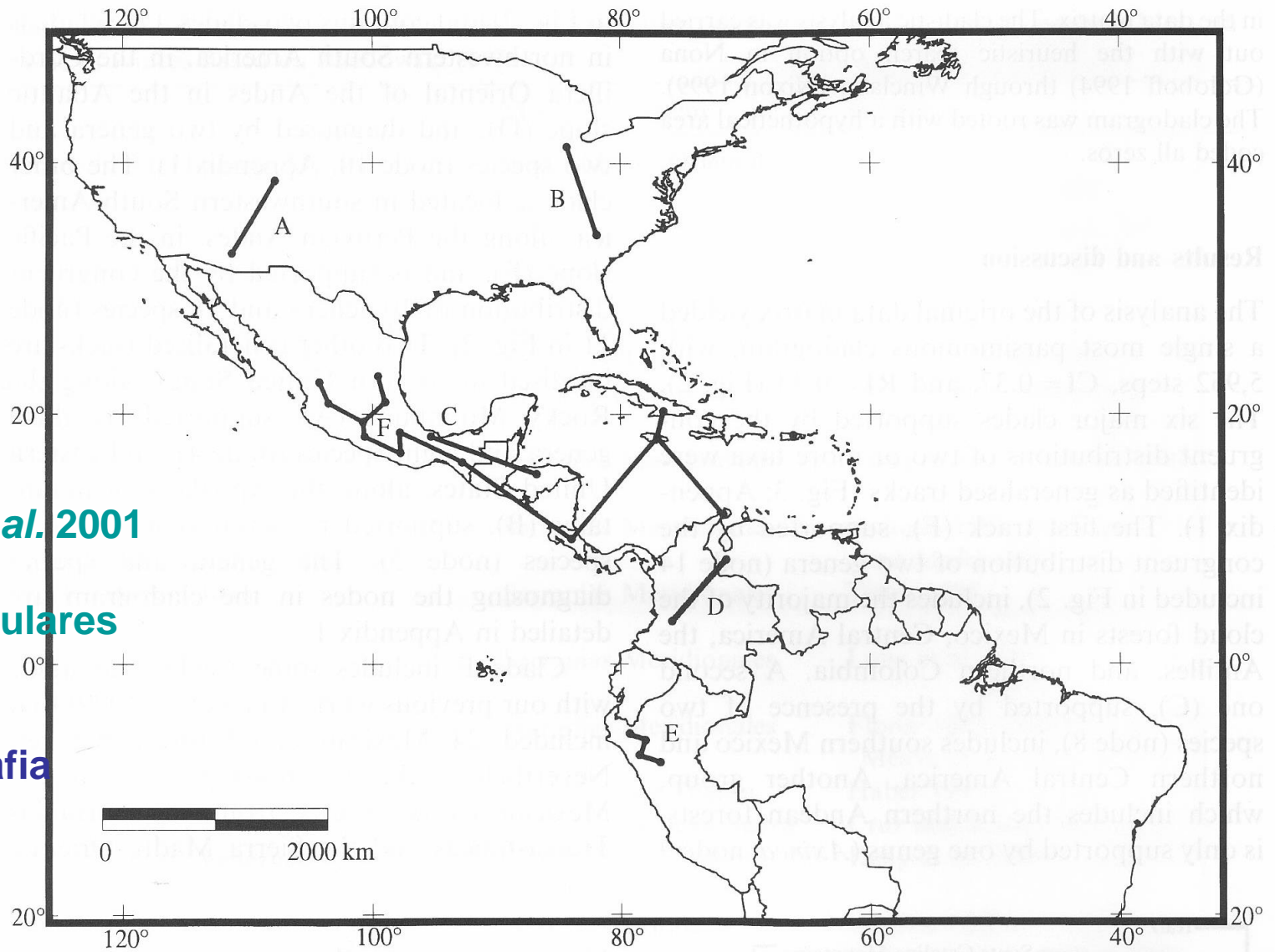
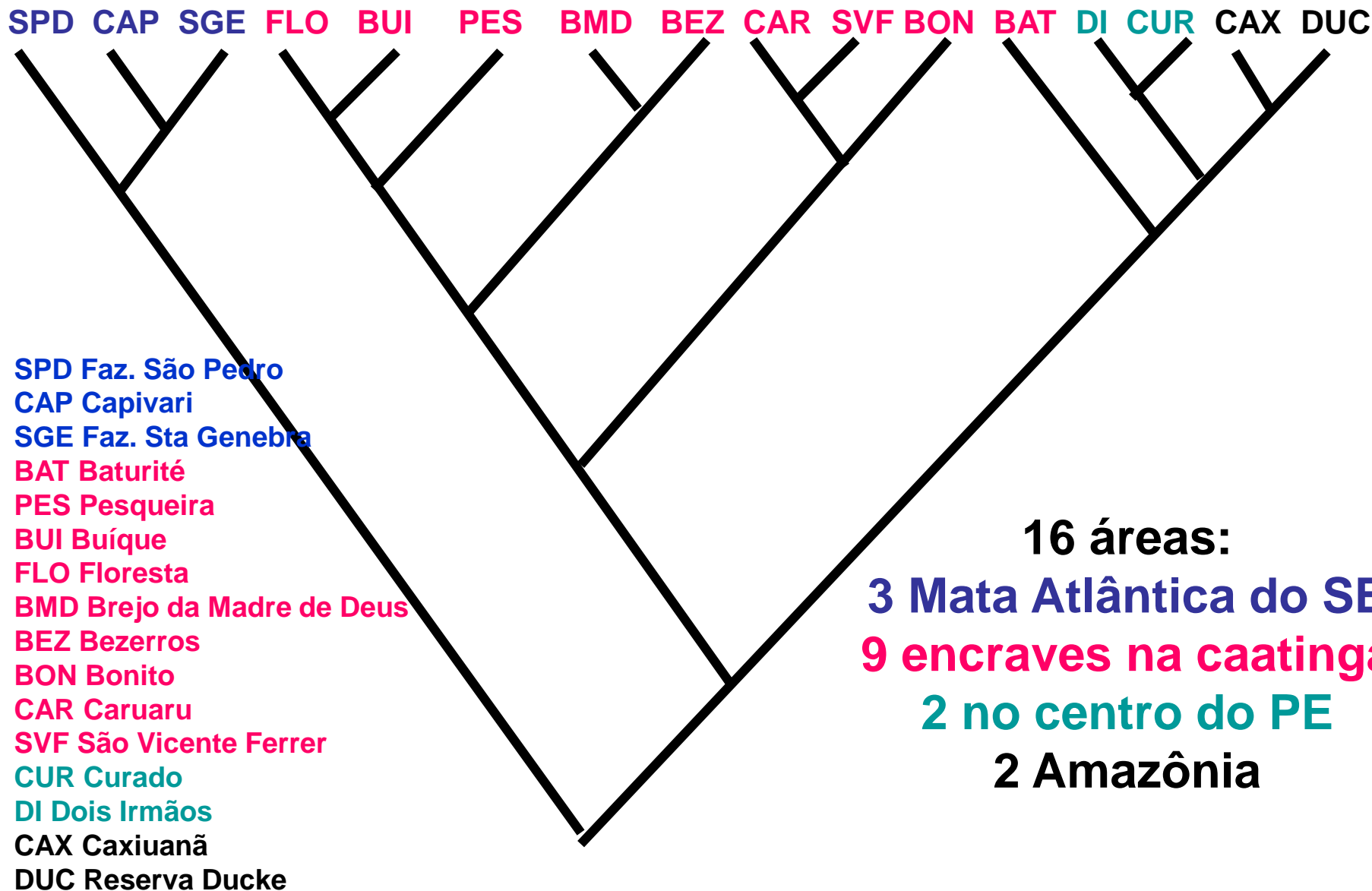


Fig. 3. Generalised tracks obtained in the analysis

Exemplo 4: PAE de florestas do NE. Santos et al. 2007

452 spp lenhosas e
293 gên. (745 taxa)



Exemplo 5: uso de PAE como etapa inicial de estudo filogeográfico nos desertos da América do Norte

Riddle & Hafner 2006

438

B.R. Riddle, D.J. Hafner / *Journal of Arid Environments* 66 (2006) 435–461

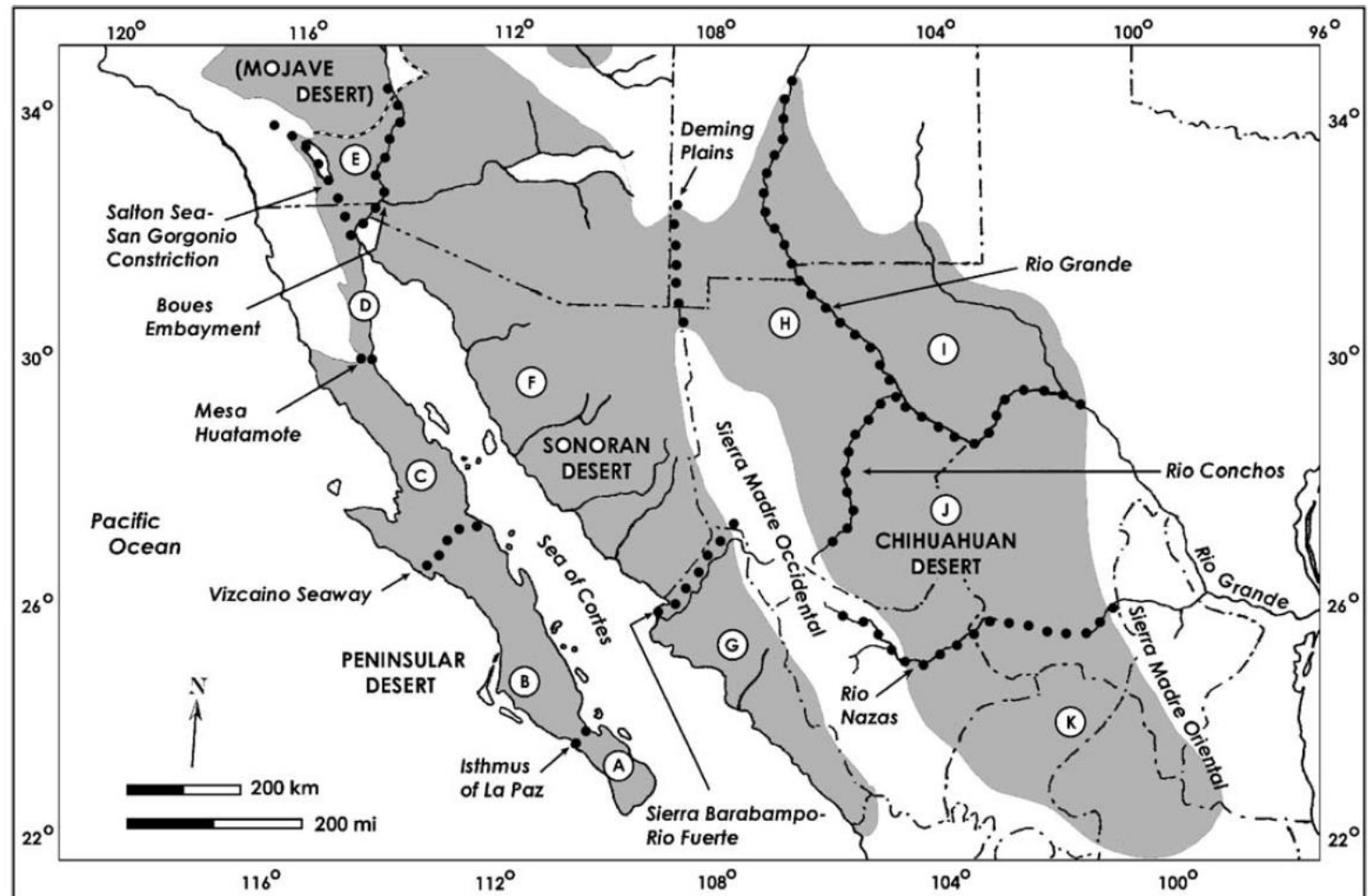


Fig. 1. Shaded areas are regional warm deserts, generally as delineated by Shreve (1942), but with recently suggested updates (the Peninsular Desert separate from the Sonoran [Hafner and Riddle, 1997]; addition of

Exemplo 5: uso de PAE como etapa inicial de estudo filogeográfico nos desertos da América do Norte

Riddle & Hafner 2006

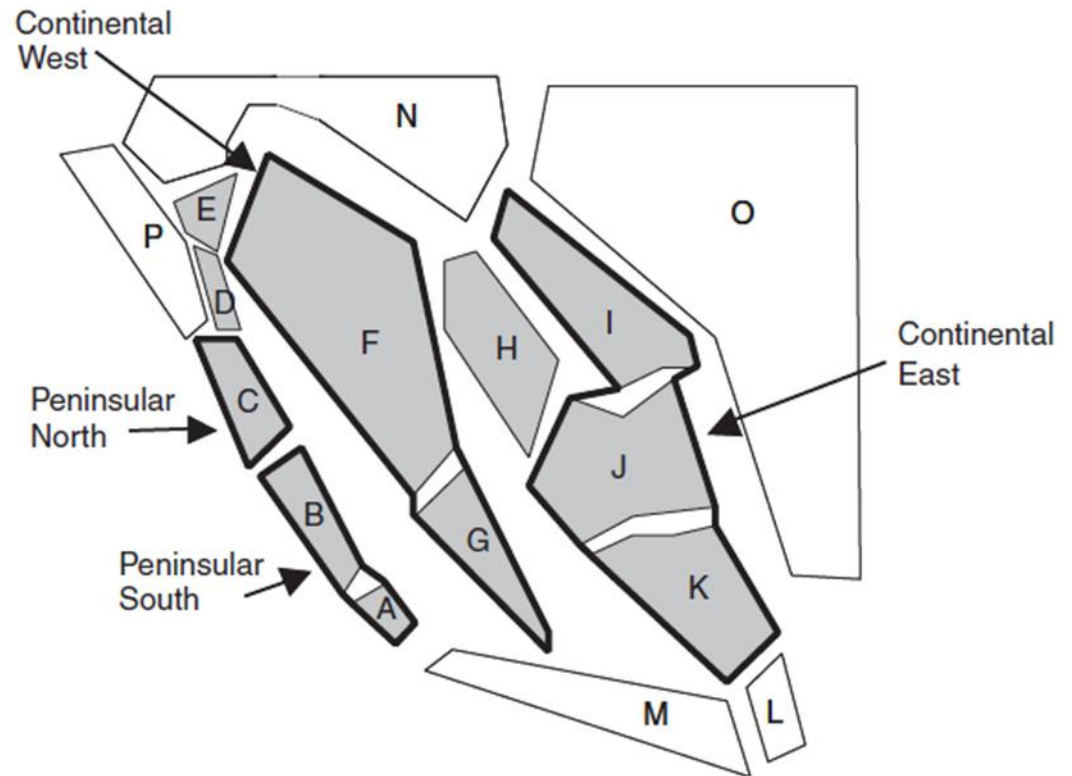
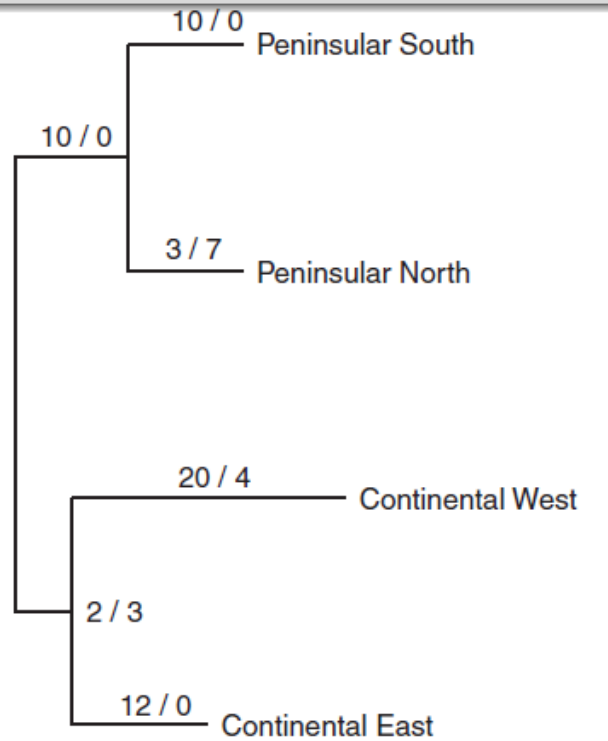


Fig. 5. Final PAE parsimony tree (top) and postulated areas of endemism comprised of one or more distributional areas (bottom). Numbers indicate endemic/widespread taxa.

Áreas de Endemismo na Região Neotropical

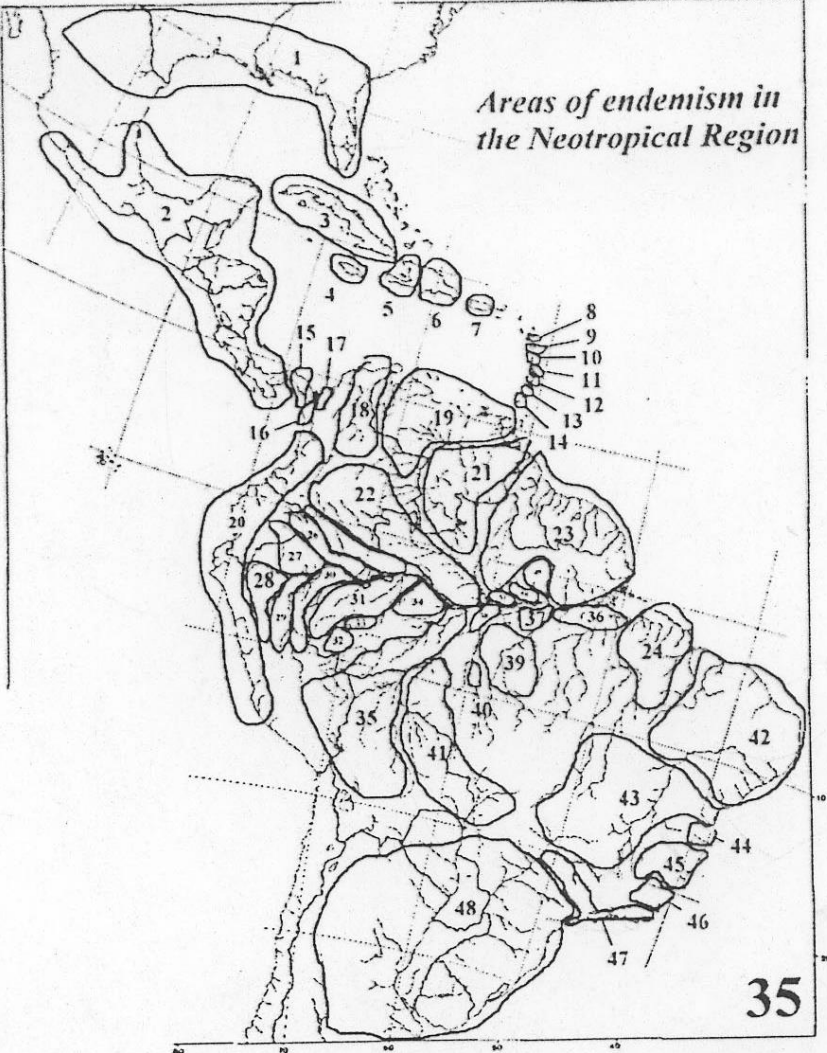
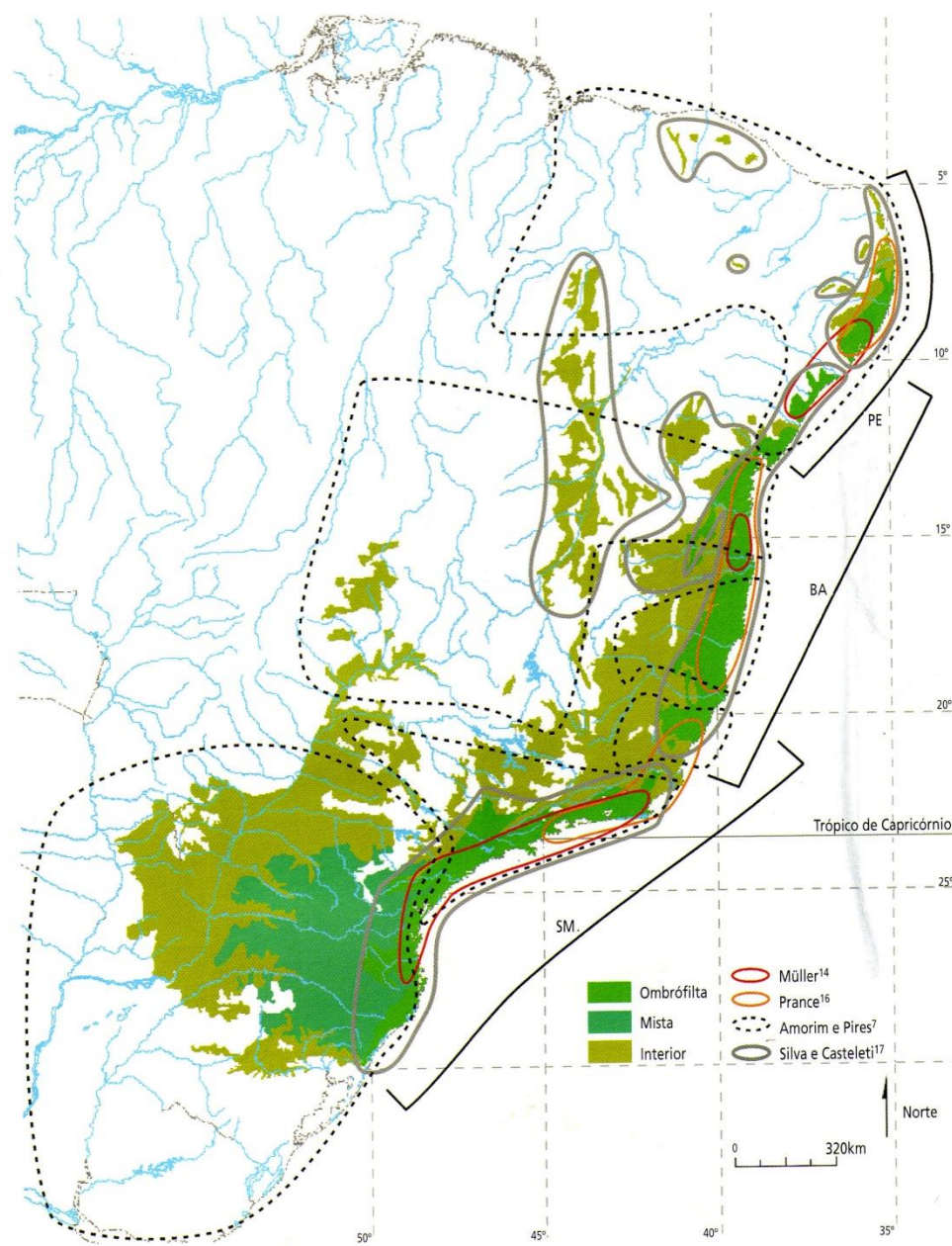


Figure 35. Most well corroborated areas of endemism in the Neotropical region. There are many areas with missing information.

Amorim & Pires 1996



4 hipóteses de Áreas de Endemismo sobrepostas às fisionomias da Mata Alântica

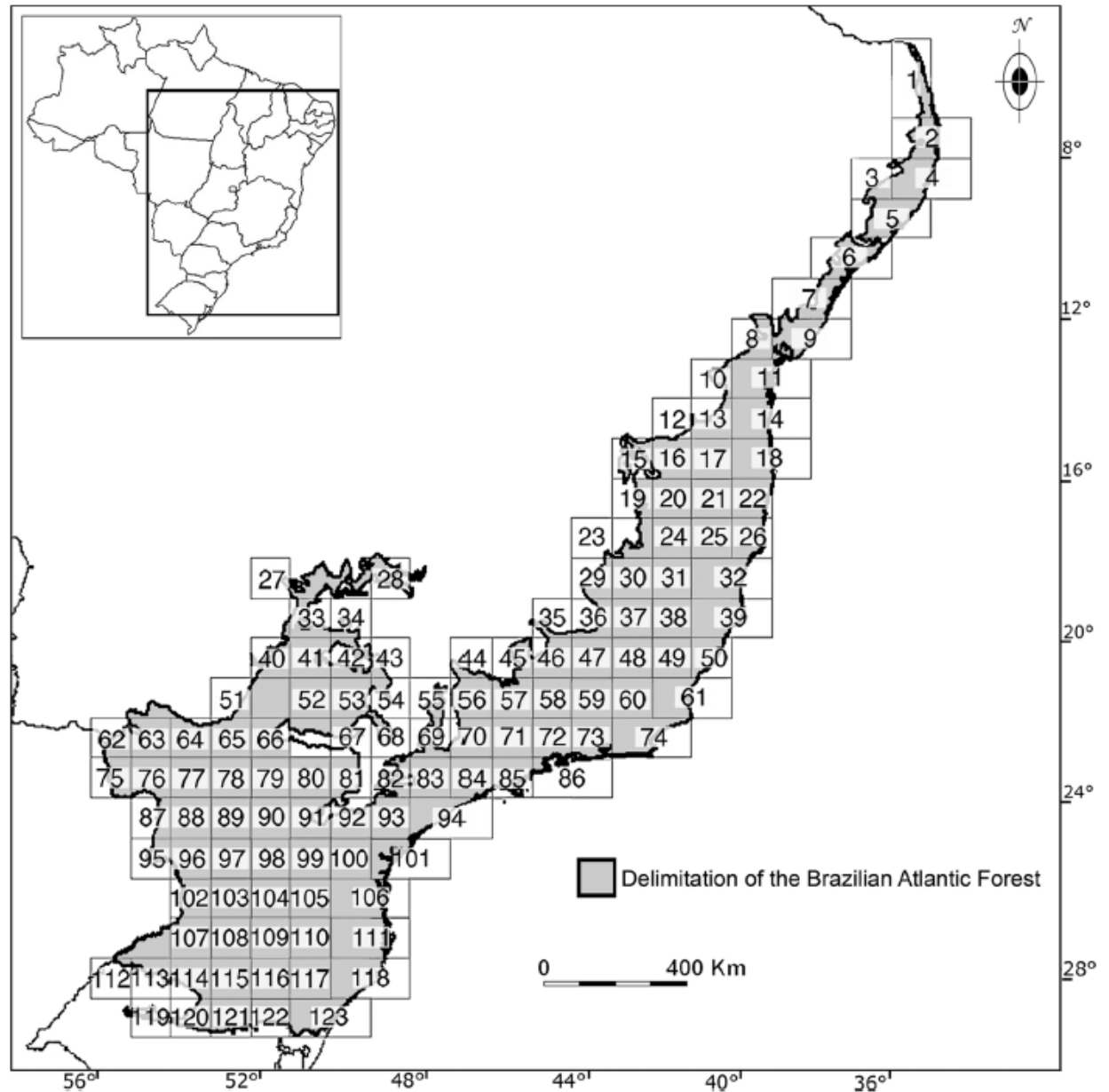
DaSilva & Pinto-da-Rocha
2010

Figura 14.1 – Quatro hipóteses de áreas de endemismo sobrepostas às principais fisionomias da Mata Atlântica (Floresta Ombrófila, Mista e Estacionais, ou do Interior). As propostas indicam em geral as áreas Pernambuco (PE), Bahia (BA) e Serra do Mar (SM) com limites nunca totalmente coincidentes. As áreas de Silva e Casteletti¹⁷ têm seus limites acompanhando as linhas das fisionomias e manchas florestais. As propostas de Müller¹⁴, Prance¹⁶ e Amorim e Pires⁷ estão representadas de modo semelhante aos limites publicados originalmente.

Fig. 1 Grid cells of $1^\circ \times 1^\circ$ and $2^\circ \times 1^\circ$ used in the analyses

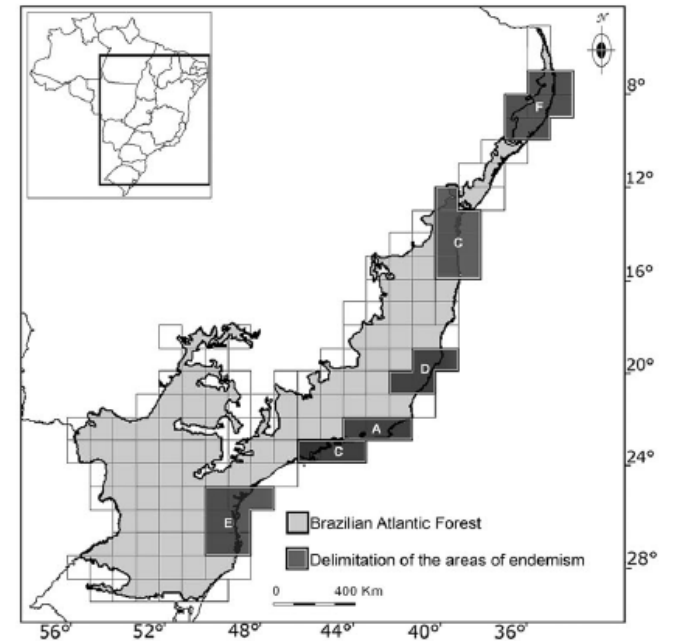
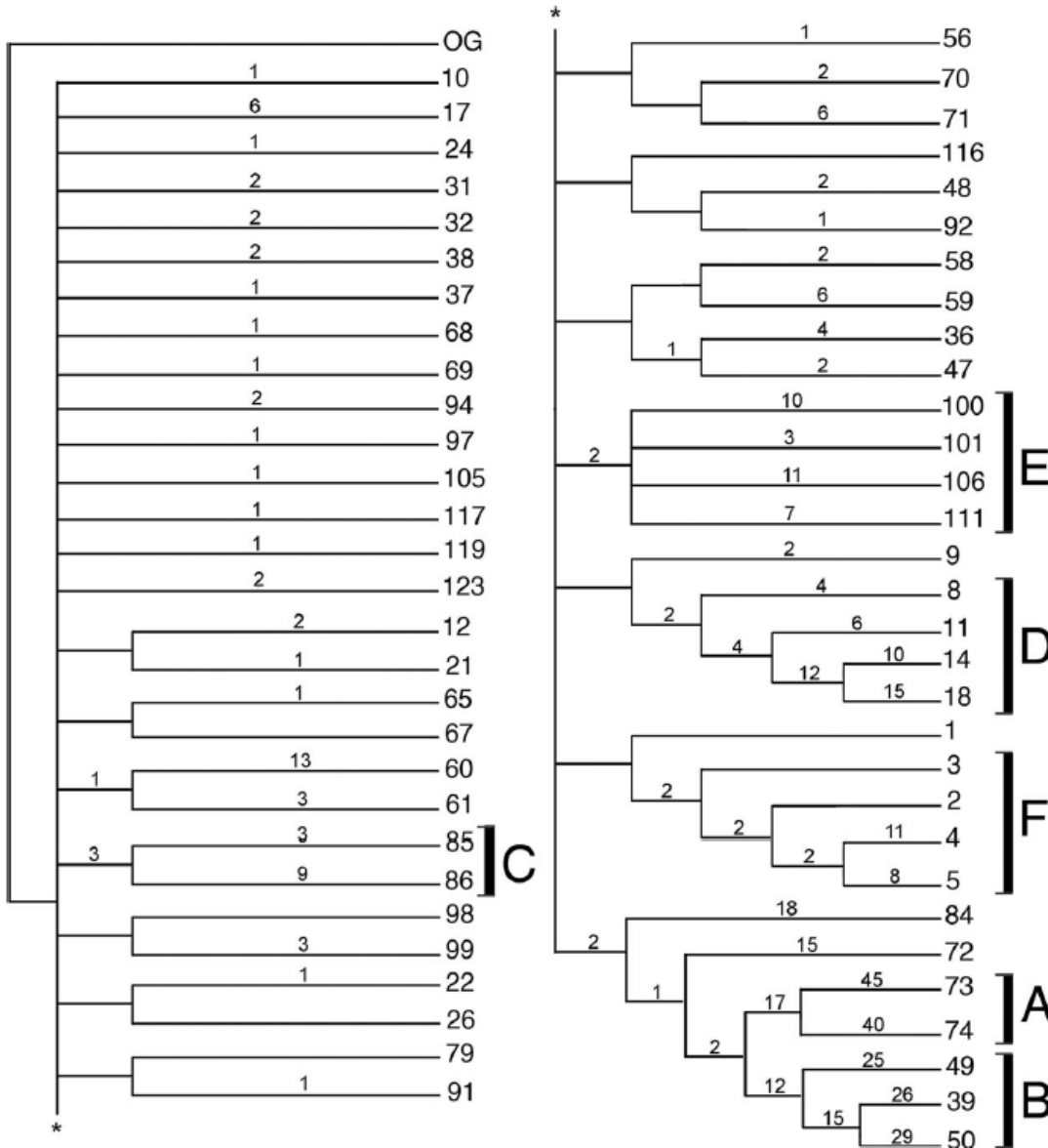
**Áreas de Endemismo
da
Mata Atlântica
(análise baseada
em EPÍFITAS)**

Menini Neto et al. 2015



Áreas de Endemismo da Mata Atlântica (análise baseada em EPÍFITAS)

Menini Neto et al. 2015

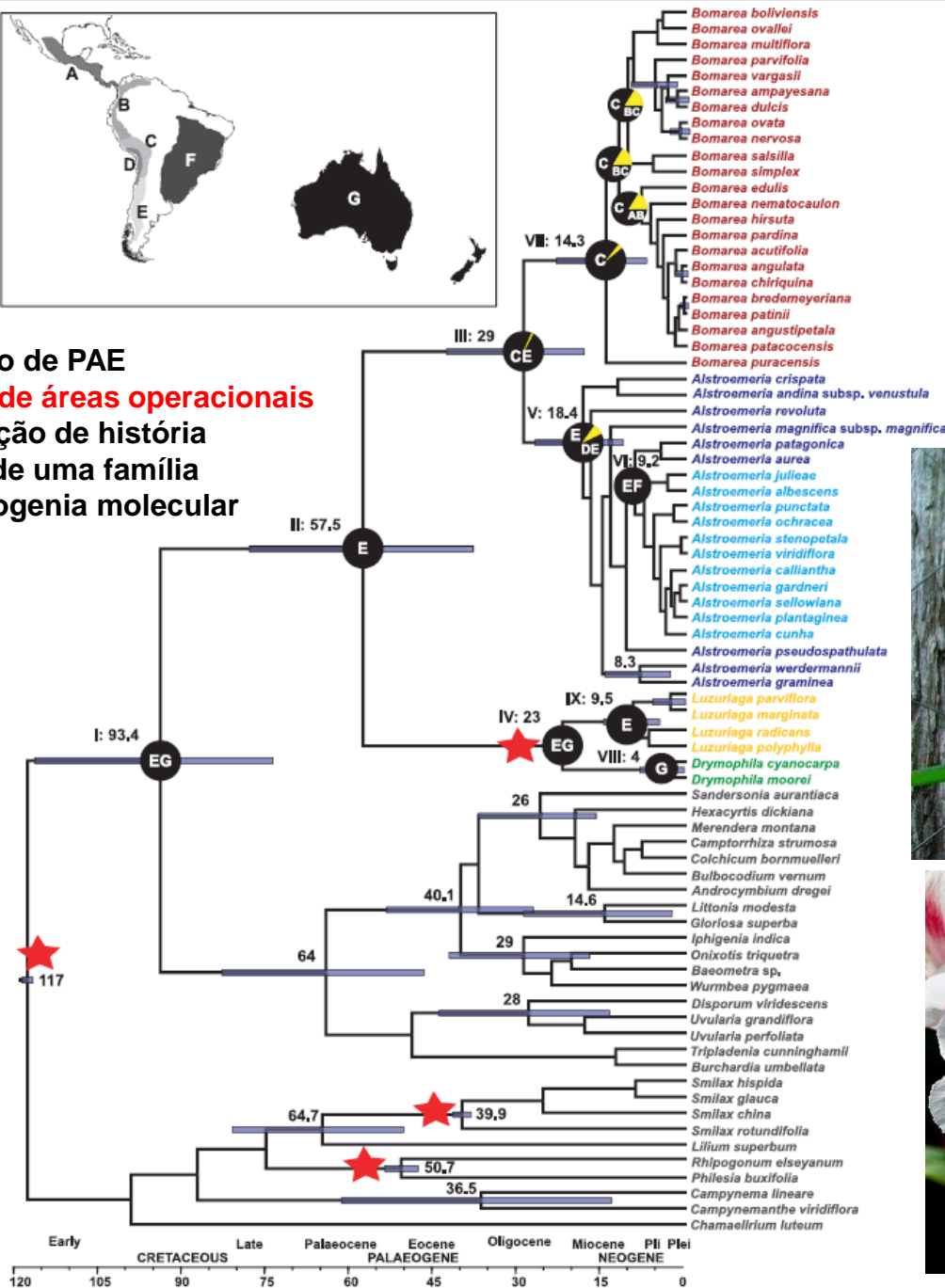




From East Gondwana to Central America: historical biogeography of the Alstroemeriaceae

Chacon et al. 2012

Exemplo de uso de PAE
para **obtenção de áreas operacionais**
para reconstrução de história
biogeográfica de uma família
baseada em filogenia molecular



Parsimony analysis of endemism as a panbiogeographical tool: an analysis of Caribbean plant taxa

AMPARO ECHEVERRY and JUAN J. MORRONE

2010

2 data matrices of 40/38 biogeographic provinces X 148 plant species from the Caribbean subregion of the Neotropical region,

one where taxa are represented by individual tracks and the other where taxa are represented by single sample localities.

6 generalized tracks resulted from the PAE of the areas X individual tracks matrix,
1 generalized track from the PAE of the areas X single sample localities matrix,
with the latter nested within the former tracks.

The results obtained show that PAE works as a panbiogeographical tool if it is based on an areas X individual tracks matrix.

Performed in this way, PAE retrieves spatial information that is lost when it is based on an areas X single sample localities matrix, raising doubts regarding the conclusions derived from this latter type of analysis

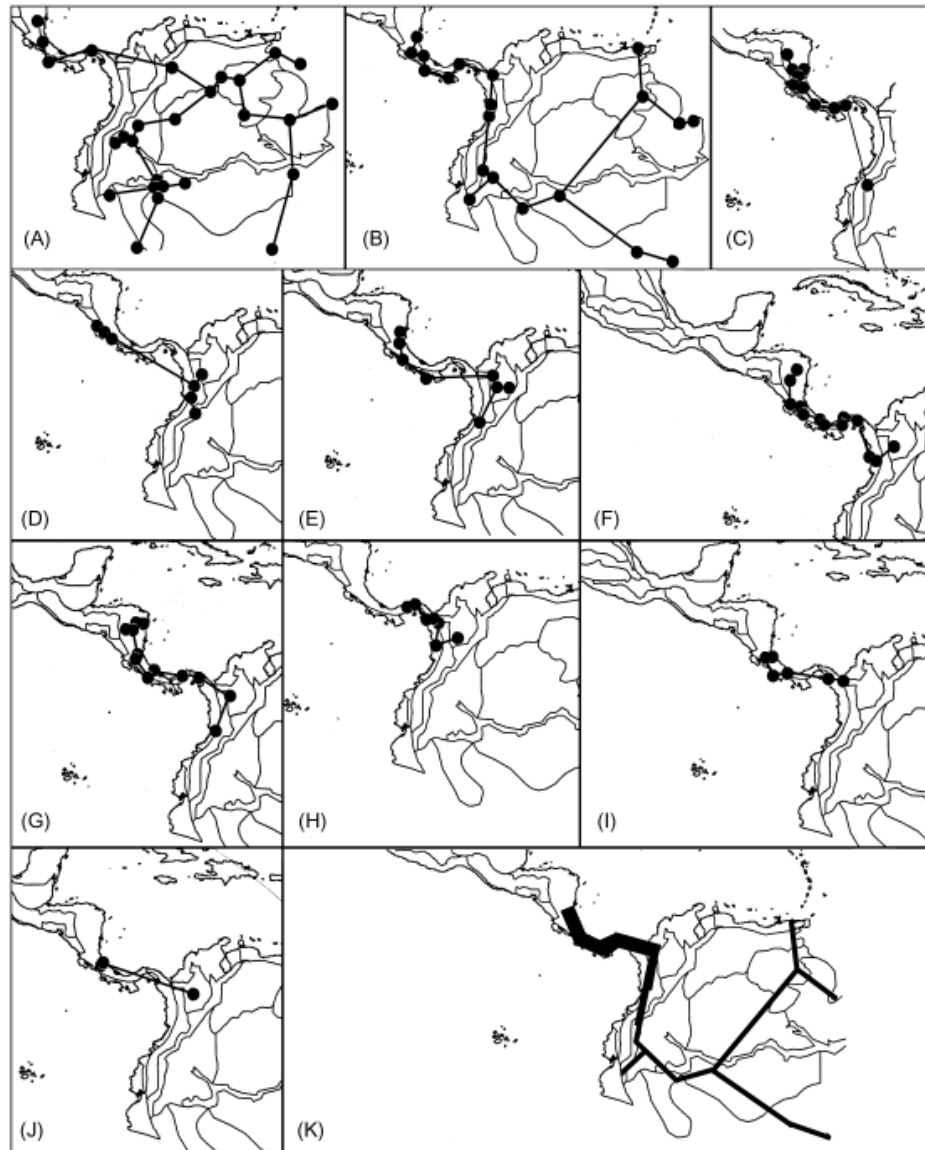


Figure 6. Species distribution (A, B, C, D, E, F, G, H, I, J) supporting the generalized tracks (K, L) identified by PAE from the areas X individual tracks matrix. A, *Inga alba*. B, *Inga sertulifera*. C, *Anthurium consobrinum*. D, *Inga sierrae*. E, *Ocotea aurantiadora*. F, *Philodendron ligulatum*. G, *Inga goldmanii*. H, *Inga mucuna*. I, *Anthurium clidemioides*. J, *Inga latipes*. K, four generalized tracks (with the relative thickness representing the three tracks nested within the other).

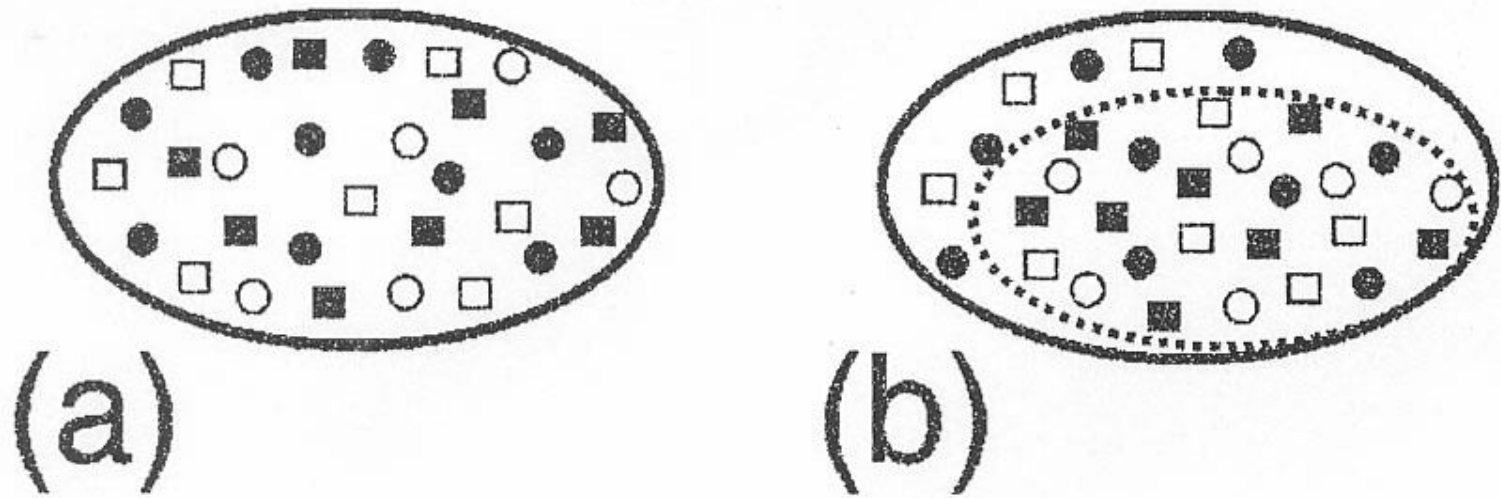


FIGURE 1. Examples of ideal (a) and realistic (b) distributions of species endemic to an area. (a) The two species (black squares and white circles) occupy all the area. (b) Both species are confined to some sector of the area (stippled).

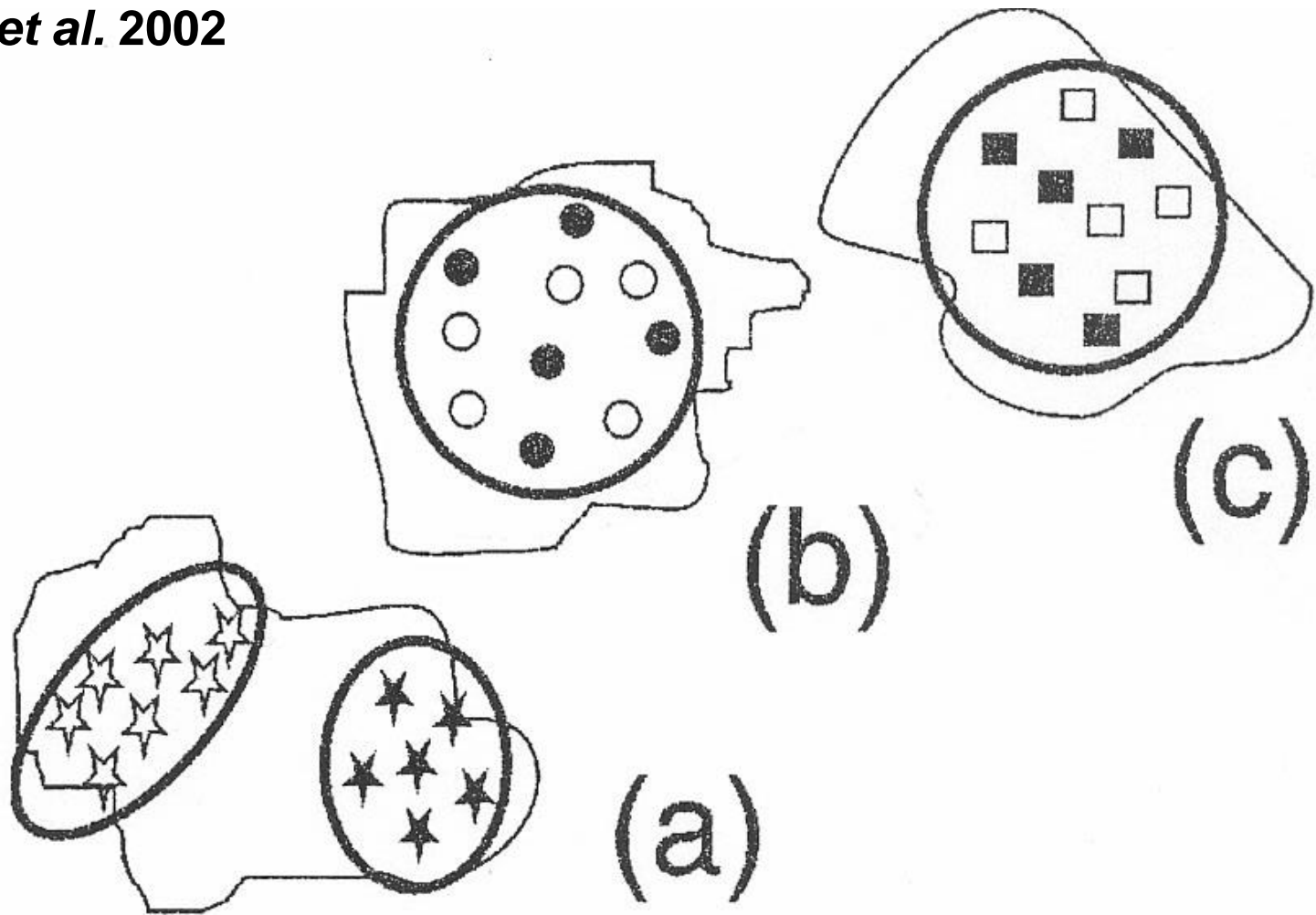


FIGURE 2. Distributions of species inhabiting islands (a, b, c). Redrawn from Harold and Mooi (1994: Fig. 2).

Szumik *et al.* 2002

Um método para determinação de AEs baseado em critério explícito de otimização deve prover meios de alcançar um valor de endemicidade para uma determinada área.

Para diferentes definições de uma área, haverá números diferentes de spp. que poderão ser consideradas endêmicas.

4 possíveis critérios para determinar uma AE de acordo com a presença das spp. nas quadrículas da grade:

1 e 2 : mais restritivos (conceito ideal de endemismo, exigindo alta congruência entre distr. das spp. e a área)

3 e 4: menos rigorosos (mas mais realista, permitindo certa incongruência).

Szumik *et al.* 2002

Critério de otimização para determinar AEs

Critério 1:
 sp contribui para a formação da AE se estiver restrita à área e cada quadr. tiver a mesma composição específica.

Critério 2:
 Similar ao 1, mas a sp pode contribuir mesmo se ocorrer também em quadr. fora mas adjacente à area proposta

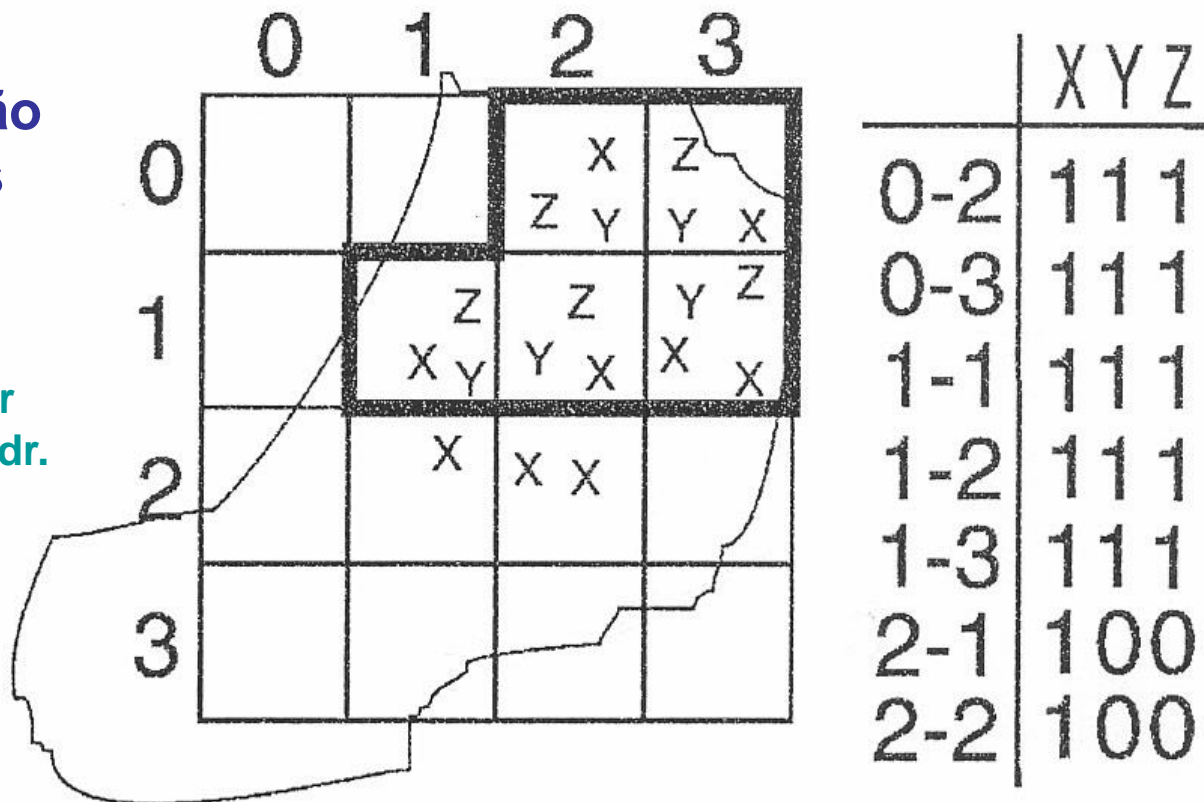


FIGURE 3. An area (including five grid cells) with score 2 under criterion 1 and score 3 under criterion 2. Under criterion 1, species X, even if occurring in each cell of the area, does not contribute to the score because it is also found in cells outside the area. Under criterion 2, species X contributes to the score. All the cells in the area have identical species composition.

Szumik *et al.* 2002

Critério de otimização
para determinar AEs

Critério 3:
Permite que as
quadr. tenham
composição específica
diferente, mas a sp
contribui apenas
se estiver em
todas as quadr.

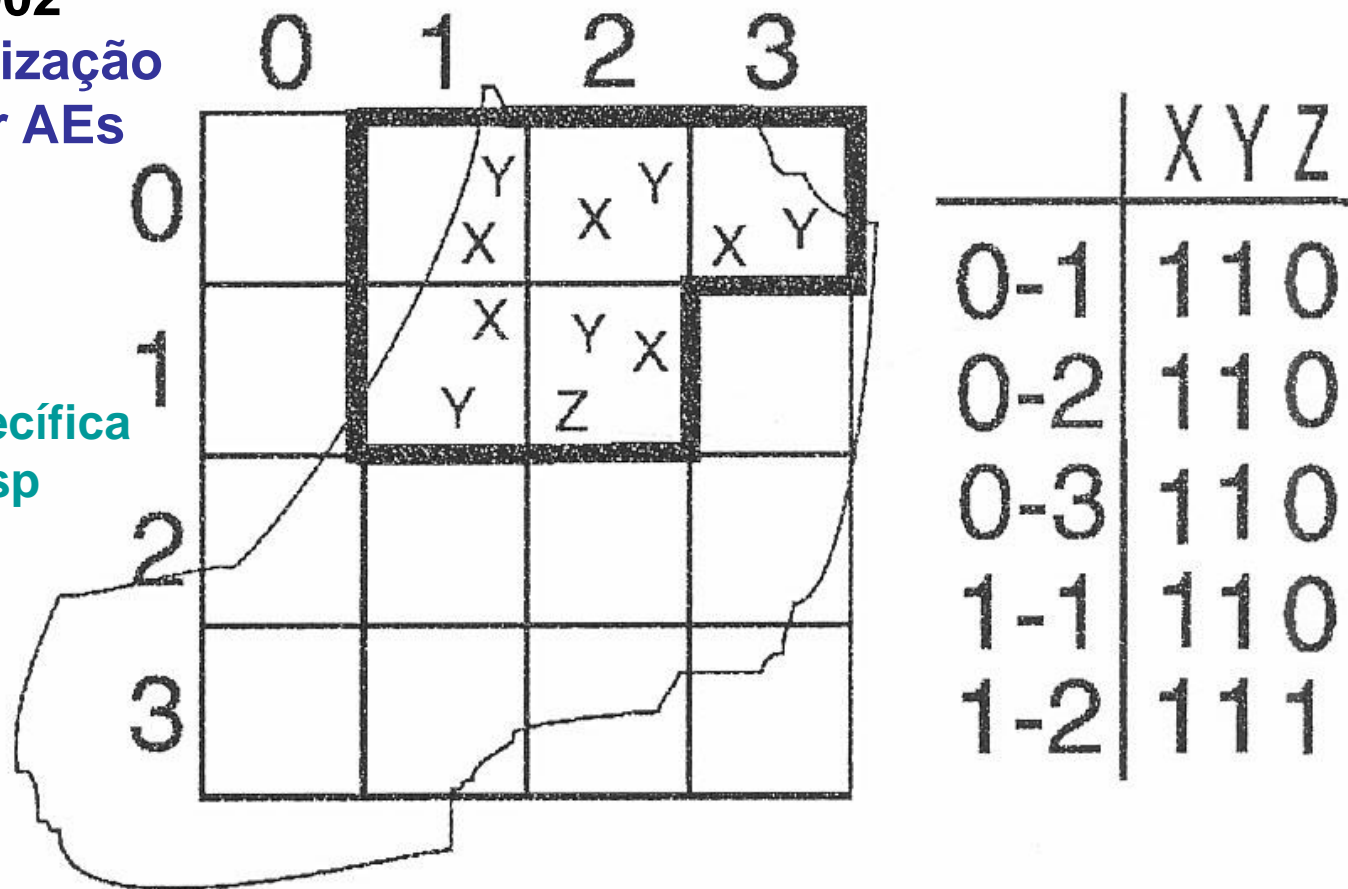


FIGURE 4. An area with score 2 under criterion 3. Not all cells in the area have identical species composition. Species X and Y contribute to the score; species Z does not because it is found in only some cells of the area.

Szumik *et al.* 2002

Critério de otimização
para determinar AEs

Critério 4:
Permite que uma sp
contribua para a
demilitação da AE
mesmo se estiver
ausente em
alguma das quadr.

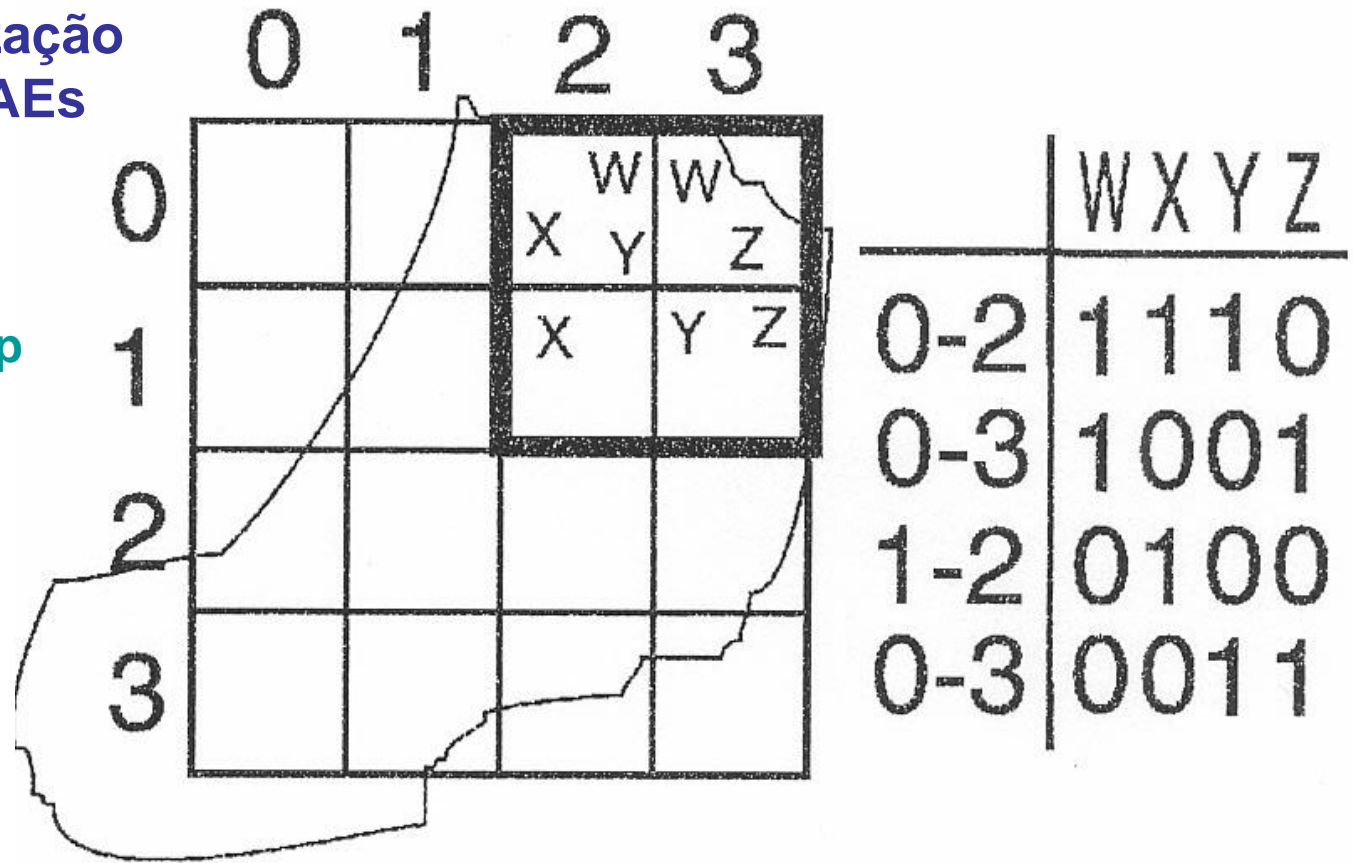


FIGURE 5. An area with score 4 under criterion 4. None of the species are found in every cell of the area, but all satisfy the requirement of having no more than seven empty cells around a given cell in the area and having at least one adjacent cell occupied.

Szumik *et al.* 2002

Critério de otimização
para determinar AEs

Algoritmos eurísticos
NDM
NDM-VNDM*
(Goloboff 2001, 2007)

•VNMD permite
visualização
e diagnóstico,
por ex. quais spp.
contribuíram
para o escore
mais elevado

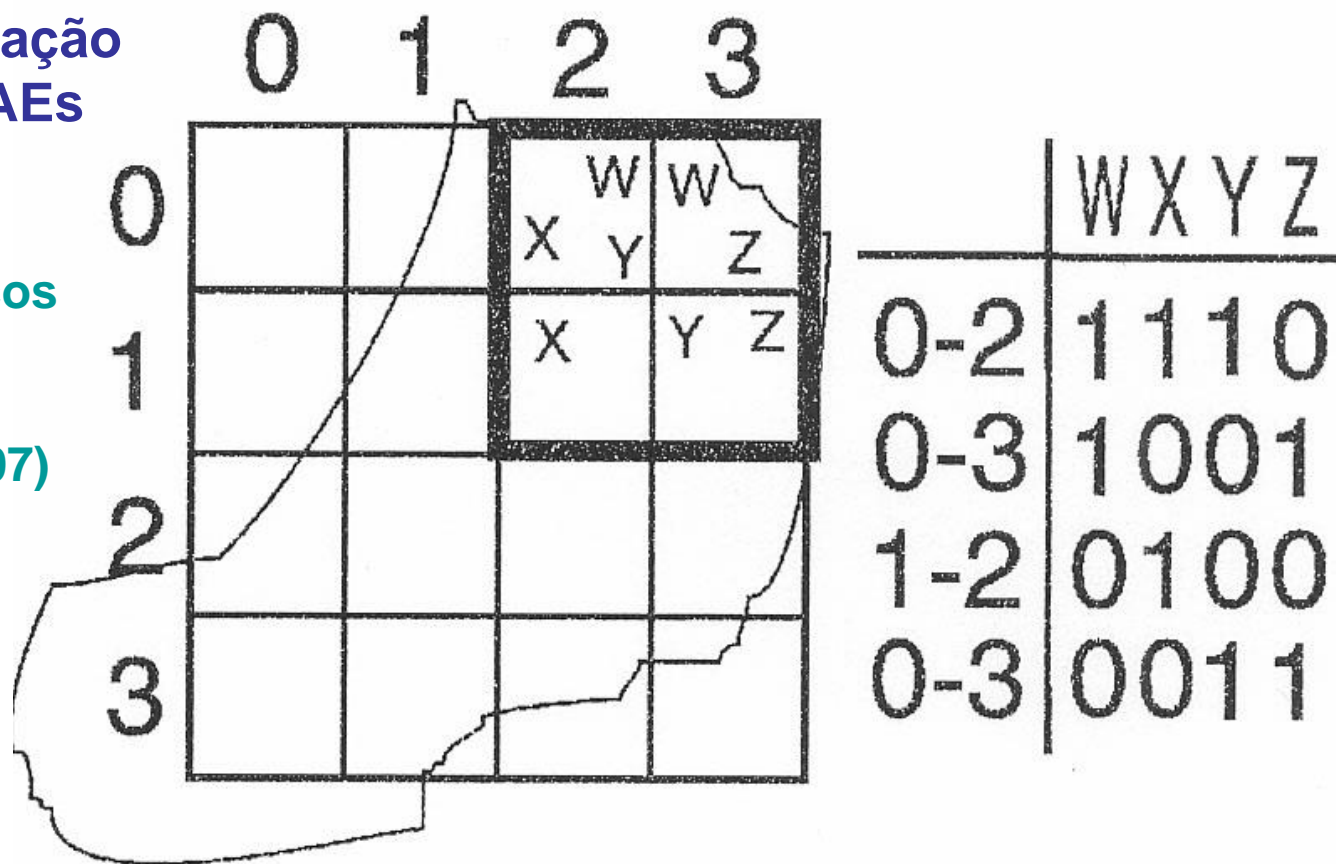


FIGURE 5. An area with score 4 under criterion 4. None of the species are found in every cell of the area, but all satisfy the requirement of having no more than seven empty cells around a given cell in the area and having at least one adjacent cell occupied.

Phylogenetic endemism: a new approach for identifying geographical concentrations of evolutionary history

DAN ROSAUER,^{*,†} SHAWN W. LAFFAN,^{*} MICHAEL D. CRISP,[‡] STEPHEN C. DONNELLAN,^{§,¶} and LYN G. COOK^{**}

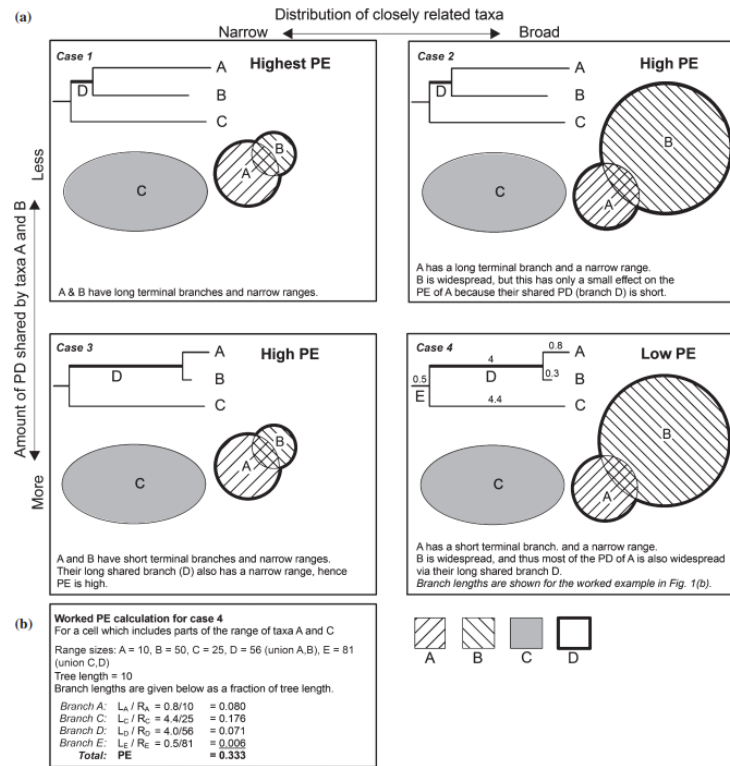


Fig. 1 (a) Estimating phylogenetic endemism (PE) in four simple cases. In each case, we show the ranges of three taxa and the PE of an area where only taxon A is found. Two parameters are varied: the range size B, and the amount of PD shared by A and B. The range size of C affects PE in this case through the range of the branch it shares with D. PE varies as a consequence of branch length and range size of each clade, including terminal taxa. (b) A worked example estimating PE based on the parameters and ranges in case 4 in Fig. 1a. Branch lengths are given above the lines. Terms as in eqn 3. In this case, we assume that the calculation includes parts of the ranges of taxa A and C, while species B is absent, but is found elsewhere in the study area. While taxon B is absent from this location, its range affects the PE estimation through the range of branch D.

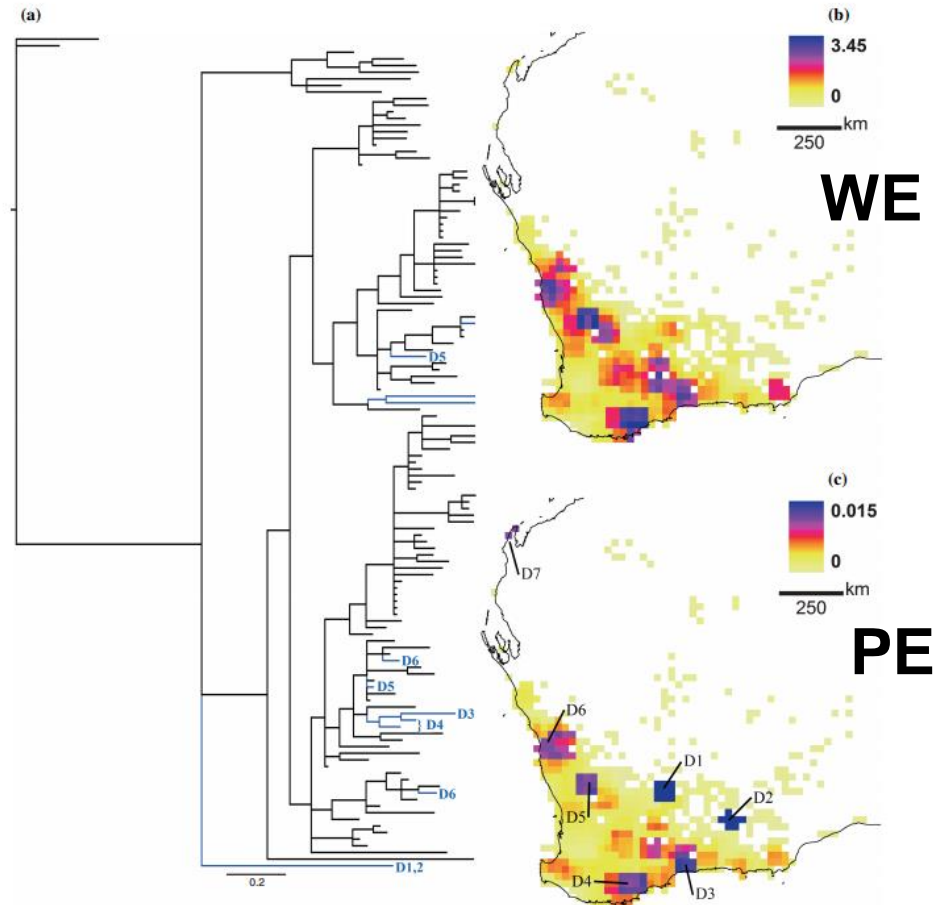


Fig. 3 (a) A Bayesian phylogeny for *Daviesia* derived from ribosomal DNA ITS sequence data. Those branches contributing the majority of the PE score at each of the numbered locations in (c) are coloured in blue. (b) Weighted endemism and (c) PE in *Daviesia*, south-west Western Australia; 0.25° cells, nine-cell neighbourhood. Numbered areas of high PE are given in Table 1.

Rosauer et al. 2009

Daviesia - Austrália

Detecting areas of endemism with a taxonomically diverse data set: plants, mammals, reptiles, amphibians, birds, and insects from Argentina

Table 1
Number of orders, families, genera, and species for each major taxonomic group analysed

	Orders	Families	Genera	Species
Plants	27	45	115	187
Insects	5	30	177	300
Reptiles	1	6	21	89
Amphibians	1	5	20	41
Birds	9	18	46	49
Mammals	10	25	84	140
Total	53	129	463	805

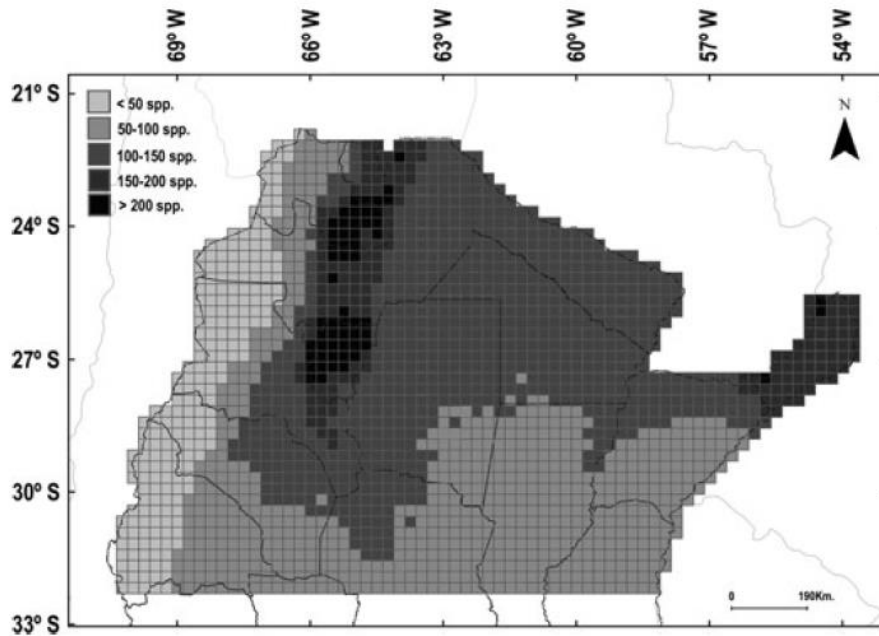


Fig. 2. Species diversity in the study region on cells of $0.25 \times 0.25^\circ$.

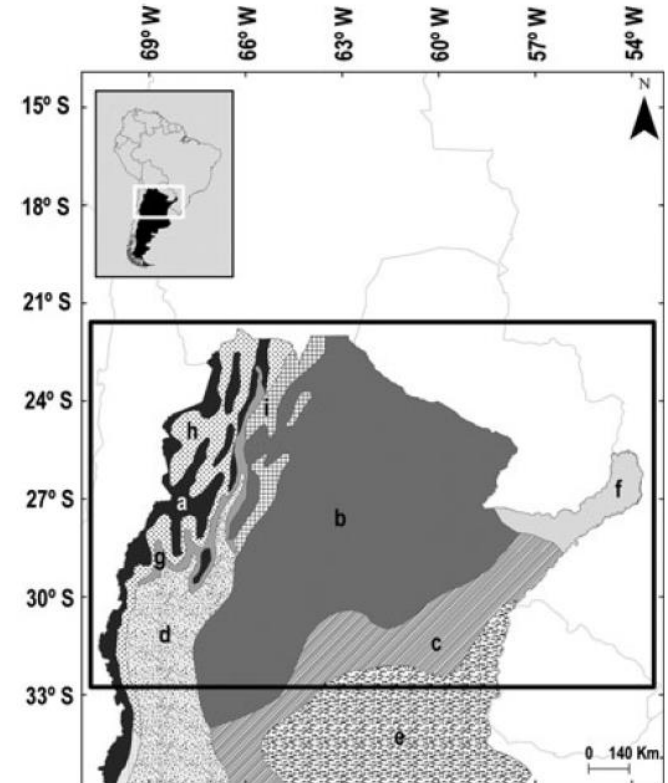


Fig. 1. Biogeographical divisions for the study region according to Cabrera and Willink (1973).

In total, 126 consensus areas (Table 2) were obtained, 24 (19%) of which were defined by a single taxonomic group (mostly plants or insects, and rarely by mammals or amphibians). In all these areas with a unique taxonomic group, however, the endemic taxa belonged to different genera, families, and orders. Overall, 47.6% of the consensus areas were supported by three or more taxonomic groups when comparing the total of 126 consensus areas under the three different grid sizes (Table 2). Instead of discussing each of the resulting areas found by the present analysis (beyond the scope of the present paper), it is our aim to discuss those areas

well supported by all or most of the different taxonomic groups used, illustrating cases where endemism can indeed be supported by widely different groups of taxa. Two such areas (supported by the six taxonomic groups) are the Atlantic Forest (Selva Paranaense—Neotropical, Fig. 3) and the north Yungas sector (tropical Bermejo-Toldo-Calilegua, Fig. 4). Both of these areas are recovered in all grid sizes and in every case were supported by the six major taxonomic groups included in the data set (see Appendices 2 and 3).

Topographically, the study region consists of lowland plains that rise from approximately 70 m in the east to approximately 300 m in the west, and the Andes in the west with deep valleys and peaks reaching above 6000 m. The complexity of the western part of the region is directly reflected in the higher number of consensus areas found west of 64°W, compared with the number found east of the same longitude (see Table 3). Consensus areas that extend both east and west of 64°W appear more clearly when the cell size is increased, which helps detect wide-ranging distribution patterns such as the Chaco scrubland (Fig. 5a).

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Table 2

Relationship between number of major taxonomic groups (6 to 1) supporting any of 126 consensus areas obtained for the three grid sizes

No. of taxonomic groups	Grid size			No. (%) of consensus areas
	0.25°	0.5°	1.0°	
6	2	4	3	9 (7.1)
5	1	1	6	8 (6.4)
4	2	5	10	17 (13.5)
3	2	8	16	26 (20.6)
2	13	17	12	42 (33.3)
1	9	8	7	24 (19.0)
Total	29	43	54	126

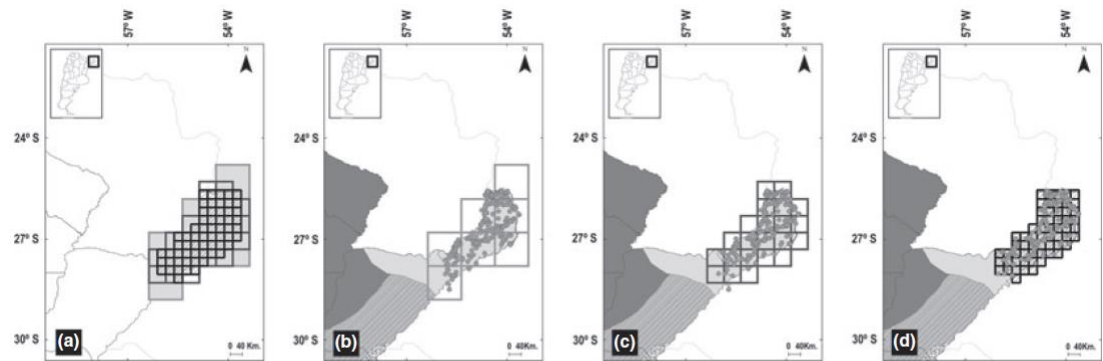


Fig. 3. Atlantic Forest. (a) Concordance between the consensus areas of the three grid sizes; (b) consensus area under 1° grid size; (c) consensus area under 0.50° grid size; (d) consensus area under 0.25° grid size.

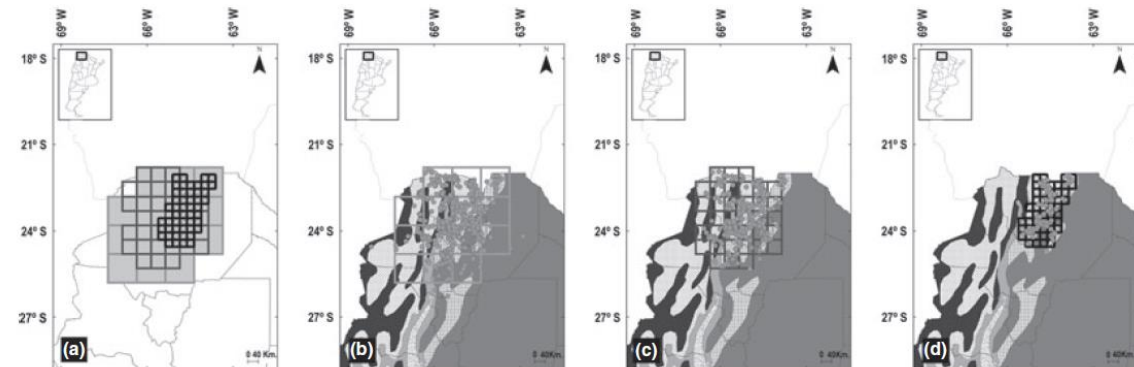


Fig. 4. Northern Yungas. (a) Concordance between the consensus areas of the three grid sizes; (b) consensus area under 1° grid size; (c) consensus area under 0.50° grid size; (d) consensus area under 0.25° grid size.

ÁREAS DE ENDEMISMO

Táxon endêmico = restrito a uma região

Área de distribuição do táxon é determinada tanto por eventos históricos como atuais.

Quaisquer sejam os fatores causais responsáveis pela área de distr., se eles afetam (ou afetaram) de modo semelhante grupos taxonômicos diferentes, haverá congruência de padrões de endemividade em diferentes grupos.

Portanto, áreas que têm muitos grupos diferentes encontrados ali e em nenhuma outra parte podem ser definidas como AEs!

Ou seja, o conhecimento dos fatores que ocasionaram processos de especiação (ou extinção) similares não é pré-requisito para a identificação da existência da AE!!



SEBA

SYSTEMATIC AND EVOLUTIONARY
BIOGEOGRAPHICAL ASSOCIATION

International Code of Area Nomenclature (ICAN) - Online

Submitted by admin on Wed, 11/21/2007 - 09:07. [ICAN](#) | [SEBA](#)

INTERNATIONAL CODE OF AREA NOMENCLATURE

Paris Code, 2007

Prepared and edited by the ICAN Committee Chair: Malte C. Ebach (Berlin) Members: Juan J. Morrone (Mexico City), Lynne R. Parenti (Washington DC) and Ángel L. Vilorio (Caracas).

The ICAN Forum is aimed at SEBA members to discuss the ICAN and post suggestions and comments. Please click [here](#) to join.

Please note that the printed version of the ICAN is published in the [Journal of Biogeography](#): Ebach, M.C., Morrone, J.J., Parenti, L.R. & Vilorio, Á.L. (2008) International Code of Area Nomenclature *Journal of Biogeography*. 35 (7) , 1153–1157.

PREAMBLE

1. An area of endemism is a geographical unit inferred from the combined distributions of endemic taxa.
2. Biogeography currently has no formal naming system by which to compare areas of endemism.
3. The International Code of Area Nomenclature (herein ICAN) provides a universal naming system to standardize area names used in biogeography and other disciplines.
4. A naming system or nomenclature as proposed in this document requires ratification by two-thirds majority of the council members of the *Systematic and Evolutionary Biogeographical Association* (herein SEBA), voting either in-person, on-line, by letter or by proxy.

SECTION A: OBJECTIVES, INTENTION AND EXCEPTIONS

Article 1: Objectives

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Box 3.1 International Code of Area Nomenclature (ICAN)

In 2007, the Systematic and Evolutionary Biogeographical Association (SEBA) drafted and adopted the first International Code of Area Nomenclature (ICAN). The code is based loosely on the International Code of Zoological Nomenclature. Its purpose is to stabilize the names of areas in biogeographic analyses (Viloria, 2004:164, 2005; Ebach et al., 2008). The aim is to have each name represent a biotic area that is accompanied by a diagnosis and description. The ICAN does not dictate how a classification is built (artificial versus natural or monophyletic) nor does it give preference to any particular method (e.g., species concept) used to diagnose taxa, and hence areas. The latest version of the ICAN is available at www.seba.uac.pt.