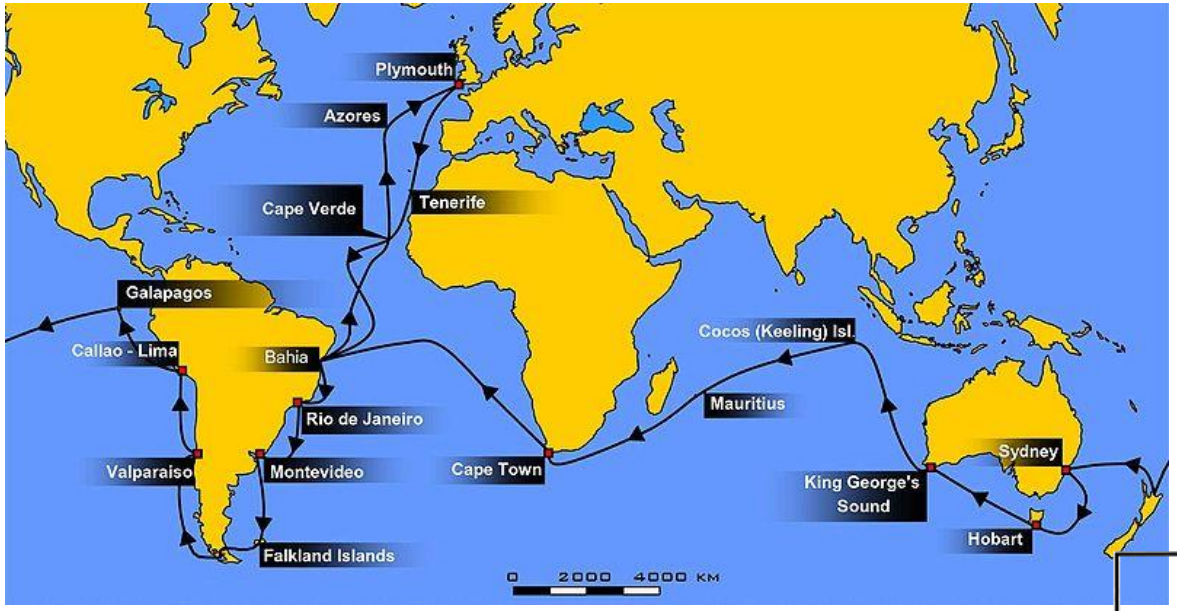
Proměnlivost a evoluce rostlin

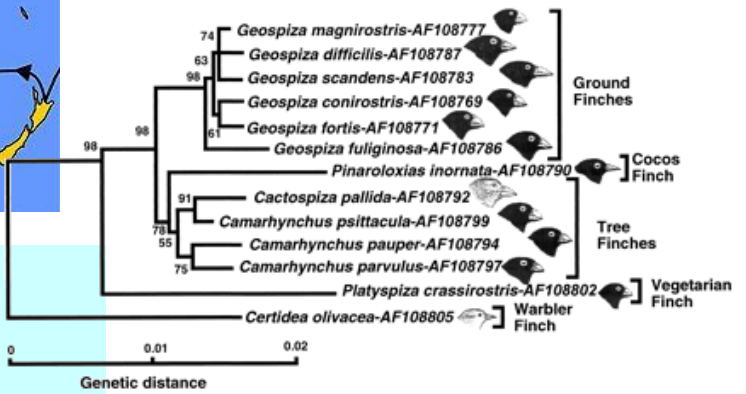
Petr Smýkal
Katedra botaniky, PřF UPOL
2013/14

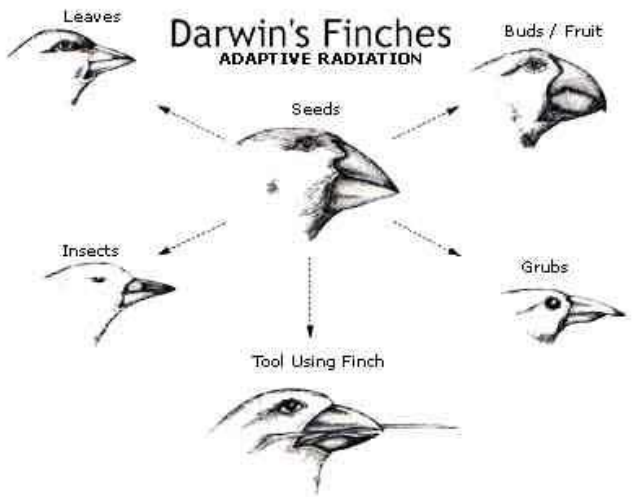
Ostrovy a vznik nových druhů

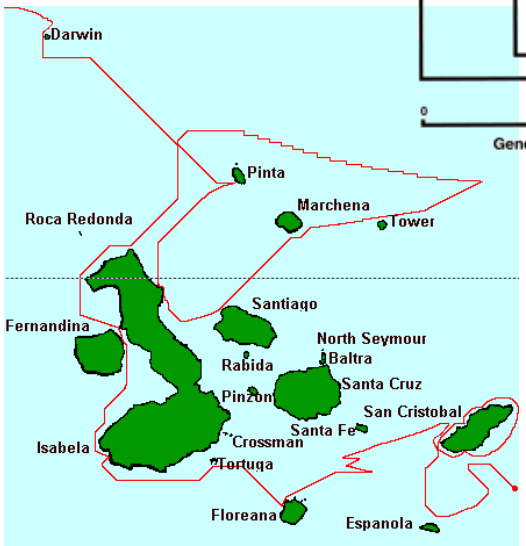
Charles Robert Darwin
(1809-1882)

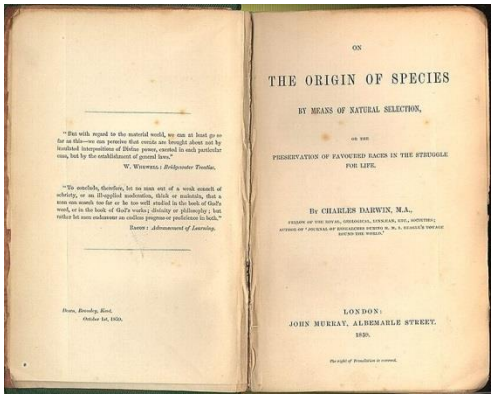


1831- 1836 výzkumná cesta kolem světa na lodi HMS Beagle









Predátoři – diverzifikující selekce na tělesnou velikost; při absenci:

ostrovní gigantismus

Aepyornis, Madagaskar, 400 kg, 3m

suchozemské želvy, ještěrky, běžci, holubi, plši, lemuři

ostrovní nanismus

sloni, ostrovy středozemního moře

„Megaherbs“ – New Zealand

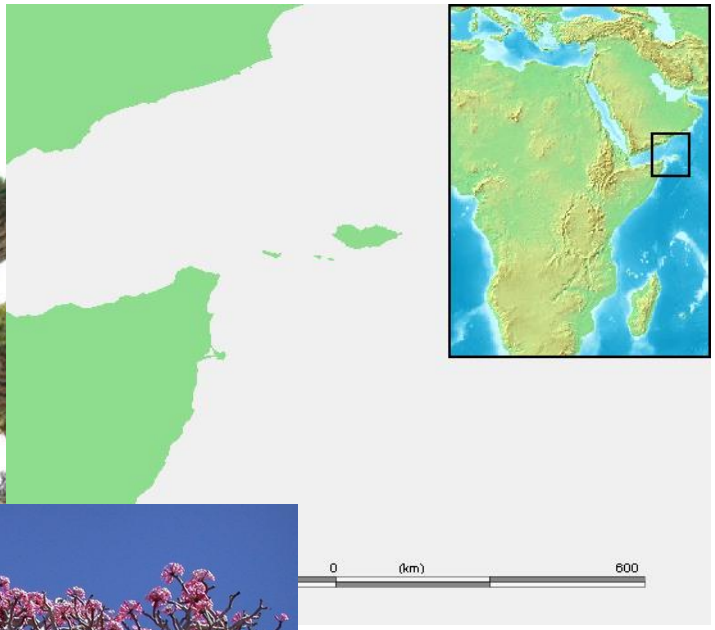
Sir James Clark Ross, 1839 – 1843 Antarctic expedition and botanist Sir Joseph Hooker

Bulbinella rossii (Ross Lily).
Anisotome latifolia (Campbell Island Carrot)
Pleurophyllum speciosum (Campbell Island Daisy)
Pleurophyllum hookeri and Pleurophyllum criniferum

Ostrov Sokotra

240 kilometres east of the Horn of Africa and 380 kilometres south of the Arabian Peninsula.

Dracaena cinnabari

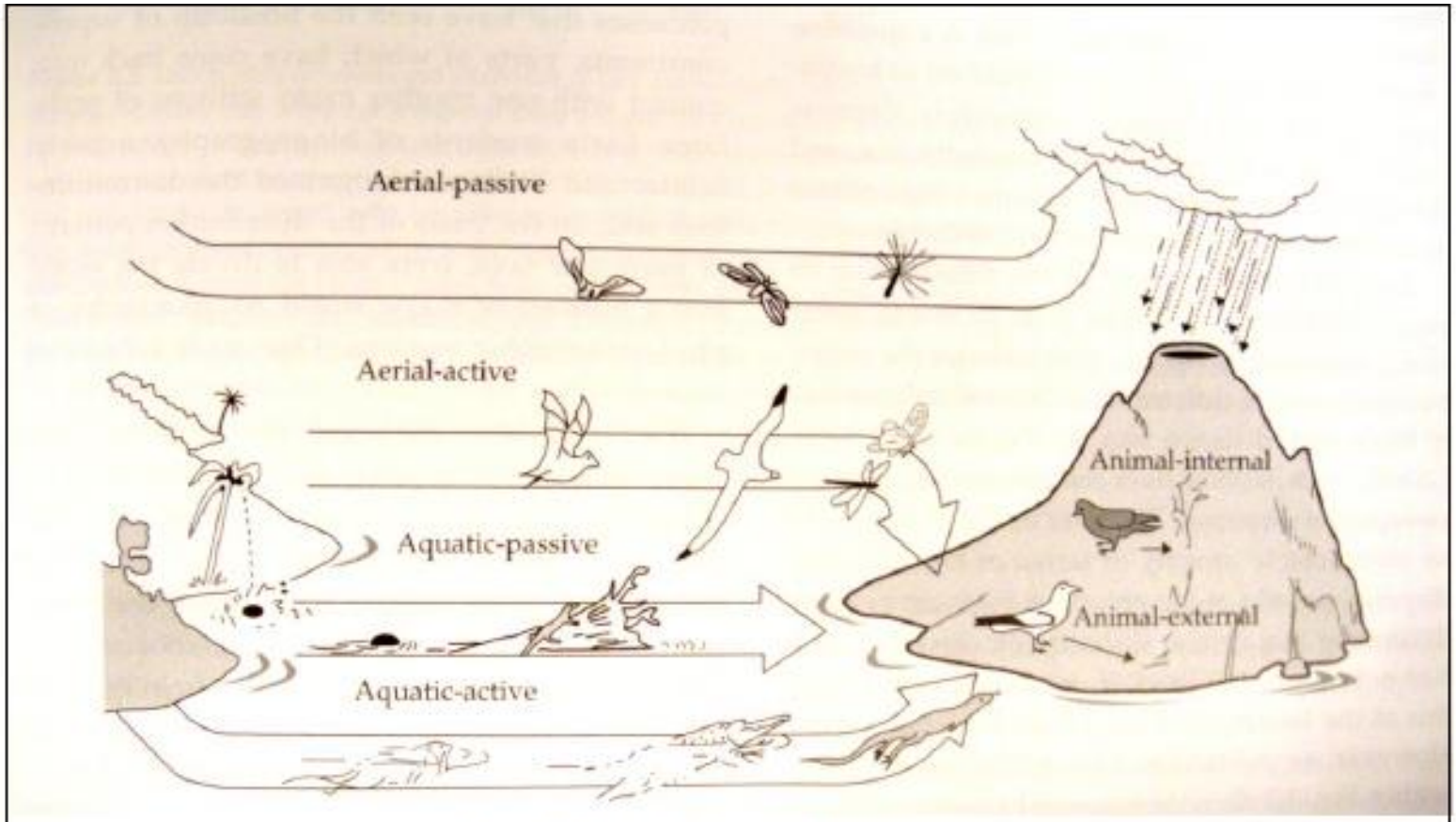


825 druhů rostlin,
307 endemitických

Adenium obesum socotranum

Dorstenia gigas, Dendrosicyos socotranus, Punica protopunica, Aloe perryi, Boswellia socotrana.

Zdrojem ostrovní bioty je disperze



Typy kolonizačních dispersí

pasivní (aeroplankton, rafting) vs. aktivní,

rostliny: **anemochorie, zoochorie (endo-, exo-), thalasochorie** (moře – např. kokos)

Doba vzniku ostrova a počet osídlených druhů

Krakatoa (Rakata) :

10.6km², 40 km od Jávy,

•1883-výbuch;

1889 40 členovců (zejm. pavouci, štírci, roztoči) , 2 plazi, 16 ptáků;

1897 62 druhů vyšších rostlin,

1906 114 spp. rostlin;

1923 500 členovců, 7 měkkýšů, 3 plazi, 26 ptáků, 3 savci.

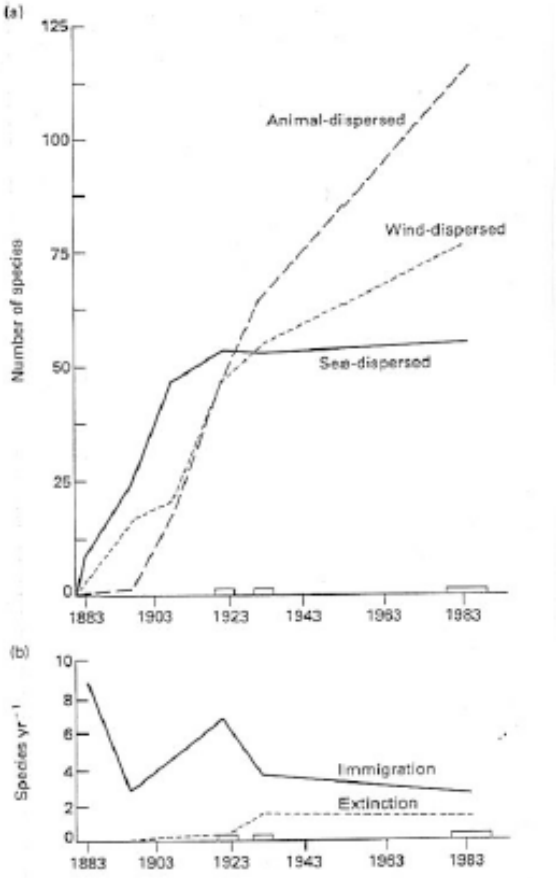


Fig. 6.5 History of the Rakata higher plant flora since 1883, excluding human introductions. (a) modes of dispersal (b) rates of immigration and extinction. After Bush & Whittaker [18].

Darwinovy pěnkavy (Geospizinae, 15 druhů)

nápadné korelace fenotyp - prostředí

Genus *Geospiza*

- Large Cactus Finch, *Geospiza conirostris*
- Sharp-beaked Ground Finch, *Geospiza difficilis*
  - Vampire Finch, *Geospiza difficilis septentrionalis*
- Medium Ground Finch, *Geospiza fortis*
- Small Ground Finch, *Geospiza fuliginosa*
- Large Ground Finch, *Geospiza magnirostris*
  - Darwin's Large Ground Finch, *Geospiza magnirostris magnirostris*
- Common Cactus Finch, *Geospiza scandens*

Genus *Camarhynchus*

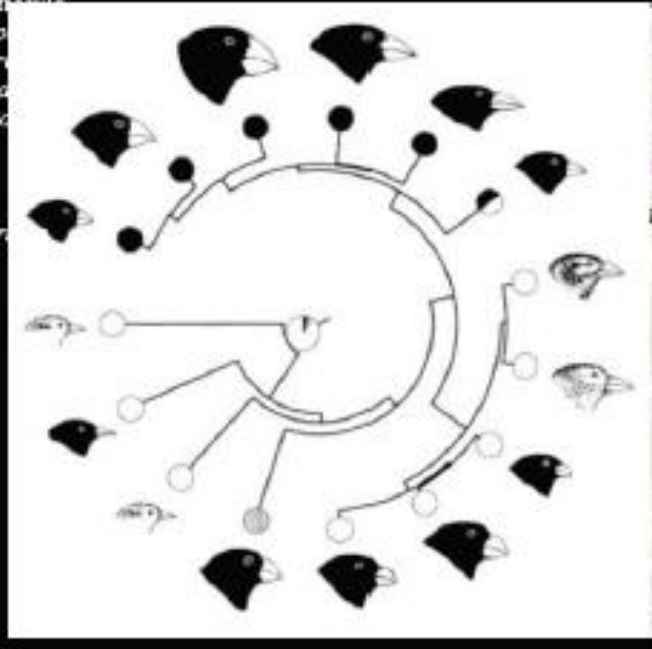
- Vegetarian Finch, *Camarhynchus crassirostris*
- Large Tree Finch, *Camarhynchus psittacula*
- Medium Tree Finch, *Camarhynchus p*
- Small Tree Finch, *Camarhynchus par*
- Woodpecker Finch, *Camarhynchus pa*
- Mangrove Finch, *Camarhynchus heli*

Genus *Certhidea*

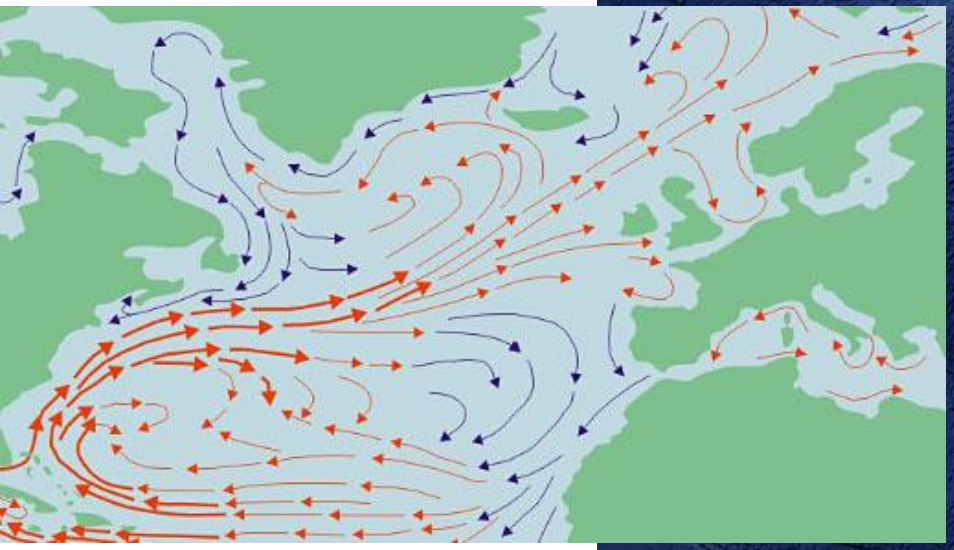
- Warbler Finch, *Certhidea olivacea*

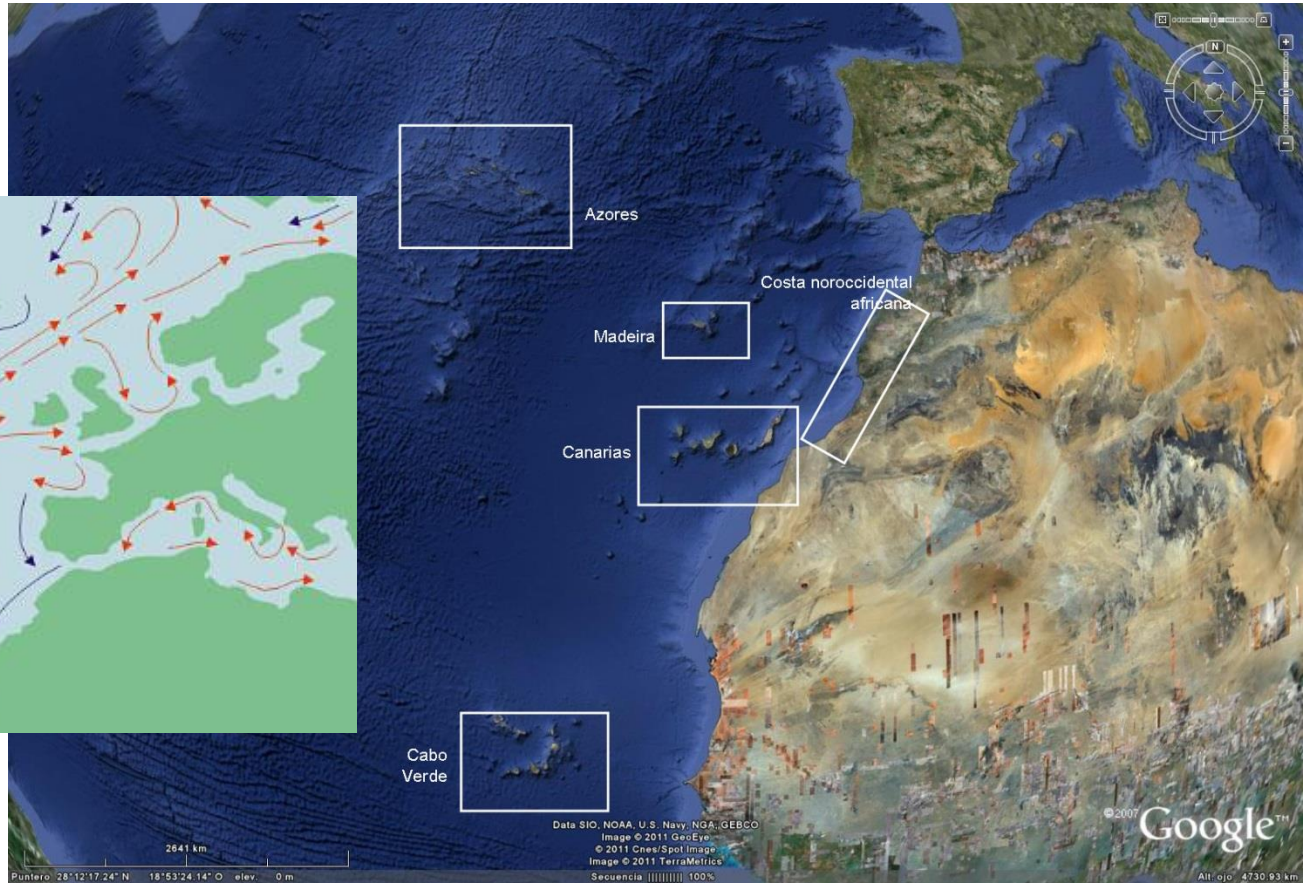
Genus *Pinarolaxias*

- Cocos Island Finch, *Pinarolaxias inor*



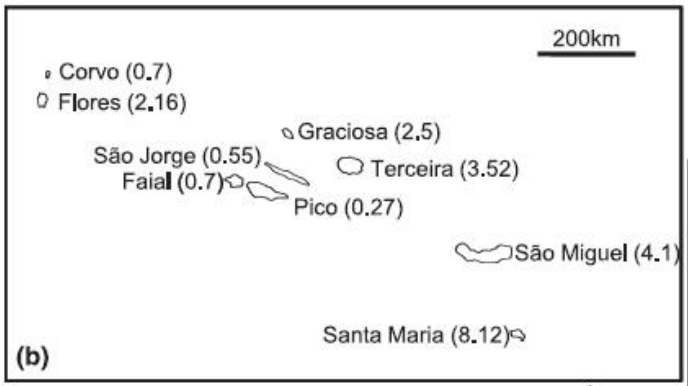
Makaronézie

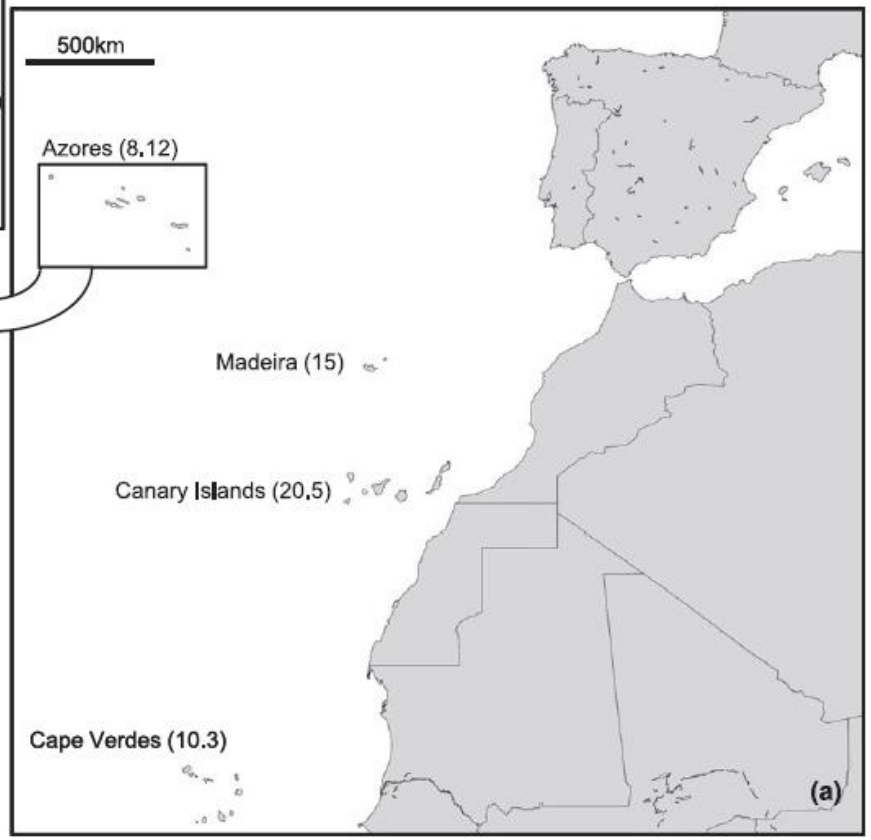




Azorské ostrovy

The Azores are a volcanic, oceanic archipelago of nine islands located in the North Atlantic Ocean, on a WNW–ESE axis between 37° and 40° N, and 25° and 31° W (Fig. 1). The archipelago spans 615 km and is approximately 1300 km west of mainland Portugal, 1600 km east of North America and 800 km north-west of Madeira. It is composed of a western group of two islands (Flores, Corvo), a central group of five islands (Faial, São Jorge, Graciosa, Pico and Terceira) and an eastern group of two islands (São Miguel and Santa Maria;





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Azorské ostrovy

9 ostrovů , 650 km

Azorské ostrovy

811 druhů rostlin, z nichž 24% (197) je původních,
70 druhů endemických, z nichž u 38 rodů je jen jeden endemický druh,
7 rodů má dva endemické druhy a 3 rody mají 3 endemické druhy

Biogeograficky Azorské ostrovy společně s Capo Verde, Kanárskými ostrovy, Salvage Island a Madeirou tvoří **Makaronésii**

Kanárské ostrovy: nejrozsáhlejší endemický rod *Aeonium (Crassulace)* 32 druhů

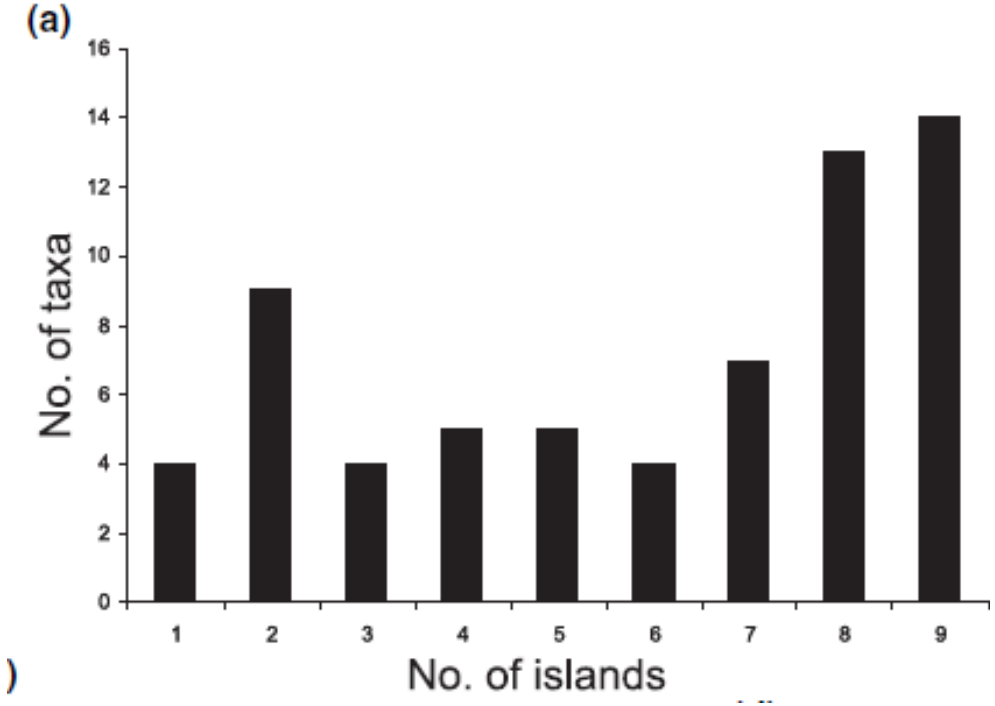
Madeira: *Sinapidendron (Brassicaceae)* 6 druhů

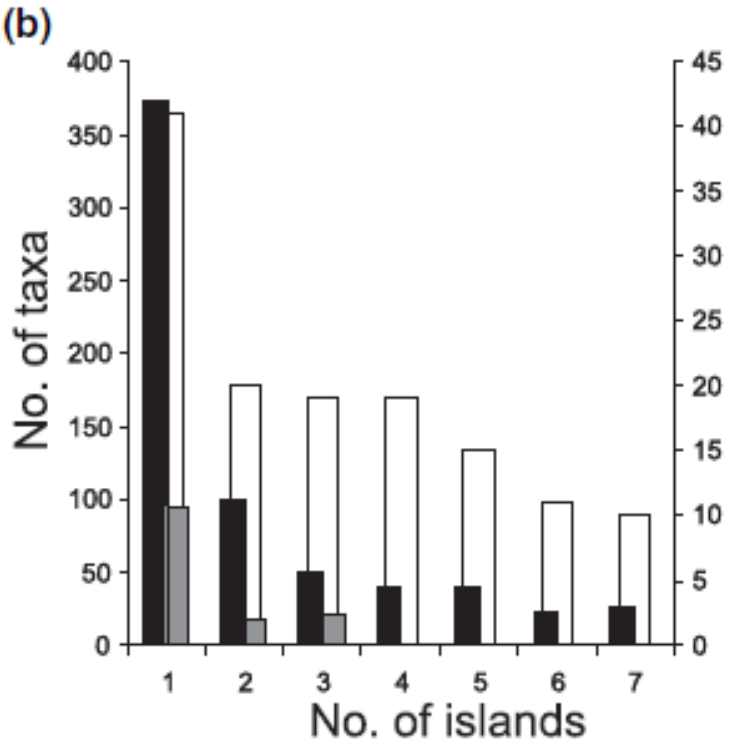
Capo Verde: *Diplotaxis (Brassicacea)* 9 druhů

Laurosilva

Laurus azorica in the Azores Islands, *Laurus nobilis* on the mainland, and *Laurus novocanariensis* in the Canary Islands

Endemismus v počtu druhů





Azorské ostrovy

Kanárské ostrovy (černá)
Kanárské ostrovy bez radiačních druhů (bílá)
Madeira (šedá)

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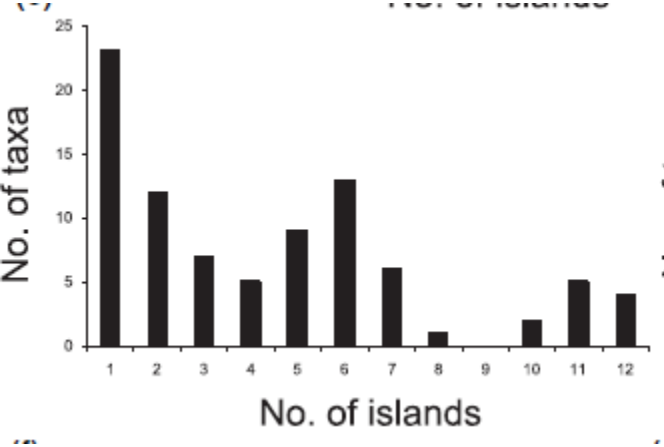
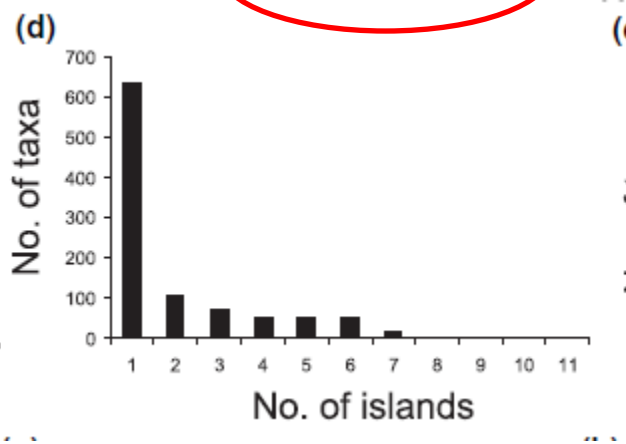
Endemismus v počtu druhů

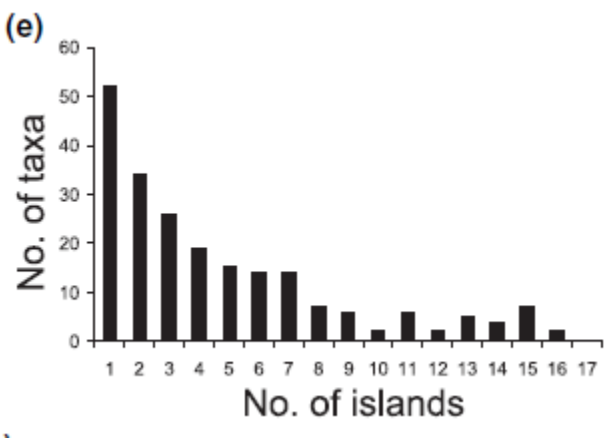
Capo Verde



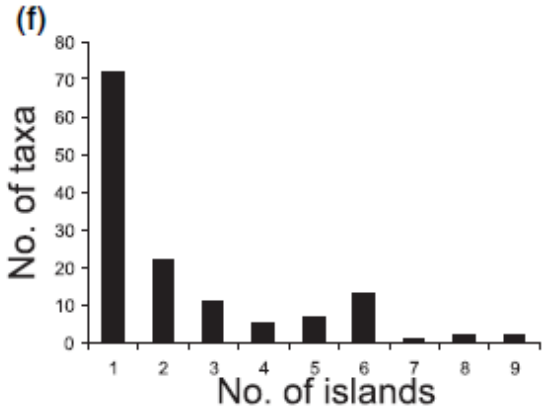
Hawaii



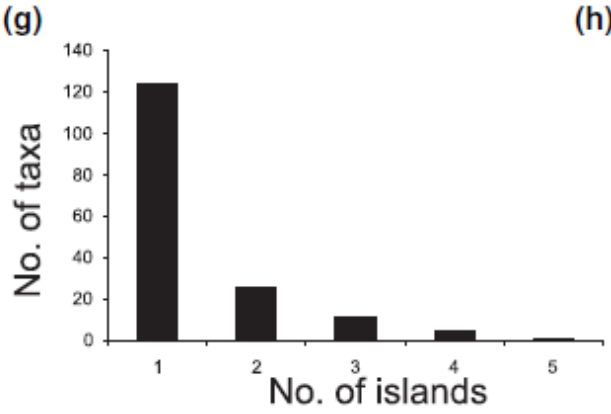
Galapágy



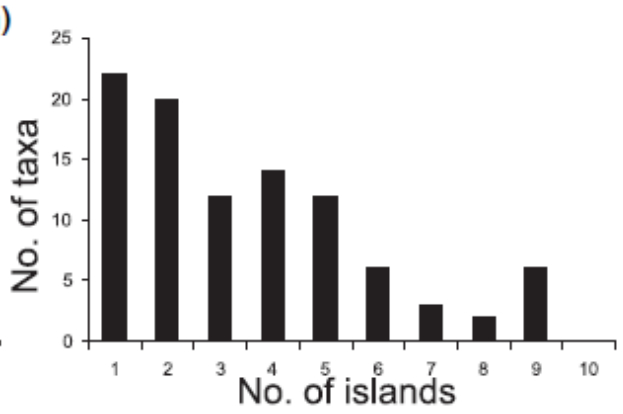
Marquézy



Společenské ostrovy



Ogasawara (Bonin)



Journal of Biogeography **37**, 77–89

Table 1 Speciation patterns in the Azorean flowering plant flora. The distribution and ecology of the nine angiosperm genera with endemic congeners in the Azores are indicated. For each genus, adaptive or allopatric speciation has been inferred as follows: (1) if the sister taxa are confined to different islands and occupy a similar habitat then inter-island allopatry is inferred, whereas (2) if the distributions are overlapping and the taxa are ecologically divergent then adaptive, ecological speciation is inferred. Islands are as follows: CO, Corvo; FL, Flores; FA, Faial; TE, Terceira; PI, Pico; GR, Graciosa; JO, São Jorge; SM, São Miguel; MA, Santa Maria.

				Islands									
Genus	Family	Speciation mode	Species	CO	FL	FA	TE	PI	GR	JO	SM	MA	Ecology
*Agrostis**	Poaceae	Adaptive, ecological speciation	*A. azorica*	•	•	•	•	•	•	•	•		High-elevation grassland
			A. congestiflora	•	•	•	•	•	•	•	•		Coastal cliffs, steep slopes and rocks
Ammi	Apiaceae	Adaptive, ecological speciation	*A. seubertianum*					•				•	Coastal cliffs
			A. trifoliatum	•	•	•	•	•		•	•		Inland cliffs
Euphorbia	Euphorbiaceae	Inter-island allopatry [also ecologically differentiated]	*E. stygiana* subsp. *stygiana*	•	•	•	•	•		•	•		Volcanic craters, ravines, juniper forest
			E. stygiana subsp. *santamariae*									•	*Picconia* forest
Euphrasia	Orobanchaceae	Inter-island allopatry	*E. azorica*	•	•								Steep slopes, inland cliffs, waterfalls
			E. grandiflora				•	•		•			Steep slopes, volcanic craters
Festuca	Poaceae	Adaptive, ecological speciation	*F. petraea*	•	•	•	•	•	•	•	•	•	Coastal halophytic soils
			F. francoi†	•	•	•	•	•		•	•	•	Steep slopes, volcanic craters, inland cliffs
Leontodon	Asteraceae	Inter-island allopatry?	*L. filii*				•	•		•	•		Volcanic craters, steep cliffs, ravines
			L. spec. nov.				•	•			•		Volcanic craters, steep cliffs, ravines
			L. rigens	•	•								Volcanic craters, steep cliffs, ravines
Myosotis	Boraginaceae	Adaptive, ecological speciation	*M. azorica*	•	•								Inland cliffs, volcanic craters, waterfalls
			M. maritima	•	•	•	•	•	•	•	•	•	Coastal cliffs
Pericallis	Asteraceae	Adaptive, ecological speciation	*P. malvifolia* subsp. *malvifolia*			•	•	•		•	•	•	Coastal cliffs
			P. malvifolia subsp. *caldeirae*			•	•						Volcanic craters, ravines
Platanthera‡	Orchidaceae	Adaptive, ecological speciation	*P. azorica*		•	•		•		•			Volcanic craters, steep slopes
			P. micrantha	•	•	•	•	•		•	•	•	Volcanic craters, steep slopes

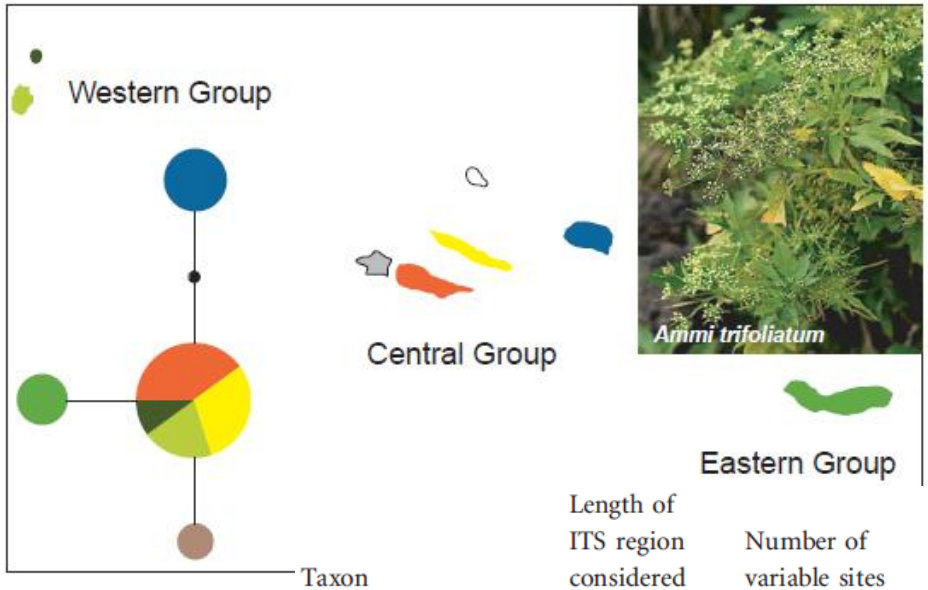
Journal of Biogeography (*J. Biogeogr.*) (2011)

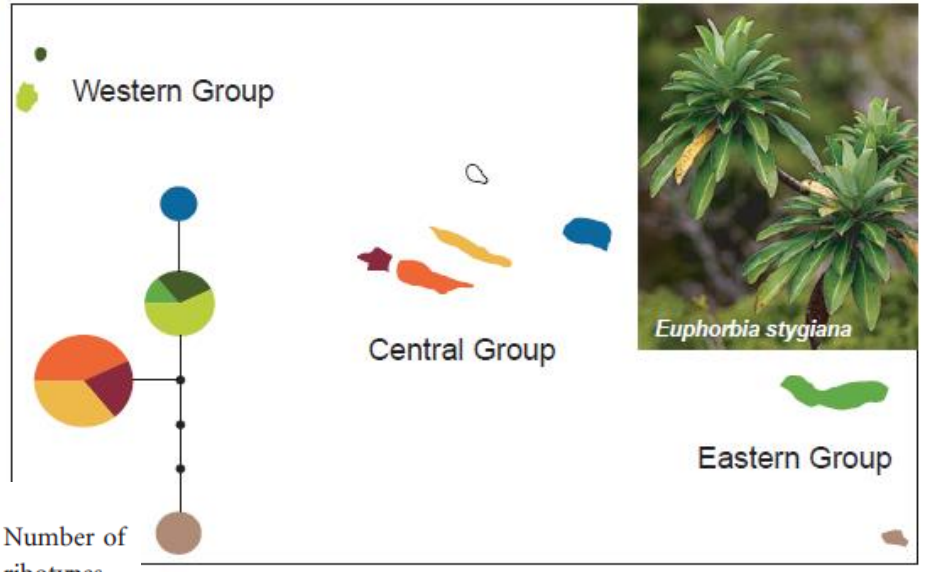
ORIGINAL ARTICLE

The Linnean shortfall in oceanic island biogeography: a case study in the Azores

Hanno Schaefer[1,2*], Mónica Moura[3], M. Graciete Belo Maciel[3], Luís Silva[3], Fred J. Rumsey[4] and Mark A. Carine[4]

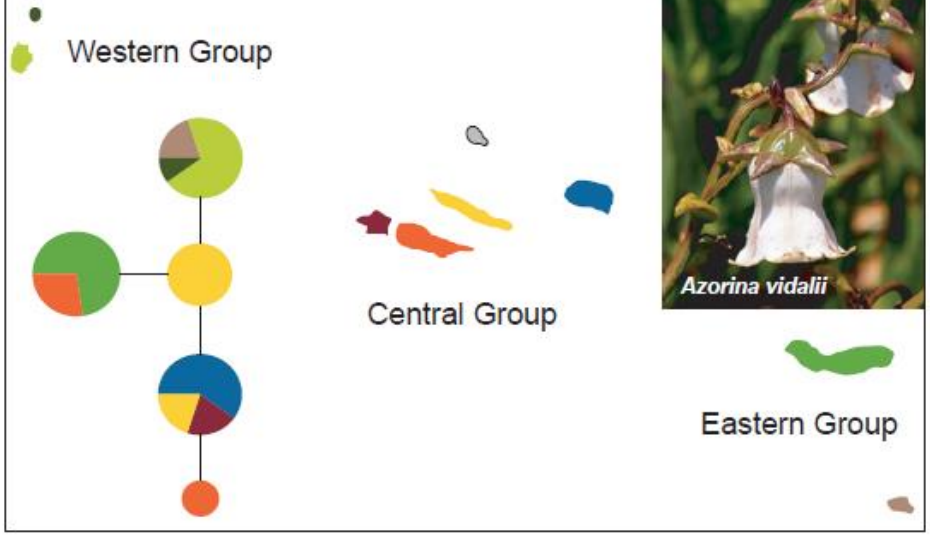
Genus	Family	Speciation mode	Species	Distribution								
				CO	FL	FA	TE	PI	GR	JO	SM	MA
Ammi	Apiaceae	Ecological speciation	*A. seubertianum* (H. C. Watson) Trel.					•			•	•
			A. trifoliatum (H. C. Watson) Trel.	•	•	○	•	•		•	•	
Angelica	Apiaceae	–	*A. lignescens* J.P. Reduron & Danton		•		•	•		•	•	
Azorina	Campanulaceae	–	*A. vidalii* (H. C. Watson) Feer	•	•	•	•	•	○	•	•	•
Euphorbia	Euphorbiaceae	Inter-island allopatry (and some extent of ecological speciation for the S. Maria population)	*E. stygiana* H. C. Watson subsp. *stygiana*	•	•	•	•	•		•	•	
			E. stygiana subsp. *santamariae* H. Schaef.									•
Pericallis	Asteraceae	Ecological speciation	*P. malvifolia* (L'Hér.) B. Nord. subsp. *malvifolia*			•	•	•		•	•	•
			P. malvifolia subsp. *caldeirae* H. Schaef.			•	•					

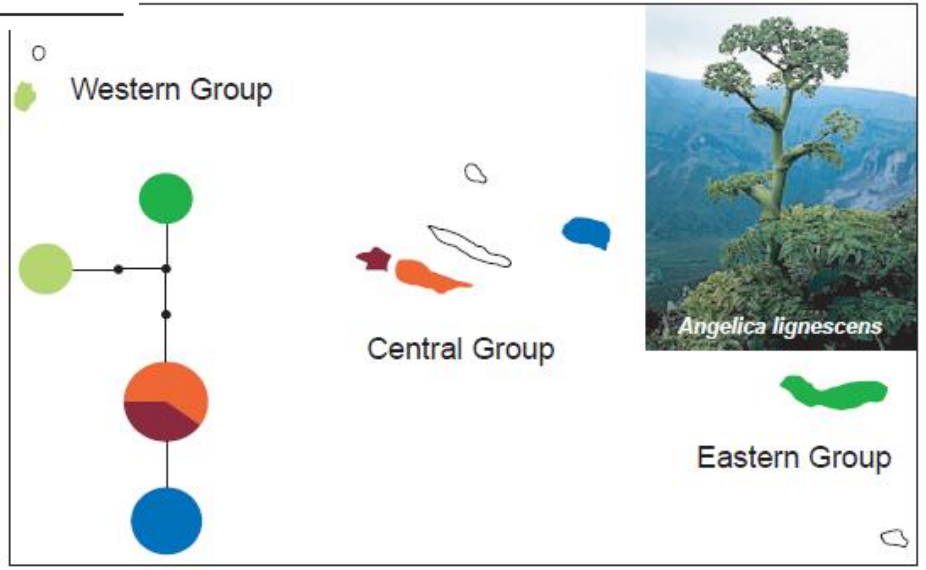




Taxon	Length of ITS region considered	Number of variable sites	Number of ribotypes
Ammi trifoliatum/ A. seubertianum	655	4	3
Angelica lignescens	584	6	5
Azorina vidalii	768	4	5
Euphorbia stygiana	605	6	4
Pericallis malvifolia	732	2	2*

Identifikovány ribotypy (ITS varianty) specifické pro dané ostrovy.
Poměr uznaných druhů / ITS variant je 0,33.





U ostatních je však poměr opačný !!

Větší počet rozeznaných druhů než ITS variant

Table 3 ITS variation in Canarian plant lineages. For each lineage, the number of taxa sampled, the number of accessions sampled and the number of ribotypes observed are given.

Genus	No. of Canarian taxa sampled	No. of Canarian accessions sampled	No. of Canarian ribotypes	Reference
Bystropogon	11	13	11	Trusty *et al.*, 2005
Cheirolophus	10	10	5	Susanna *et al.*, 1999
Cistus	4	6	3	Guzmán & Vargas, 2005
Descurania	7	16	9	Goodson *et al.*, 2006
Echium	18	18	7	Böhle *et al.*, 1996
Hedera	1	2	1	Valcárcel *et al.*, 2003
Isoplexis	3	4	4	Bräuchler *et al.*, 2004
Lotus	15	15	7	Allan *et al.*, 2004
Convolvulus	3	33	4	Carine *et al.*, 2004
Sideritis	6	6	6	Barber *et al.*, 2002
Totals	**80**	**131**	**63**	

Table 1 Shared native angiosperm genera of the Hawaiian and Galápagos Islands. Genera in bold have endemic species on both archipelagos (data from Wiggins & Porter, 1971; Wagner *et al.*, 1990; Carr, 2006; Bungartz *et al.*, 2009).

		Hawaii		Galápagos	
Genus	Family	Endemic	Native	Endemic	Native
Abutilon	**Malvaceae**	**3**	**1**	**1**	**0**
Acacia	Mimosaceae	2	0	0	3
Amaranthus	**Amaranthaceae**	**1**	**0**	**4**	**1**
Cordia/Varronia	Boraginaceae	0	1	4	2
Cuscuta	**Cuscutaceae**	**1**	**0**	**2**	**0**
Dodonaea	Sapindaceae	0	1	1	0
Chamaesyce	**Euphorbiaceae**	**15**	**0**	**8**	**0**
Gossypium	**Malvaceae**	**1**	**0**	**2**	**0**
Heliotropium	Boraginaceae	0	2	1	3
Ipomaea	**Convolvulaceae**	**1**	**4**	**2–3**	**3**
Lobelia	Campanulaceae	13	0	0	1
Lycium	Solanaceae	0	1	1	0
Peperomia	**Piperaceae**	**23**	**2**	**4**	**2**
Phyllanthus	Euphorbiaceae	1	0	0	1
Phytolacca	Phytolaccaceae	1	0	0	1
Pilea	Urticaceae	0	1	1	1
Pisonia	**Nyctaginaceae**	**2**	**3**	**1**	**0**
Plantago	**Plantaginaceae**	**3**	**0**	**1**	**0**
Plumbago	Plumbaginaceae	0	1	0	2
Portulaca	**Portulacaceae**	**3**	**1**	**1**	**0**
Psychotria	**Rubiaceae**	**11**	**0**	**2**	**0**
Sesuvium	Aizoaceae	0	1	1	1
Sicyos	**Cucurbitaceae**	**14**	**0**	**2**	**0**
Solanum	**Solanaceae**	**3**	**1**	**1**	**1**
Waltheria	Sterculiaceae	0	1	0	1

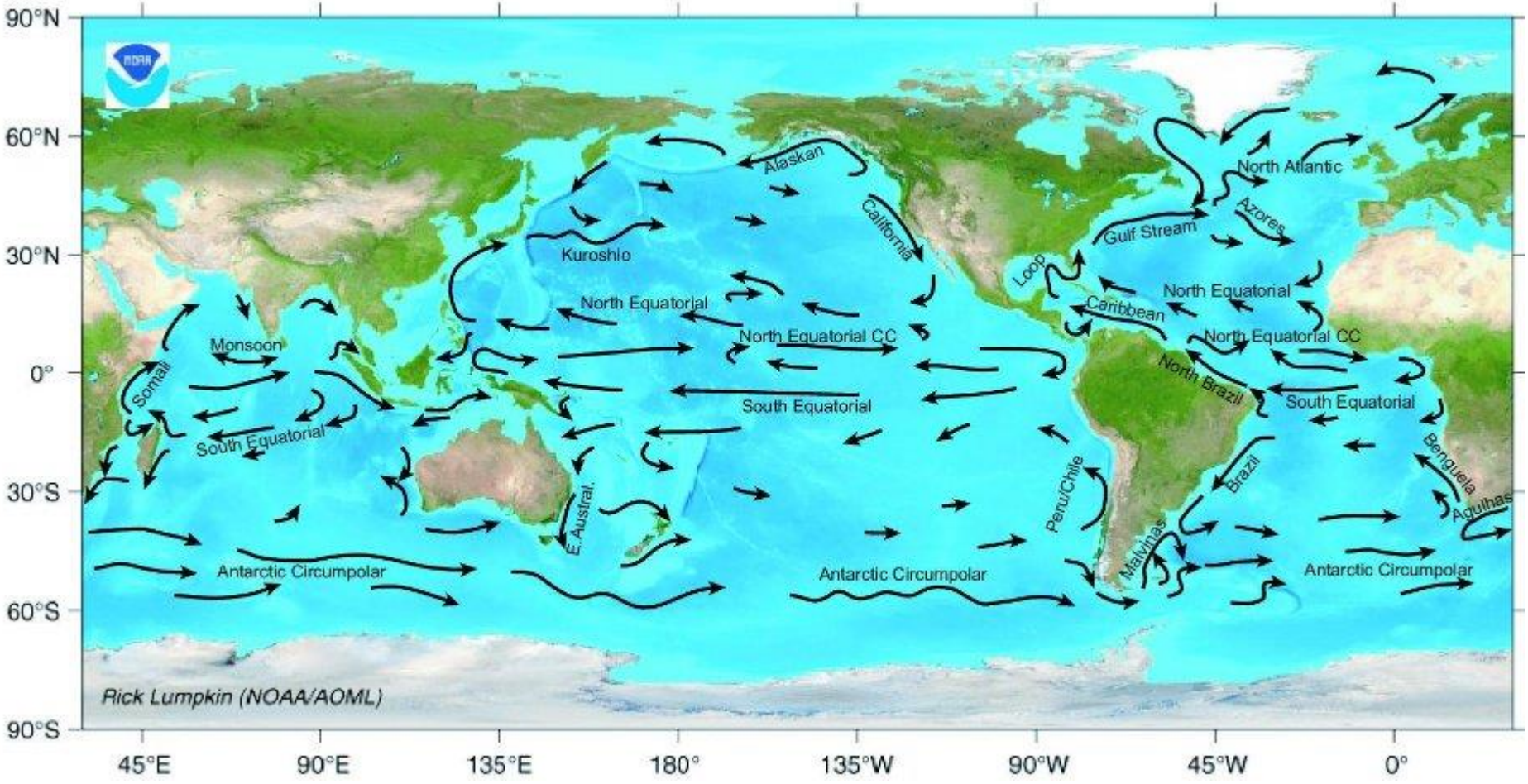
Journal of Biogeography (J. Biogeogr.) (2012) **39**, 1427–1438

ORIGINAL ARTICLE

Radiation following long-distance dispersal: the contributions of time, opportunity and diaspore morphology in *Sicyos* (Cucurbitaceae)

Patrizia Sebastian[1], Hanno Schaefer[2], Rafael Lira[3], Ian R. H. Telford[4] and Susanne S. Renner[1]*

Figure 1 Habitats, flowers, and armed or unarmed fruits of *Sicyos* species from Hawaii, Australia and the continental mainland: (a) *S. angulatus* visited by *Vespula germanica* (USA), (b) *S. pachycarpus* (Hawaii), (c) *S. maximowiczii* growing in a colony of great frigatebird (*Fregata minor*), (d) *S. undara* (Australia), (e) *S. pachycarpus* (Hawaii), (f) *S. weberbaueri* (Peru), (g) *S. australis* (Australia), (h) *S. acarianthus* (Peru), (i) *Microsechium ruderale* (Guatemala). Scale bar = 1 cm. Photographs by: Forest & Kim Starr (a, e), T. Rau (b; Carr, 2006), H. Schaefer (b), P. Sebastian (d), M. Weigend (f, h), A. Lyne (g; APII) and M. Nee (i).


90°N
60°N
30°N
0°
30°S
60°S
90°S
45°E
90°E
135°E
180°
135°W
90°W
45°W
0°
Alaskan
California
Kuroshio
North Equatorial
North Equatorial CC
Monsoon
Somali
South Equatorial
South Equatorial
E. Austral.
Antarctic Circumpolar
Antarctic Circumpolar
North Atlantic
Azores
Gulf Stream
Loop
Caribbean
North Equatorial
North Equatorial CC
North Brazil
South Equatorial
Peru/Chile
Brazil
Malvinas
Benguela
Agulhas
Antarctic Circumpolar
Rick Lumpkin (NOAA/AOML)

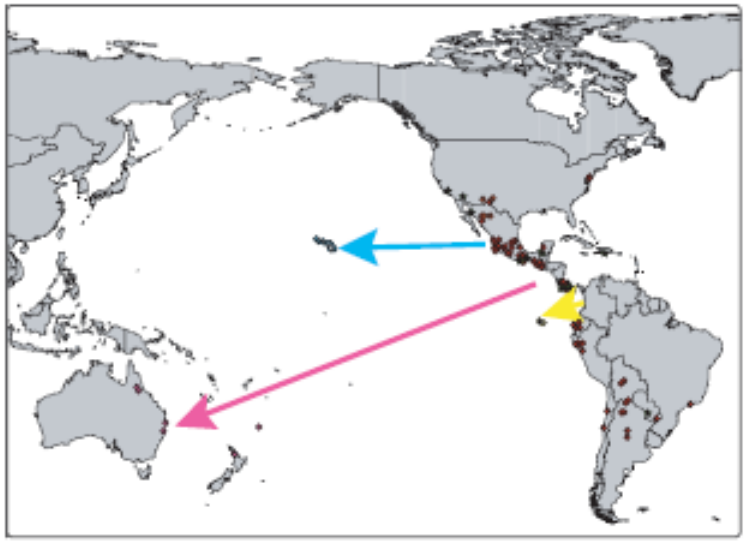
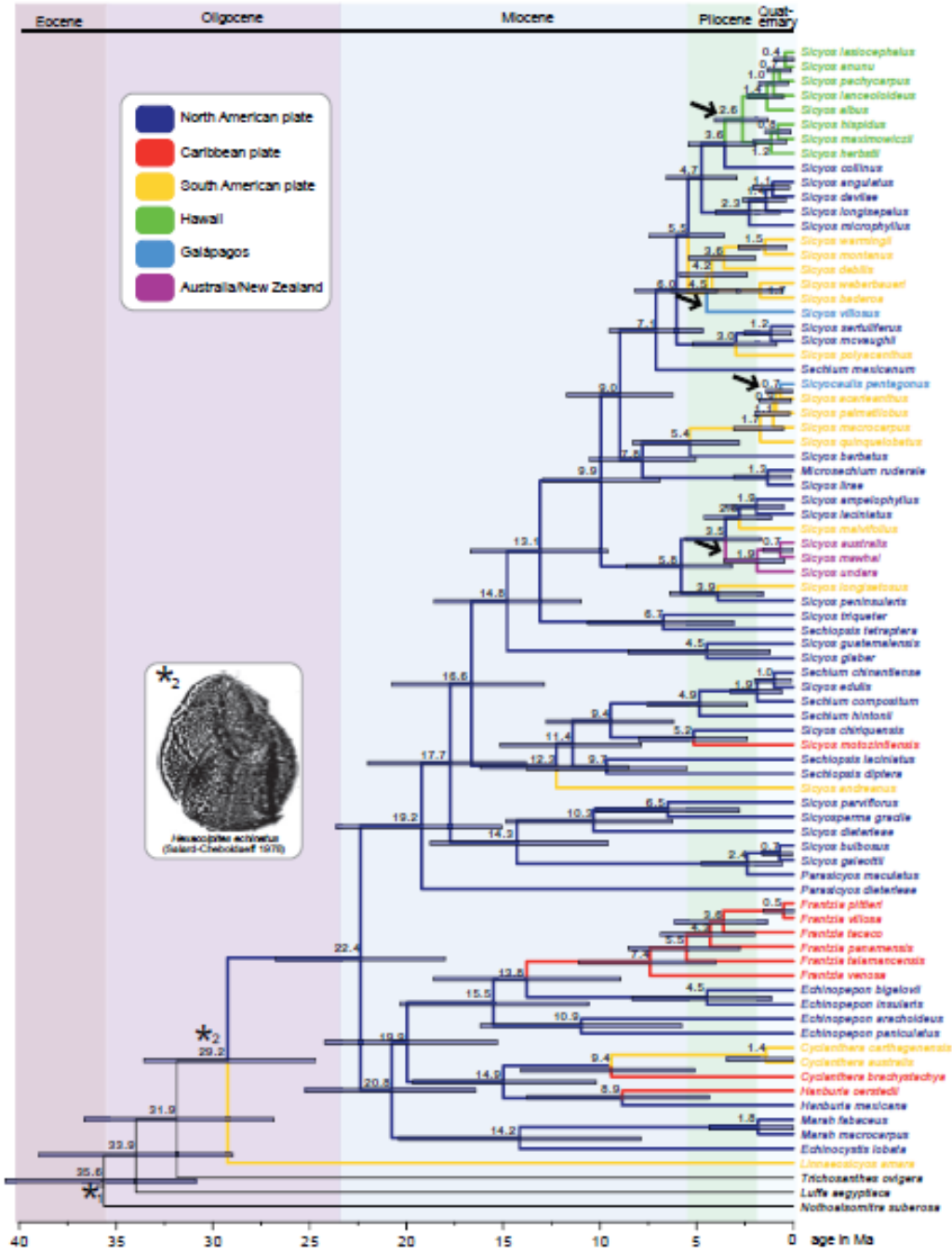


Table 2 Characteristics of the four *Sicyos* disjunctions compared here.

Characteristic	Hawaii	Australia/New Zealand	Galápagos 1 (*Sicyos villosus*)	Galápagos 2 (*Sicyocaulis pentagonus*)
Number of extant species	14	3	1	1
Distance from likely region of origin [km]	3800	6000	930	930
Relative habitat diversity	High	High	Low	Low
Dispersal ability (diaspore morphology)	Low	High	High	High
Stem age [Ma]	5.5–1.9	5.6–1.7	6.4–2.8	1.5–0.08
Crown age [Ma]	4.1–1.3	3.6–0.5	NA	NA
Diversification rate ($k = 0$) [species Myr^{-1}]	0.47–1.45	0.11–0.81	0	0
Diversification rate ($k = 0.9$) [species Myr^{-1}]	0.18–0.58	0.03–0.24	0	0

NA, not applicable.



Rod *Sycios* vznikl v Severní Americe (Mexiku) pravděpodobně během Miocénu (23-15 milionů let)

Kolonizace Hawaje před 4-2 mil, poté radiace

Galapážský druh *S. villosus*, patří do skupiny jihoamerických druhů, které se oddělily před 5- 4 mil

Australské a NZ druhy se vyvinuly před 2- 0,7 mil let

ABSTRACT

Aim To infer the most plausible explanations for the presence of 14 species of the Neotropical cucurbit genus *Sicyos* on the Hawaiian Islands, two on the Galápagos Islands, two in Australia, and one in New Zealand.

Location Neotropics, the Hawaiian and Galápagos archipelagos, Australia and New Zealand.

Methods We tested long-problematic generic boundaries in the tribe Sicyoeae and reconstructed the history of *Sicyos* using plastid and nuclear DNA sequences from 87 species (many with multiple accessions) representing the group's generic and geographic diversity. Maximum likelihood and Bayesian approaches were used to infer relationships, divergence times, biogeographic history and ancestral traits.

Results Thirteen smaller genera, including *Sechium*, are embedded in *Sicyos*, which when re-circumscribed as a monophyletic group comprises 75 species. The 14 Hawaiian species of *Sicyos* descended from a single ancestor that arrived *c.* 3 million years ago (Ma), Galápagos was reached twice at *c.* 4.5 and 1 Ma, the species in Australia descended from a Neotropical ancestor (*c.* 2 Ma), and New Zealand was reached from Australia. Time since arrival thus does not correlate with *Sicyos* species numbers on the two archipelagos.

Main conclusions A plausible mechanism for the four trans-Pacific dispersal events is adherence to birds of the tiny hard fruit with retrorsely barbed spines found in those lineages that underwent long-distance migrations. The Hawaiian clade has lost these spines, resulting in a lower dispersal ability compared with the Galápagos and Australian lineages, and perhaps favouring allopatric speciation.

Proc. Natl. Acad. Sci. USA
Vol. 93, pp. 11740–11745, October 1996
Evolution

Island colonization and evolution of the insular woody habit in *Echium* L. (Boraginaceae)

(speciation/selection/perennial growth/woodiness/founding populations)

UTA-REGINA BÖHLE*, HARTMUT H. HILGER*, AND WILLIAM F. MARTI

Proč často jednoleté byliny se na ostrovech vyvinou ve víceleté dřeviny ?

Termín „***insular woodiness***“ Carlquist 1971 často se vyskytující u horských druhů

Boraginaceae
Campanulaceae
Asteraceae
Lobelliaceae
Euphorbiaceae

FIG. 1. *Echium creticum* (*Left*) and *Echium simplex* (*Right*), representatives of the herbaceous continental and woody island species, respectively, found in this genus of circummediterranean and Macaronesian (Canary, Madeira, and Cape Verde archipelagos) distribution. *E. creticum* is annual to biennial, whereas *E. simplex*, an endemic of the Anaga mountains (Tenerife), is a monocarpic rosette tree—i.e., forms a perennial vegetative rosette and flowers only once in life, producing several thousand propagules and dies.

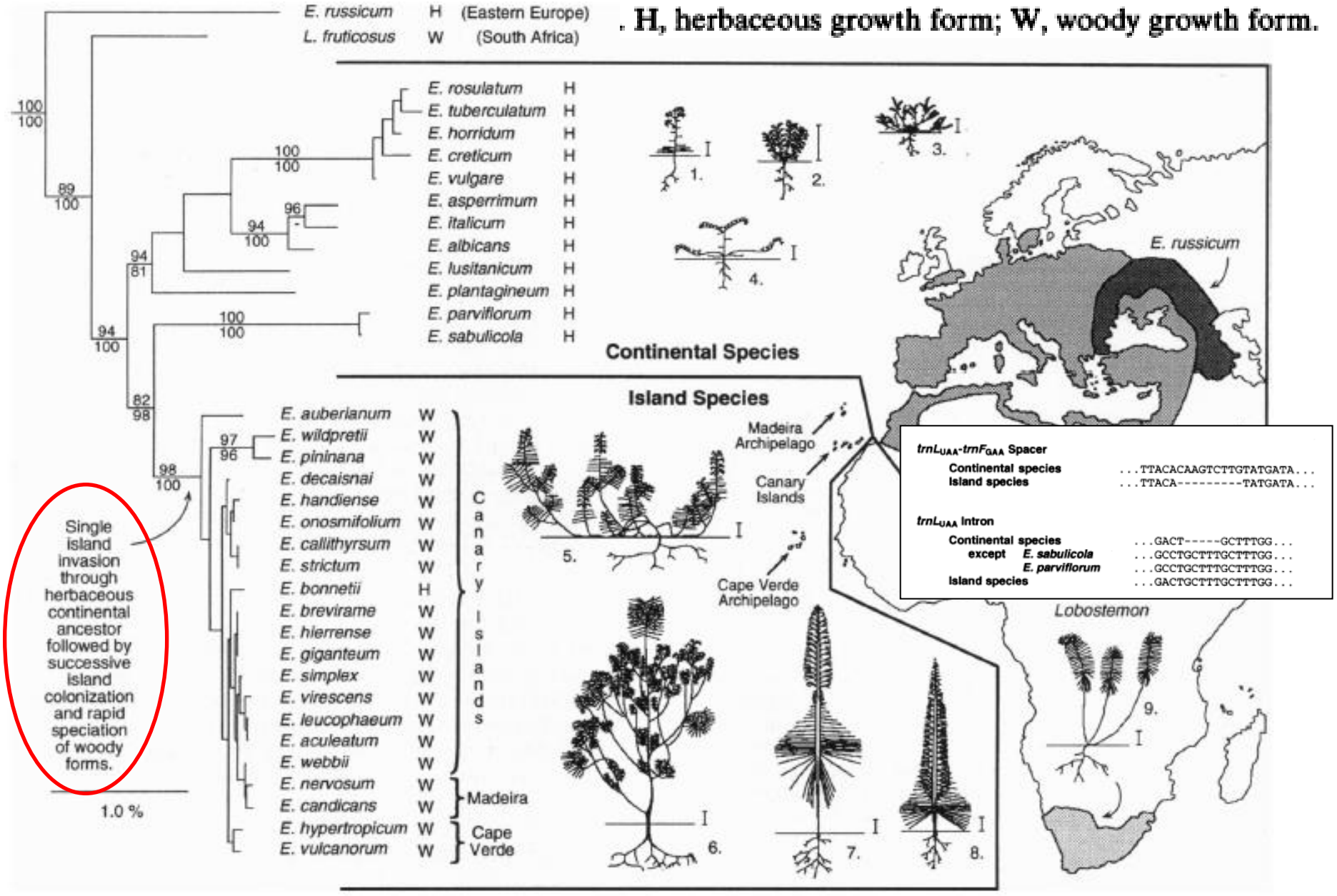
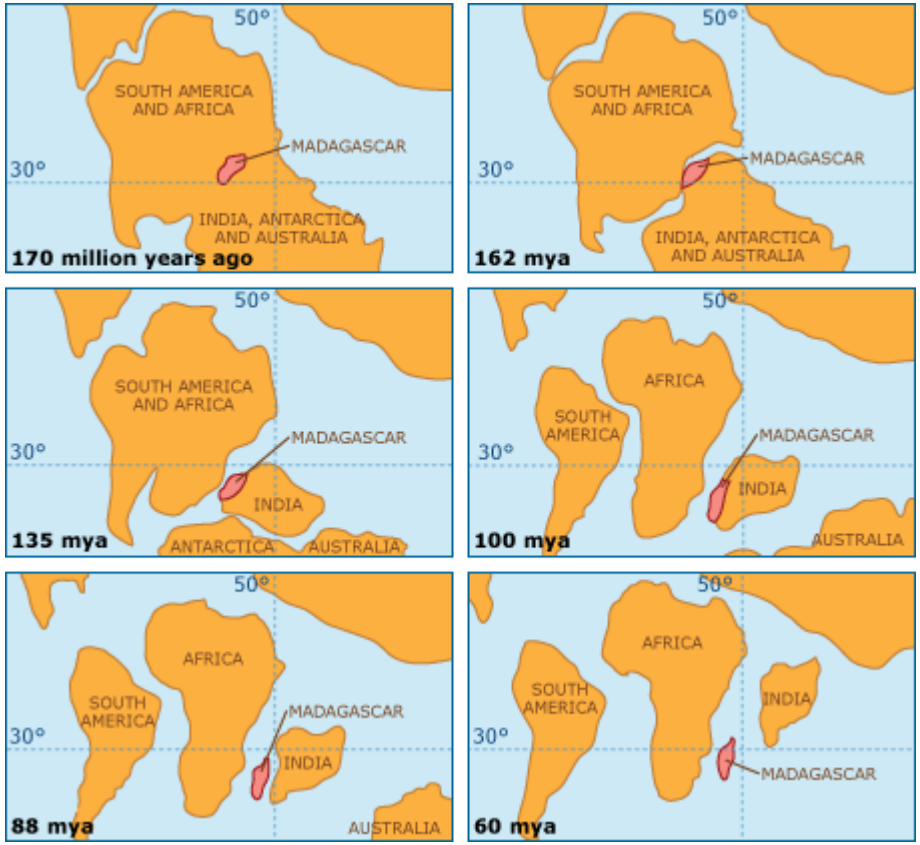
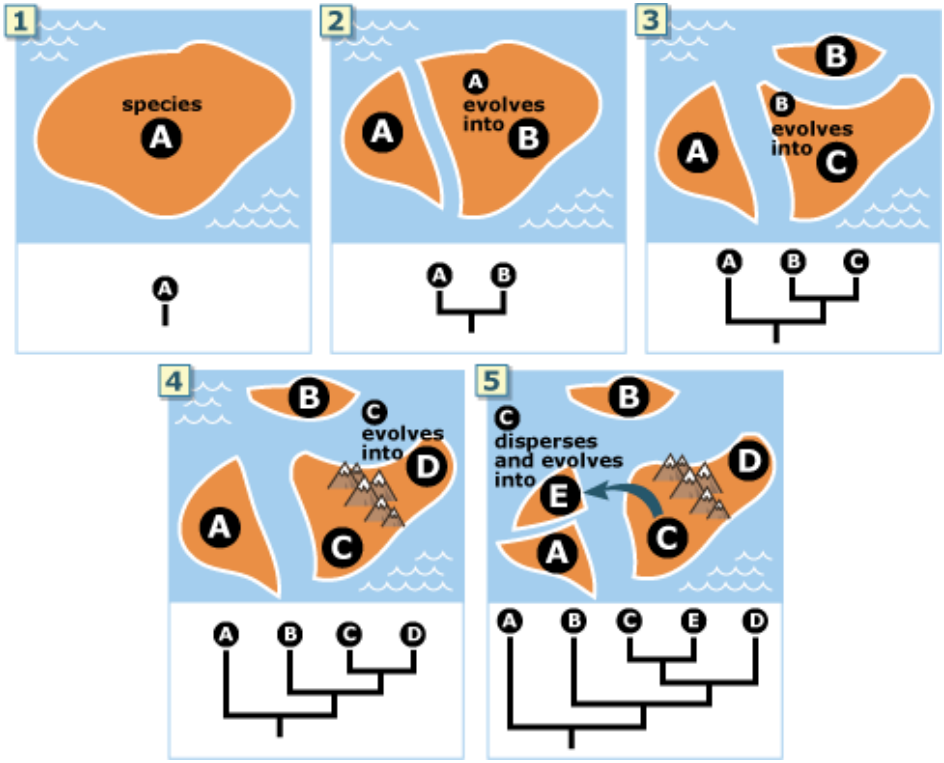


FIG. 3. Correlation between phylogeny and biogeography in *Echium*. On the left side of the figure is a neighbor-joining tree (26) for Kimura istances (27) between combined sequences from noncoding cpDNA and nuclear DNA. The horizontal scale bar indicates 1% sequence divergence.

Madagaskar


50°
30°
SOUTH AMERICA AND AFRICA
MADAGASCAR
INDIA, ANTARCTICA AND AUSTRALIA
170 million years ago
162 mya
INDIA
135 mya
ANTARCTICA
AUSTRALIA
AFRICA
SOUTH AMERICA
100 mya
88 mya
60 mya


1
species
A
2
A evolves into B
3
B evolves into C
4
C evolves into D
5
C disperses and evolves into E

Madagaskar

12,000 plant species with 70-80% of which are endemic
10 families and 260 genera of plants are endemic to Madagascar.
Only Australia (with 13) has more endemic species of plants.
165 of Madagascar's 170 palms are not found anywhere else.
For comparison, mainland Africa has less than 60 species of palm
Of the 8 species of baobab found in the world, six are endemic to Madagascar
An entire family of plants, the Didiereaceae is unique to Madagascar. Didiereaceae plants are found in the arid southwest and closely resemble some forms of cacti. Unlike catci though, they produce small deciduous leaves which are protected by meanacing thorns and spines that grow directly out of the plant's many branches.
95% of the species found in the Spiny desert exist only in this habitat unique to Madagascar.
Madagascar has nearly 1000 known species of orchids, of which 85% are endemic.

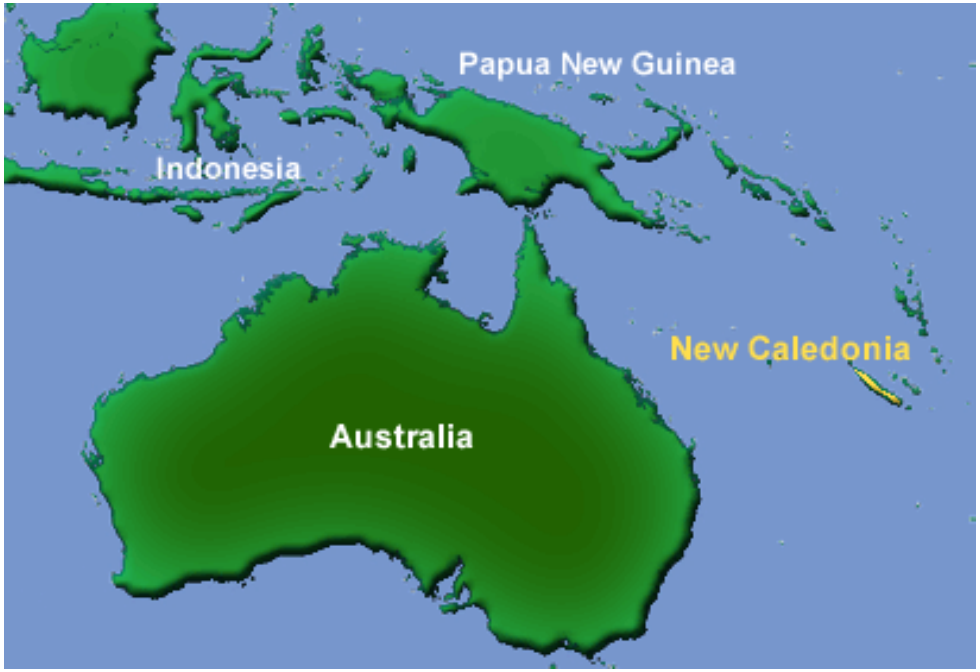
Adansonia suarezensis

Euphorbia milii

Ravenala madagascariensis

Angraecum sesquipedale

Nová Kaledonie



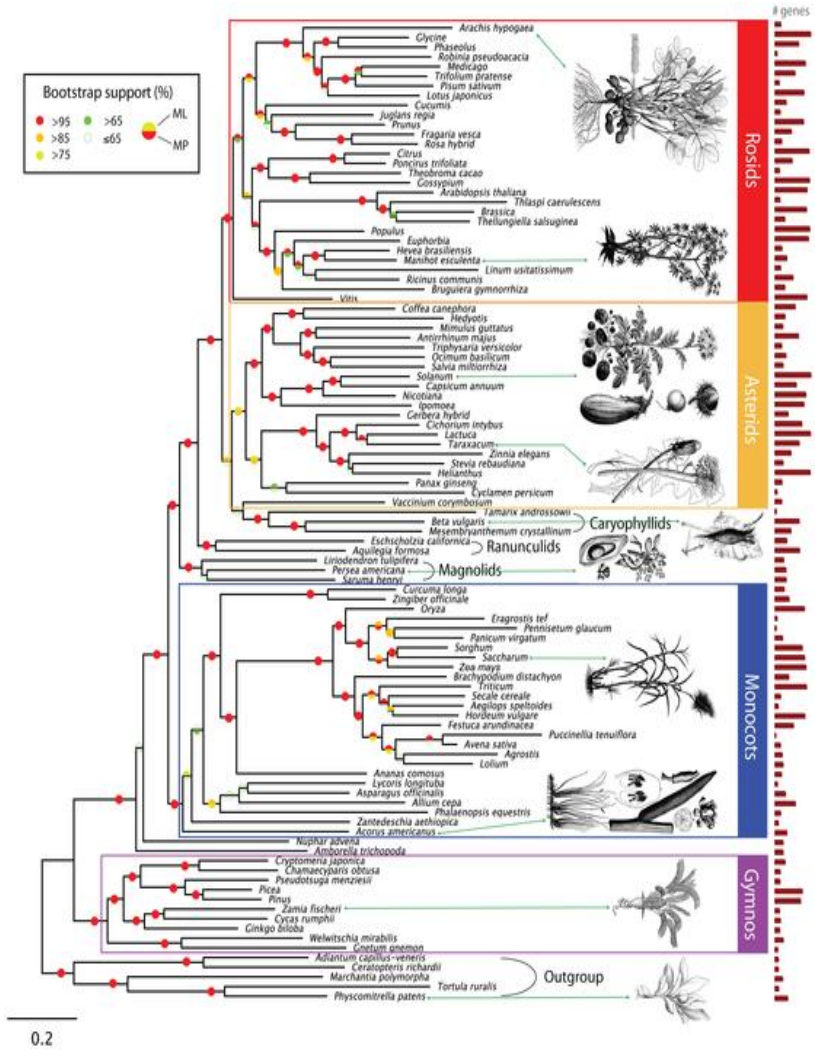
plant diversity consists of 3,261 species of indigenous flora (74% strictly endemic), which is nearly as many as on the whole of continental Europe (3,500 species).The territory also hosts 106 species of endemic reptiles, 6 species of endemic bats and 4,500 species of invertebrates (90% endemic). The birdlife of New Caledonia includes 23 species of endemic birds. Since 2008, the lagoons of New Caledonia and their reef diversity and associated ecosystems are designated in the UNESCO List of World Natural Heritage sites.

Amborella trichopoda

jediný druh rodu *Amborella* čeledi *Amborellaceae* i samostatného řádu *Amborellales*.
Stojí podle nejnovějších výzkumů na samém základu vývojového stromu krytosemenných rostlin. Jediný žijící zástupce této čeledi je tedy považován za nejpůvodnější krytosemennou rostlinu.

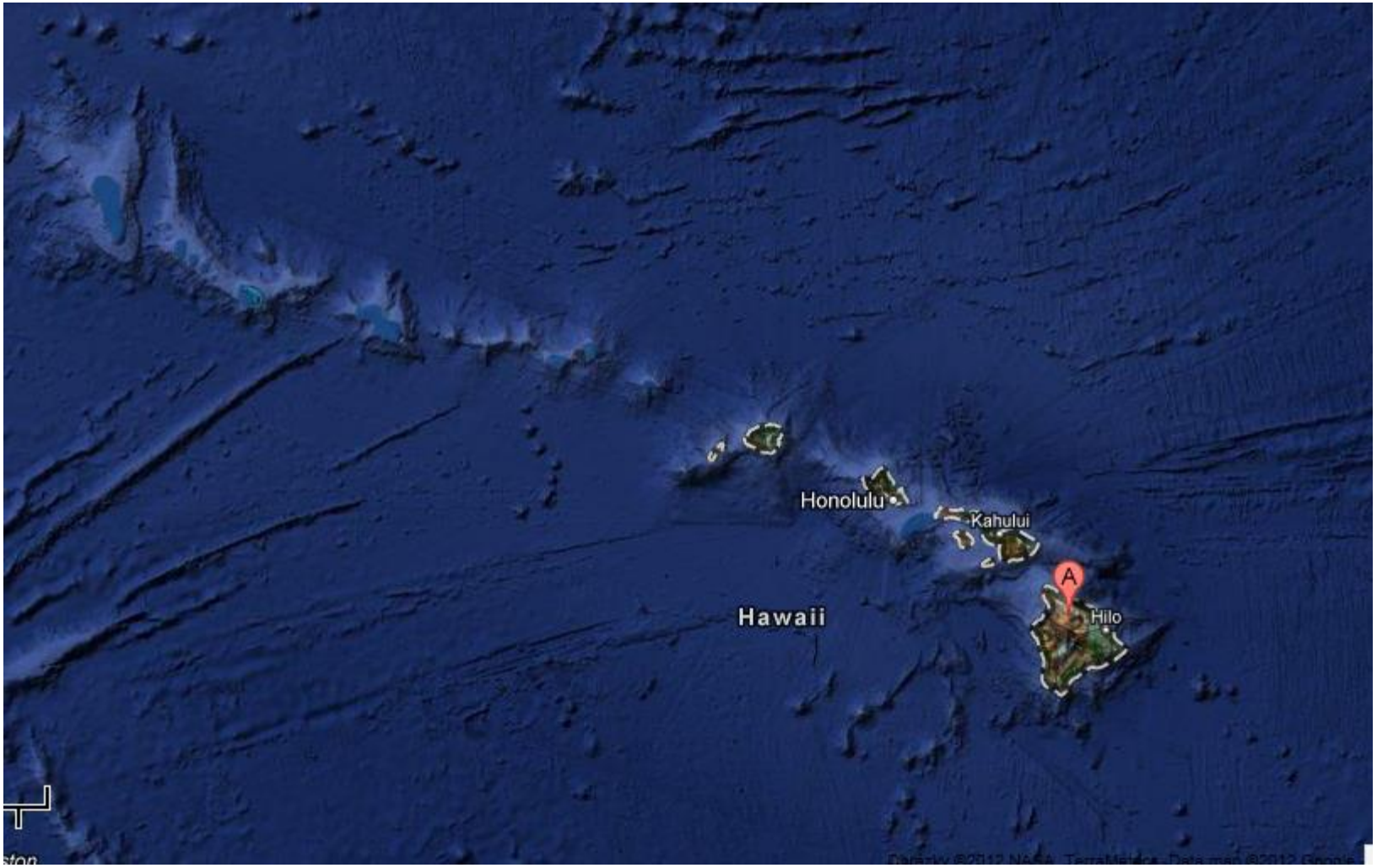
je dvoudomý stálezelený keř rostoucí na Nové Kaledonii. Listy jsou jednoduché, kožovité, střídavé, bez palistů. Květy jsou drobné, jednopohlavné, v úžlabních květenstvích. Nápadné zbytky druhého pohlaví svědčí o tom, že původně byly květy oboupohlavné. Bělavé okvětí sestává z neustáleného počtu 5-8 plátků. Tyčinky mají plochou nitku s prašníkem na vrcholu. Gyneceum v samičích květech apokarpní, v kruhu, z 5-8 volných plodolistů, s kratší bliznovou částí na vrcholu. V každém plodolistu je jedno vajíčko. Plody připomínají peckovici.

Archaické znaky, svědčící o starobylém původu, se týkají především stavby dřeva, které neobsahuje pravé cévy, dále pak stavby generativních orgánů. Volné pestíčky mají okraje k sobě přitisklé, dosud však nesrostlé.



http://www.amborella.org

Havajské ostrovy



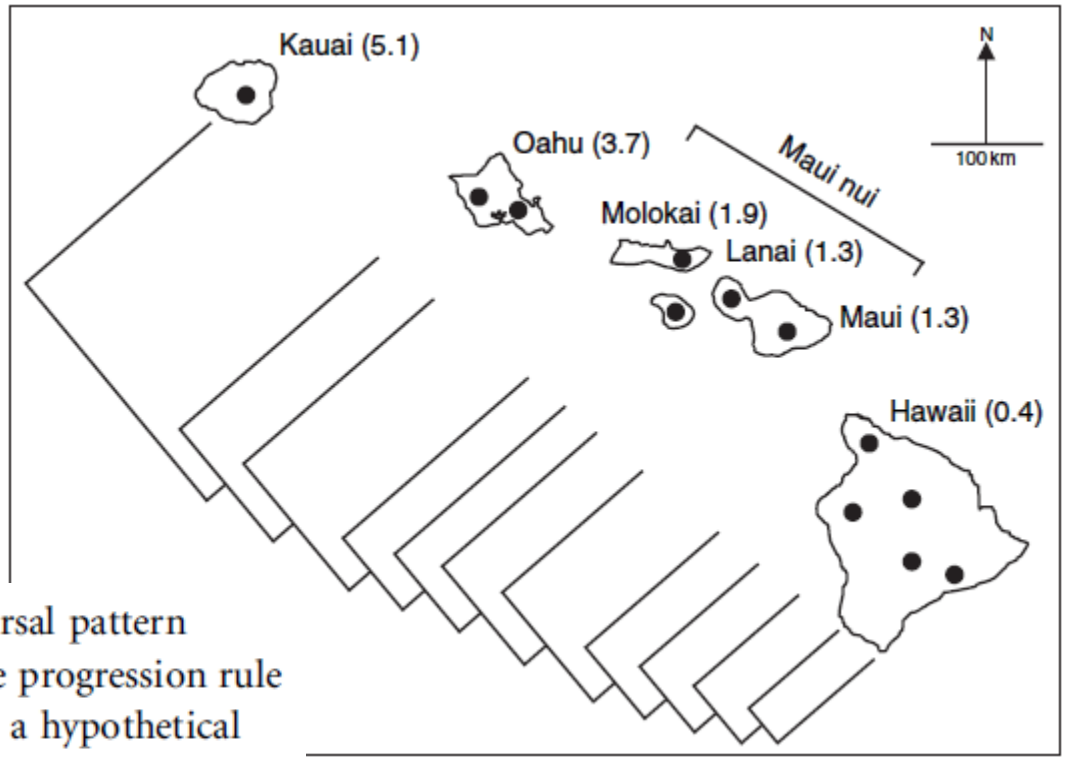


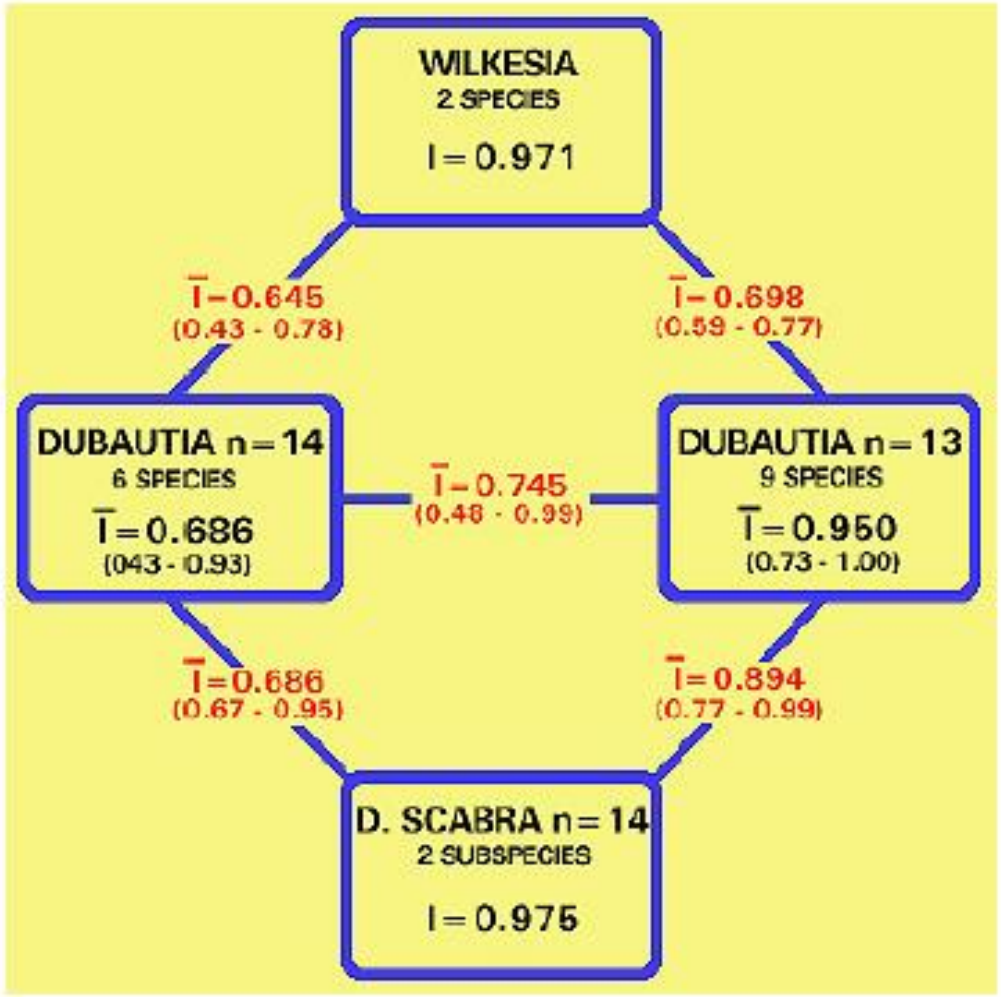
Figure 1 An example of a non-stochastic dispersal pattern observed for many plant and animal lineages, the progression rule pattern of island colonization, here depicted for a hypothetical Hawaiian island lineage. The volcanoes of the six main Hawaiian islands arose over a hot spot in the south-east. As the Pacific plate moves northwestwards it carries with it each sequentially formed island (island ages shown in parentheses, in millions of years). According to the progression rule, the initial colonization event occurs on the oldest island, Kauai, accompanied by subsequent lineage splitting as individuals disperse down the island chain from volcano to volcano (black circles). More complex patterns, involving radiations within islands, back-colonizations and dispersal that passes over an intermediate island, are often superimposed on the basic progression rule pattern.

The Hawaiian Silverswords exhibit enormous phenotypic variation (from herbs to trees to vines)..,

(photos from http://www.botany.hawaii.edu/faculty/carr/silversword.htm)

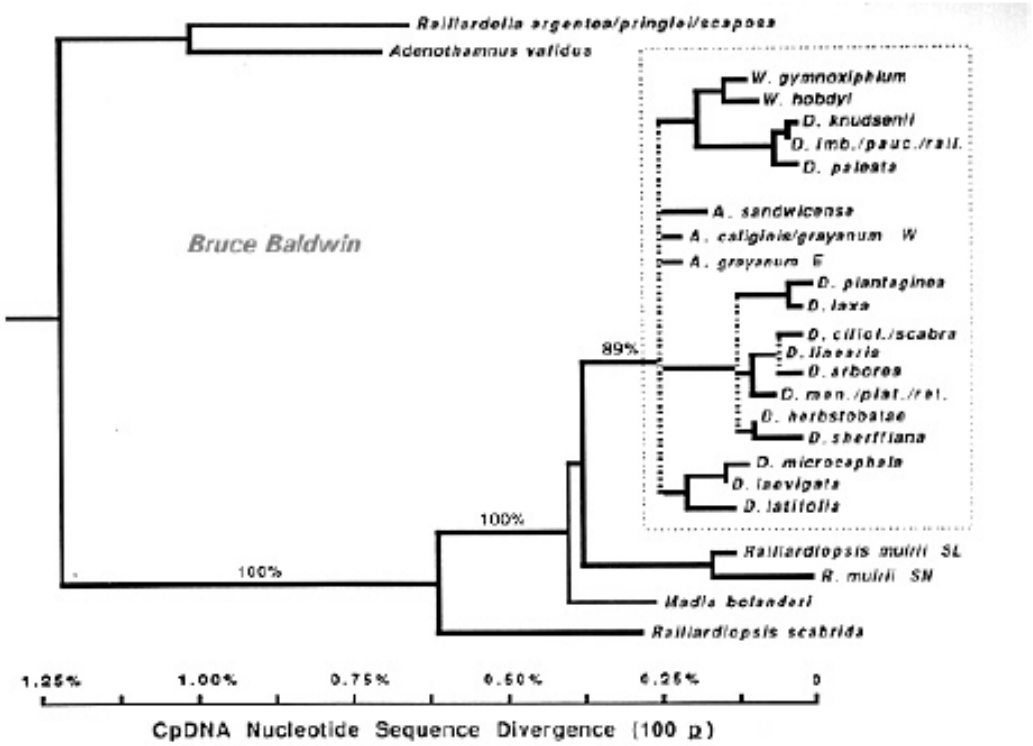
Argyroxiphium, Dubautia a Wilkesia (Asteraceae)

Velká morfologická, ekologická ale nízká genetická variabilita

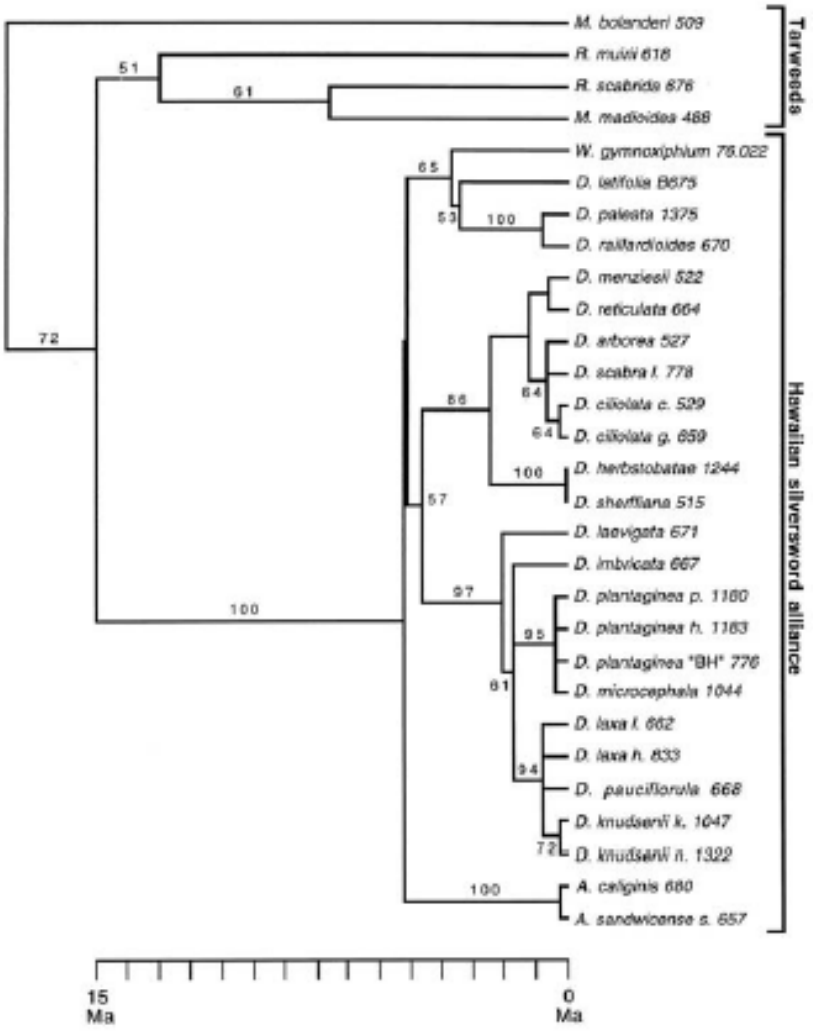


srovnatelná se vzdálenostmi mezi populacemi jednoho druhu na kontinentě

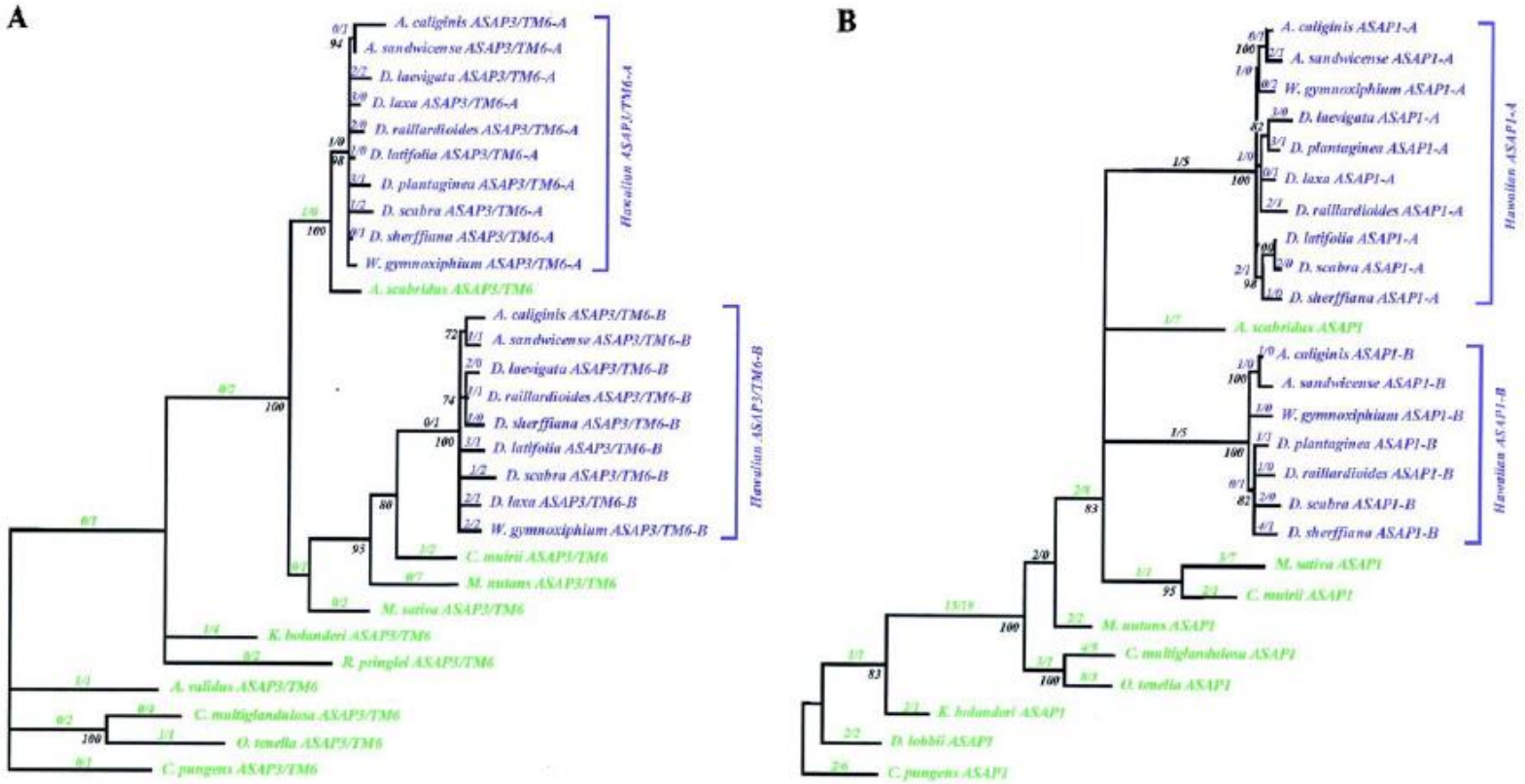
Otázka původu



- A phylogeny based on Choroplast DNA suggests that the North American Tarweeds are the nearest relatives to the Hawaiian Silverswords (Baldwin et al 1991)



- A phylogeny based on Nuclear Ribosomal DNA also points to the North American Tarweeds as the nearest relatives to the Hawaiian Silverswords
- Using an assumption of a molecular clock, the Silversword radiation is dated to have begun about 5.2 ± 0.8 million years ago. Kauai, the oldest island, has been geologically dated to 5.1 ± 0.2 million years old. (Baldwin & Sanderson 1998)



- Two regulatory gene trees based on *ASAP3/TM6* and on *ASAP1* also point to the Tarweeds as the nearest Relatives to the Silverswords (Barrier et al 2001)

Nejbližší příbuzné druhy

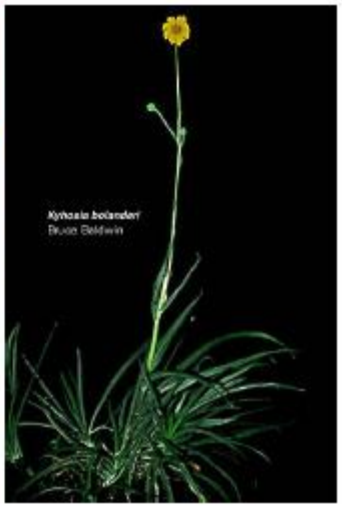
Malé byliny postrádající variabilitu havajských

North American Tarweeds

(http://www.botany.hawaii.edu/faculty/carr/silversword.htm)

Carlquistia

Anisocarpus

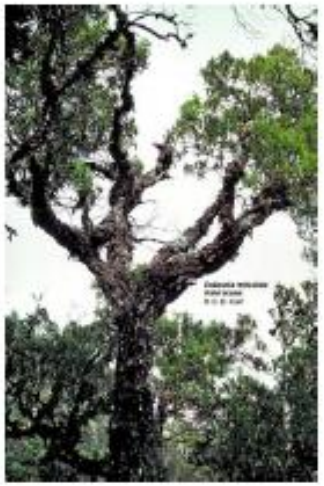


Myhosia

Jak se vyvinuly rozrůzněné havajské druhy

?

?

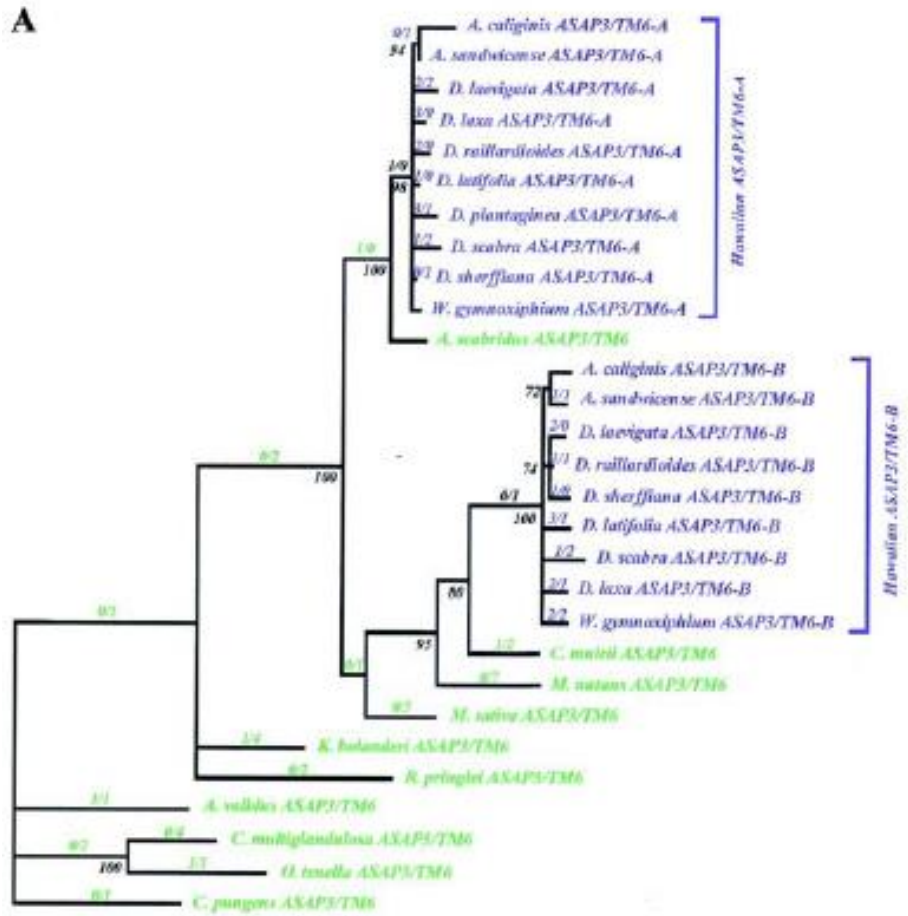


Evidence alotetraploidního hybridního původu

C. murii a C. scabrida
se ve fylogenetických studiích vyskytují mezi nejbližšími příbuznými havajských druhů

Evidence alotetraploidního hybridního původu

(Barrier et al 1999, 2001)



- One Silversword copy of regulatory gene, *ASAP3/TM6-A*, shows *R.scabrida* to be the nearest Tarweed relative to the Silverswords.
- The other copy, *ASAP3/TM6-B*, shows *R.muirii* to be the nearest Tarweed relative to the Silverswords

Havajské druhy se vyvíjejí rychleji než severoamerické

(Barrier et al 2001)

	Regulatory Genes				Structural Gene	
	ASAP3/TM6		*ASAP1*		*ASCAB9*	
Point Mutations	Hawaiian Silverswords	North American Tarweeds	Hawaiian Silverswords	North American Tarweeds	Hawaiian Silverswords	North American Tarweeds
Nonsynonymous	25	5	28	50	7	3
Synonymous	15	31	11	64	9	31

- Hawaiian Silverswords vs North American Tarweeds
  - All 3 genes accumulated relatively more nonsynonymous point mutations in the Silverswords than in the Tarweeds
- Regulatory vs Structural Genes
  - Within the Silverswords, the Regulatory Genes accumulated relatively more nonsynonymous point mutations than the Structural Gene

OPEN ACCESS Freely available online

PLoS one

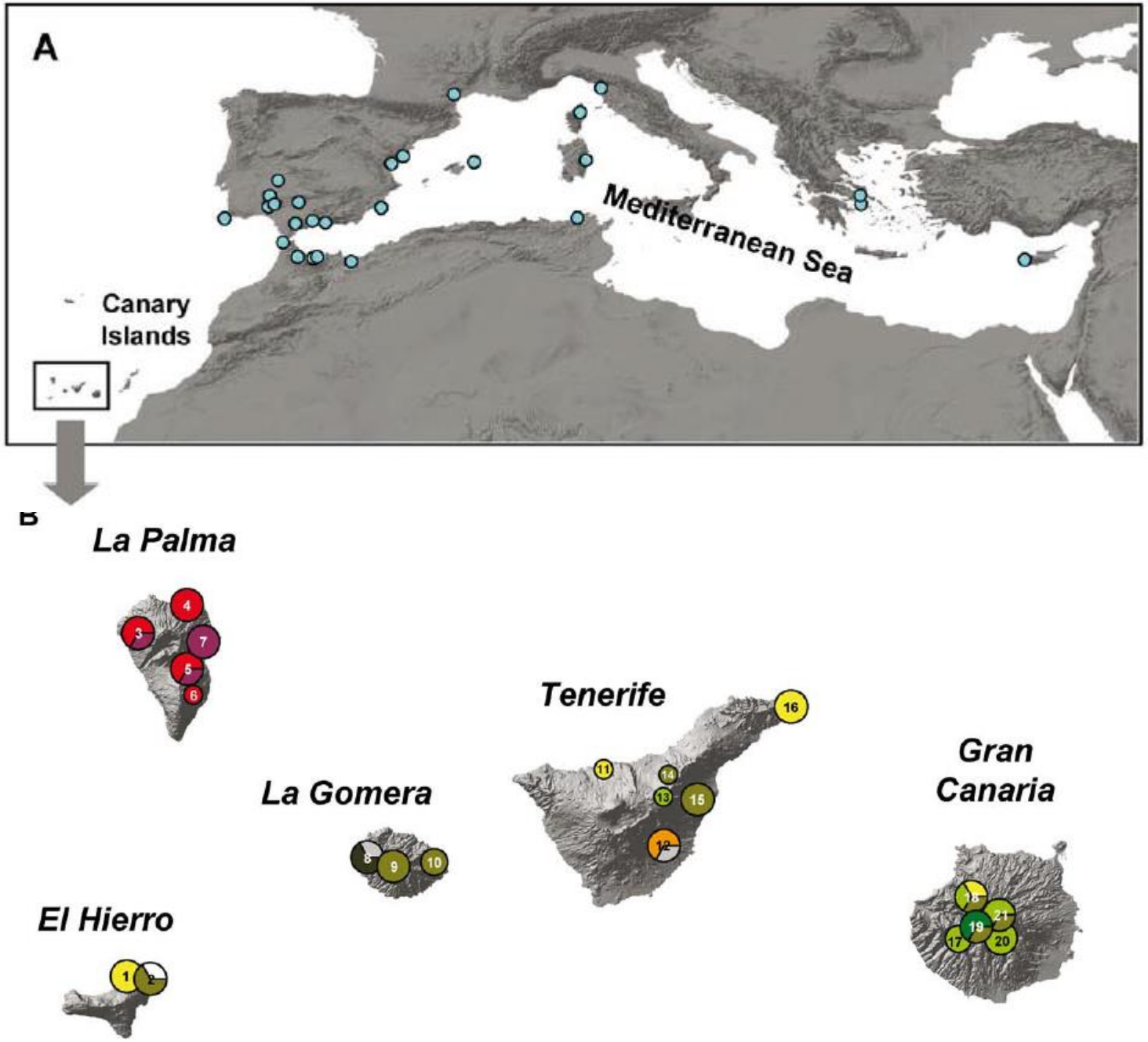
Genetically Depauperate in the Continent but Rich in Oceanic Islands: *Cistus monspeliensis* (Cistaceae) in the Canary Islands

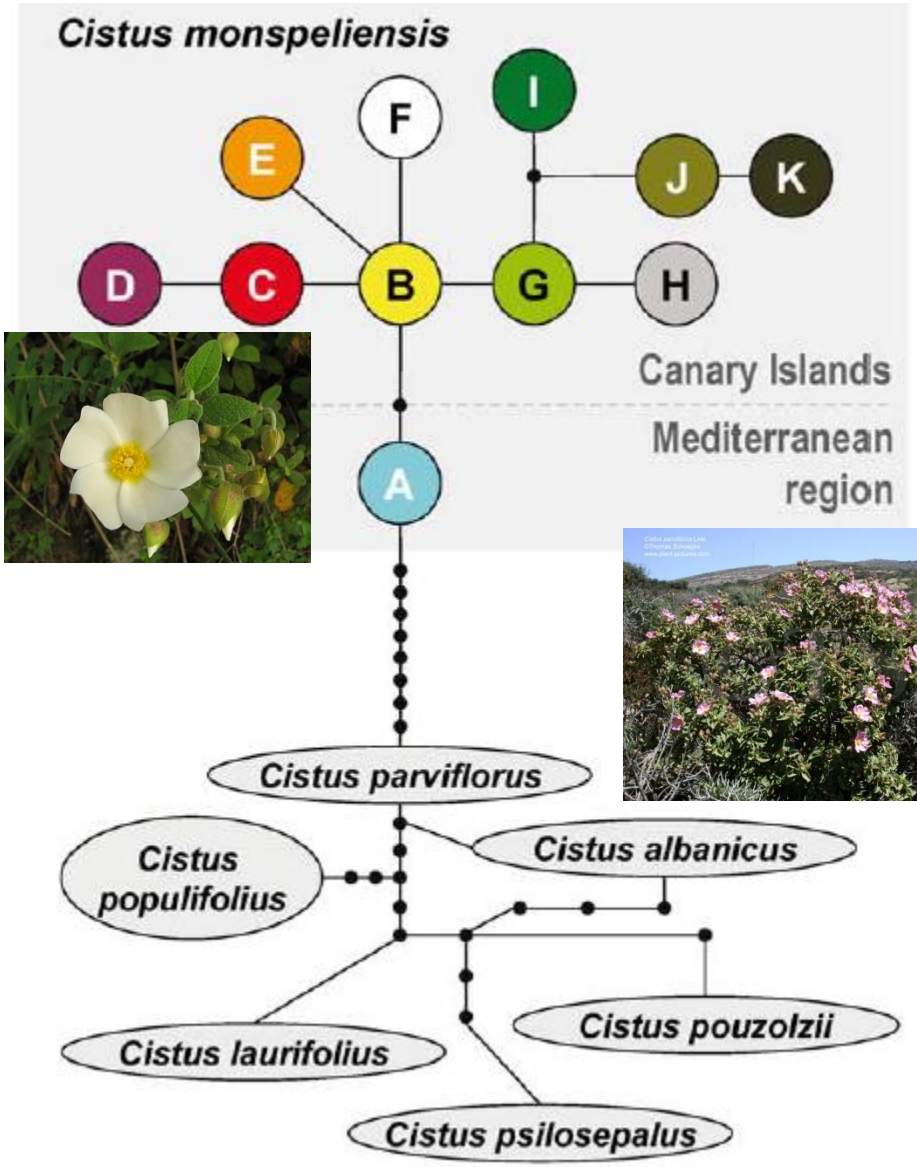
Mario Fernández-Mazuecos*, Pablo Vargas

Table 2. Variable sites of substitution-based haplotypes found in 47 *C. monspeliensis* populations from the Mediterranean (A) and the Canary Islands (B–K), based on *trn*S-*trn*G (617 bp) and *psb*K-*trn*S (367 bp) sequences.

		DNA region											
		*trn*S-*trn*G sequence position						*psb*K-*trn*S sequence position					
Haplotype	Number of individuals	3	26	357	358	396	412	458	6	14	93	124	365
A	26	T	G	G	A	T	A	A	T	A	C	T	A
B	8	T	A	T	A	T	A	A	T	A	C	T	A
C	8	T	A	T	A	T	A	A	T	A	C	A	A
D	5	T	A	T	A	T	A	A	T	T	C	A	A
E	2	T	A	T	A	T	A	A	T	A	A	T	A
F	1	T	A	T	A	T	A	C	T	A	C	T	A
G	9	T	A	T	A	T	A	A	G	A	C	T	A
H	2	T	A	T	A	T	C	A	G	A	C	T	A
I	2	T	A	T	C	G	A	A	G	A	C	T	A
J	14	T	A	T	C	T	A	A	G	A	C	T	G
K	2	G	A	T	C	T	A	A	G	A	C	T	G

doi:10.1371/journal.pone.0017172.t002


A
Mediterranean Sea
Canary
Islands
B
La Palma
4
3
7
5
6
Tenerife
16
11
14
13
15
12
La Gomera
8
9
10
Gran
Canaria
18
21
19
17
20
El Hierro
1
2


Cistus monspeliensis
F
I
E
J
K
D
C
B
G
H
A
Canary Islands
Mediterranean region
Cistus parviflorus
Cistus albanicus
Cistus populifolius
Cistus pouzolzii
Cistus laurifolius
Cistus psilosepalus

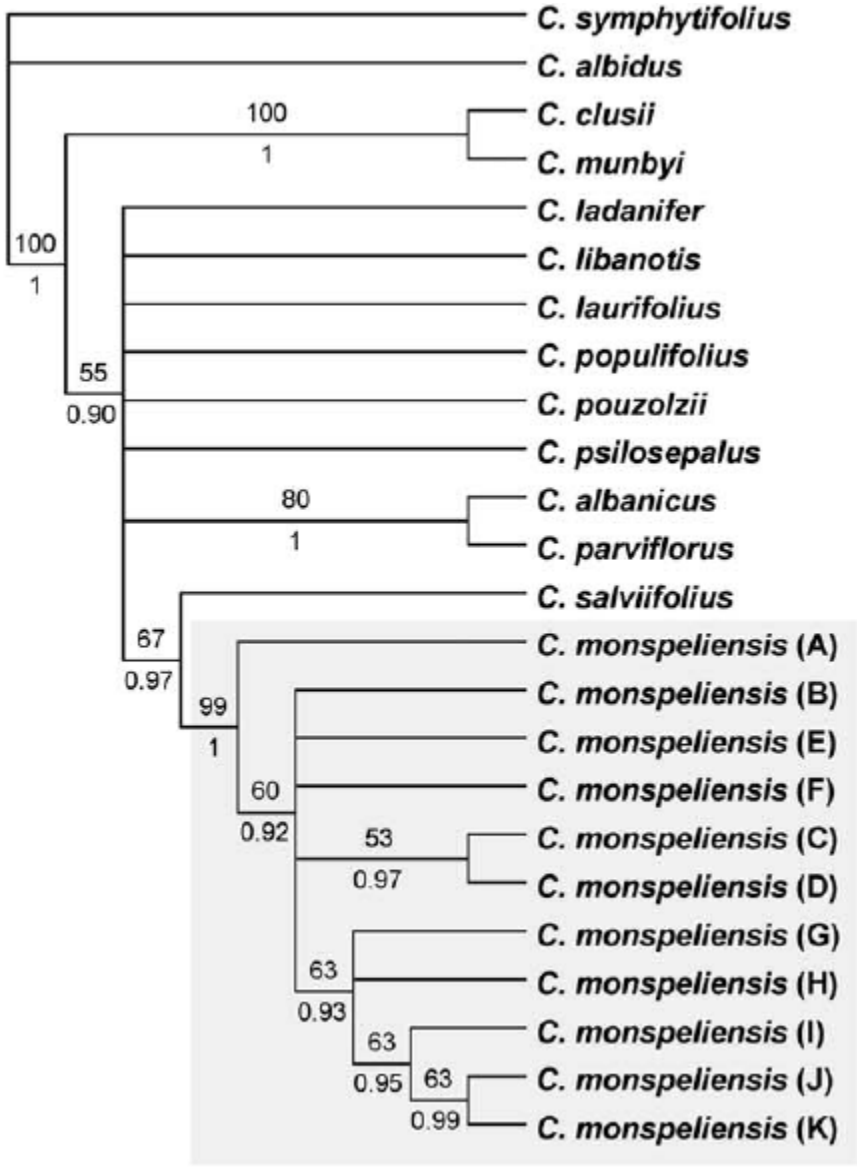

C. symphytifolius
C. albidus
C. clusii
C. munbyi
C. ladanifer
C. libanotis
C. laurifolius
C. populifolius
C. pouzolzii
C. psilosepalus
C. albanicus
C. parviflorus
C. salviifolius
C. monspeliensis (A)
C. monspeliensis (B)
C. monspeliensis (E)
C. monspeliensis (F)
C. monspeliensis (C)
C. monspeliensis (D)
C. monspeliensis (G)
C. monspeliensis (H)
C. monspeliensis (I)
C. monspeliensis (J)
C. monspeliensis (K)
100
1
100
1
55
0.90
80
1
67
0.97
99
1
60
0.92
53
0.97
63
0.93
63
0.95
63
0.99

Table 3. Genetic diversity parameters across populations of *Cistus monspeliensis* using the *trnS-trnG* and *psbK-trnS* sequence regions.

	n	*h*	*ph*	*H*
Canary Islands	53	10	10	0.857
Tenerife	12	5	1	0.803
El Hierro	6	3	1	0.733
Gran Canaria	14	4	1	0.648
La Gomera	8	3	1	0.607
La Palma	13	2	2	0.513
Mediterranean region	26	1	1	0.000

n = number of sampled individuals; *h* = number of substitution-based haplotypes; *ph* = number of private haplotypes; *H* = haplotypic diversity. Entries are sorted by *H* values.

doi:10.1371/journal.pone.0017172.t003

Datace oddělení středomořské a kanárské fylogenetických větví je **930,000 let** ve středním Pleistocénu, následovaná radiací

Středomořská linie pravděpodobně prošla obdobím genetického bottlenecku, v době zalednění a zpětné kolonizace.

Species invasions and extinction: The future of native biodiversity on islands

Dov F. Sax*† and Steven D. Gaines‡§

11490–11497 | PNAS | August 12, 2008 | vol. 105 | suppl. 1 www.pnas.org/cgi/doi/10.1073/pnas.0802290105

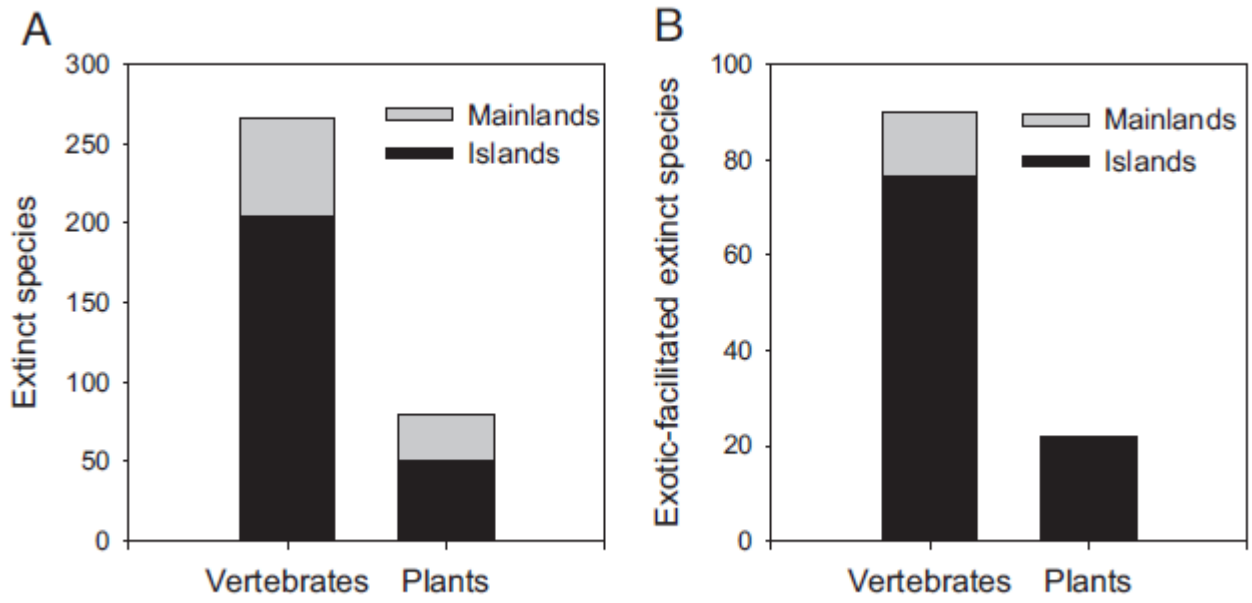


Fig. 1. Extinction patterns over the last 500 years, from the International Union for Conservation of Nature database. (*A*) The majority of documented extinctions have been on islands, as opposed to mainlands, for both terrestrial vertebrates (birds, mammals, reptiles, and amphibians) and plants. (*B*) Extinctions facilitated by exotic species (i.e., in which exotics are listed as at least one of the factors contributing to a species extinction) show the same pattern, with more extinctions on islands, as opposed to mainlands. (*C*) Among the 204 vertebrate species with listed causes of extinction, some form of predation (including human hunting, carnivory, and infectious disease) is cited as the sole factor responsible for species extinctions in 69 (33.8%) of extinctions, predation together with other

Ostrovy a invaze nových druhů rostlin

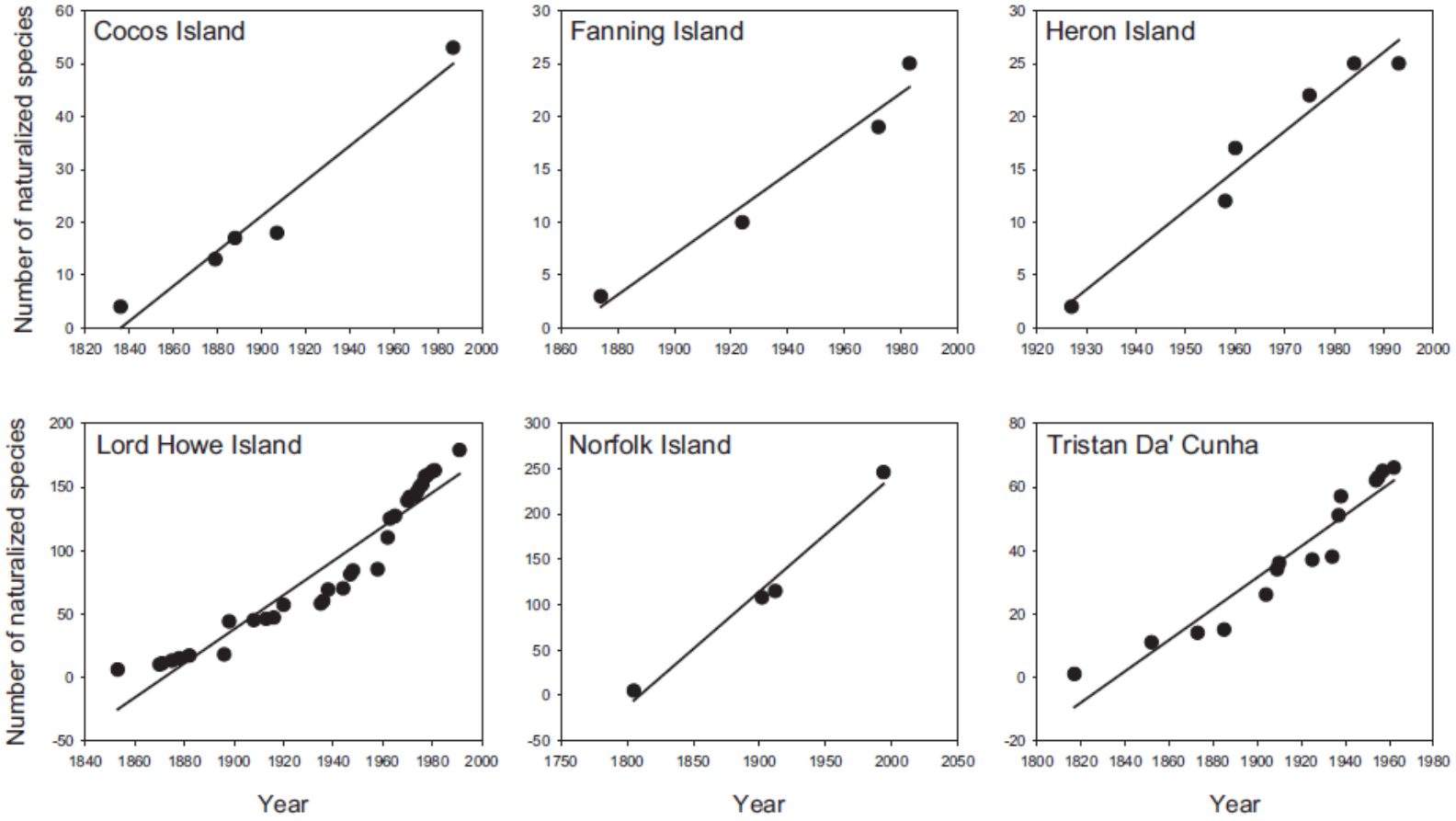
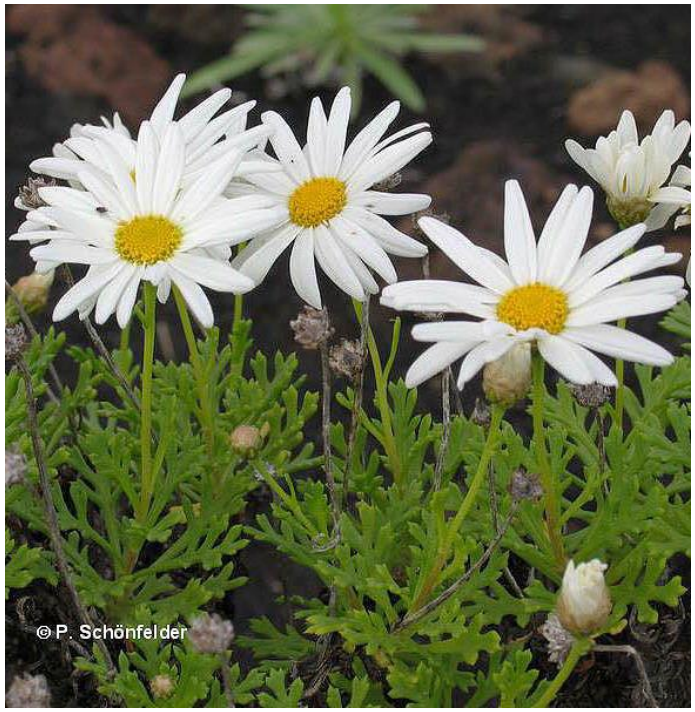


Fig. 3. Naturalized plant richness has increased on oceanic islands in an approximately linear fashion over the past 200 years. Regression lines are all highly significant. None of these islands show evidence of an asymptote in cumulative richness of naturalized species over time.

www.pnas.org/cgi/doi/10.1073/pnas.0802290105

Argyranthemum coronopifolium

Endemitický druh na Tenerife
Nacházející se na pouze 7 lokalitách



Hybridizace s rozšířenějším, invazivním
druhem *A. frutescens*

Od roku 1965 kdy byla postavena silnice procházející napříč ostrovem

V roce 1985 zaznamenímí již jen dominantní hybridi a *A. frutescens*

Erythrina tahitensis

Organism Type
Plant
Taxonomy
Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Fabales
Family: Leguminosae
Genus: Erythrina
Species: *Erythrina tahitensis*
Species Authority: Nadeaud
Biome
Terrestrial

Species Status

Critically Endangered

Invasive Species Threat Summary

Erythrina tahitensis is classified as 'Critically Endangered (CR)' in the IUCN Red List of Threatened Species. It is endemic to Tahiti in the Society Islands, French Polynesia (Florence, 1998).

Approximately 70% of Tahiti's endemic plant species occur in wet upland forests, where the primary threat encountered is the uncontrolled spread of invasive alien plants (Meyer, 2004). ***Miconia calvescens*** is the principal invader of the Society Islands, including Tahiti and thus constitutes a major threat to *E. tahitensis*. *M. calvescens* forms impenetrable monotypic stands, and its broad leaves severely reduce light levels in the understorey, which has adverse impacts on many native plant species (Meyer, 1996). Other invasive animals have also contributed to the spread of the weed through frugivory and seed dispersal; examples of introduced seed dispersers of *M. calvescens* are: the silvereye (*Zosterops lateralis*), the red-vented bulbul (***Pycnonotus cafer***), the Pacific rat (***Rattus exulans***) (Meyer, 1996), as well as feral goats (***Capra hircus***) (Meyer, 2004).

Other invasive plant species present on Tahiti and potentially affecting *E. tahitensis* include: ***Lantana camara***, which forms dense stands shading out other natives, ***Ardisia elliptica***, and the rose apple (***Syzygium jambos*** (Meyer, 2004).

Invasive Species Management Summary

Control of *M. calvescens*, which involved the release of a defoliating fungal pathogen *Colletotrichum gloeosporioides* led to severe leaf damage and seedling mortality of the weed. Long-term monitoring showed a general increase in native and endemic species richness and plant cover in treated plots (Meyer, 2012).

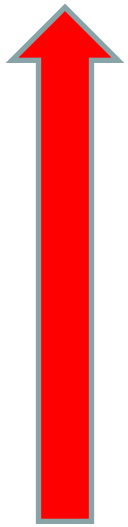
Species Impact

Refresh

Threatened Species	Species Status	Invasive Species	Impact Mechanism	Impact Outcome	Count of Species Locations
Erythrina tahitensis	Critically Endangered	*Ardisia elliptica*	Competition	Decline in population	1
Erythrina tahitensis	Critically Endangered	*Lantana camara*	Competition	Decline in population	1
Erythrina tahitensis	Critically Endangered	*Miconia calvescens*	Competition	Decline in population	1
Erythrina tahitensis	Critically Endangered	*Syzygium jambos*	Competition	Decline in population	1
Erythrina tahitensis	Critically Endangered	*Capra hircus*	Grazing/herbivory/browsing	Habitat degradation	1
Erythrina tahitensis	Critically Endangered	*Rattus exulans*	Interaction with other invasive species	Other	1
Erythrina tahitensis	Critically Endangered	*Capra hircus*	Interaction with other invasive species	Other	1
Erythrina tahitensis	Critically Endangered	*Pycnonotus cafer*	Interaction with other invasive species	Other	1
Erythrina tahitensis	Critically Endangered	*Zosterops lateralis*	Interaction with other invasive species	Other	1
Erythrina tahitensis	Critically Endangered	*Capra hircus*	Trampling	Habitat degradation	1

Table 1. Ratio (and standard error) of naturalized to native plant species on oceanic islands

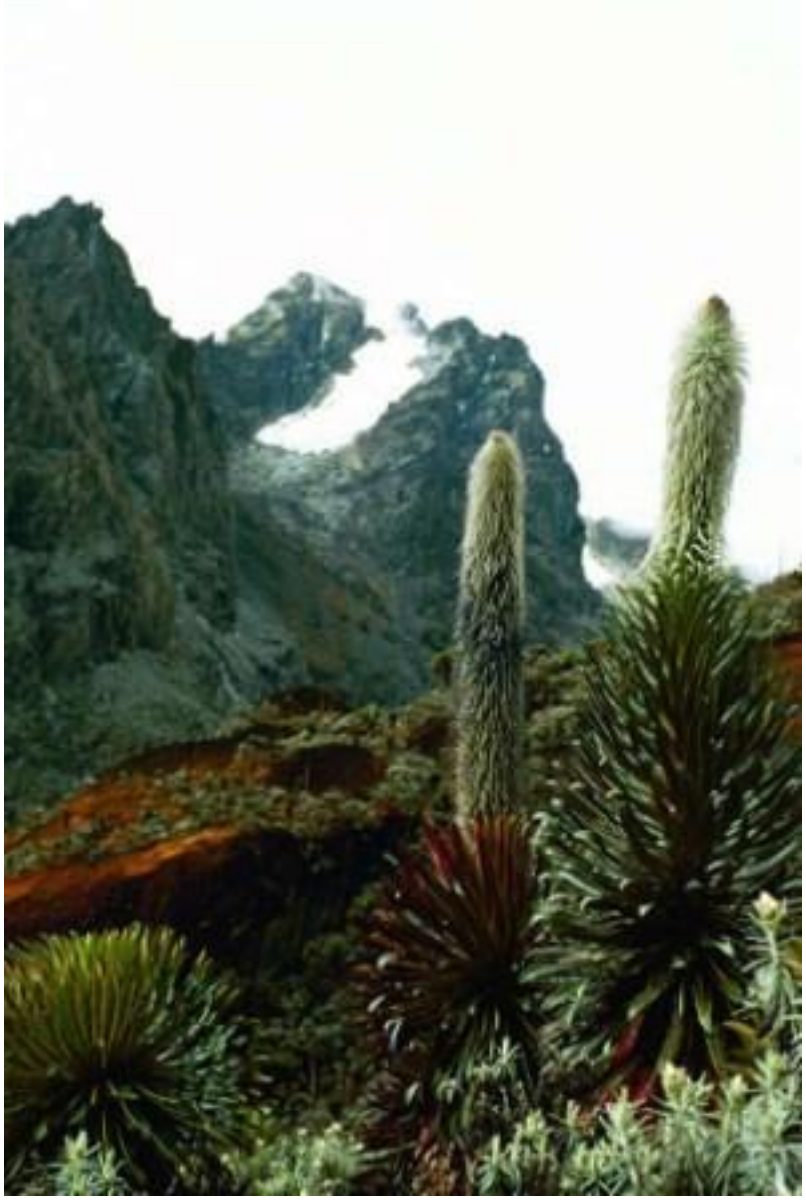
Year	Ratio	SE
2000	1.07	0.11
1980	1.07	0.14
1960	0.70	0.13
1940	0.52	0.15
1920	0.44	0.09
1900	0.31	0.09
1880	0.15	0.03
1860	0.07	0.04



Nejen ostrovy v oceánu, ale i ostrovy v rámci pevniny

Například vysokohorské druhy tropické Afriky

Senecio brassicas



Lobellia sp.

Island radiation on a continental scale: Exceptional rates of plant diversification after uplift of the Andes

Colin Hughes* and Ruth Eastwood

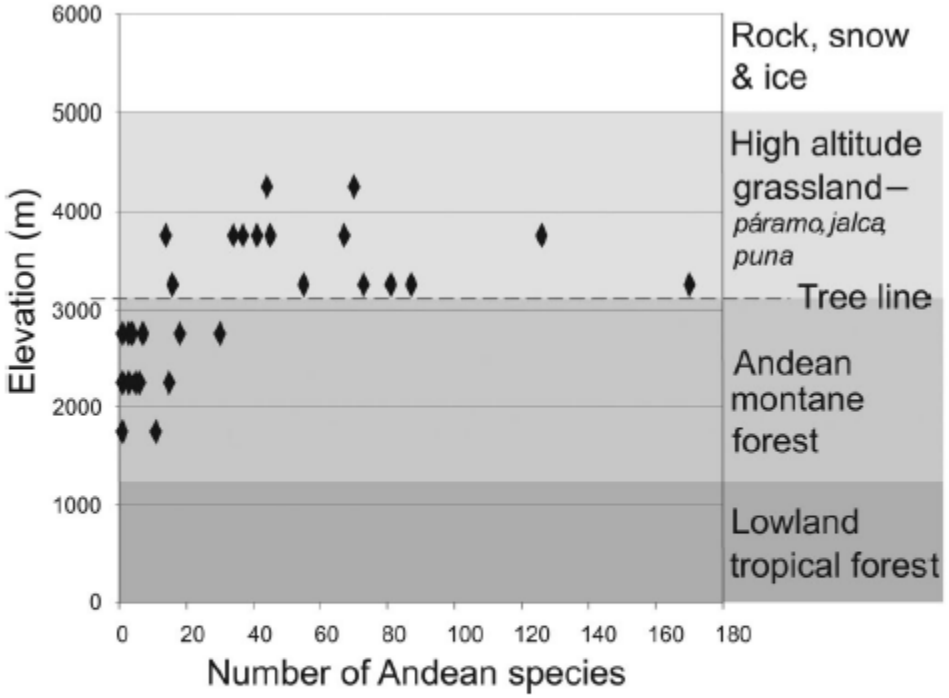


Fig. 2. Altitudinal variation in Andean species diversification. Data points represent plant genera with putative north temperate origins (see *Methods*). Diversification is concentrated above 3,000 m in the high-altitude grassland vegetation zone (Fig. 1).

Fig. 1. The Andes as an island archipelago. This map shows the distribution of land over 3,000 m elevation, corresponding to the lower limit of the high-altitude grassland (páramo, jalca, and puna) vegetation zone. Although a few Andean *Lupinus* species occur at lower elevations, the genus is most diverse in the 3,000- to 4,000-m zone. *Lupinus* species are ubiquitous in all of the high-elevation "islands" from Venezuela and the Sierra Nevada Santa Marta in northern Colombia in the north to northwest Argentina in the south, and the geographical extent of the Andean *Lupinus* radiation (Fig. 3, k) closely matches the overall area of the Andean "archipelago" as delimited here.

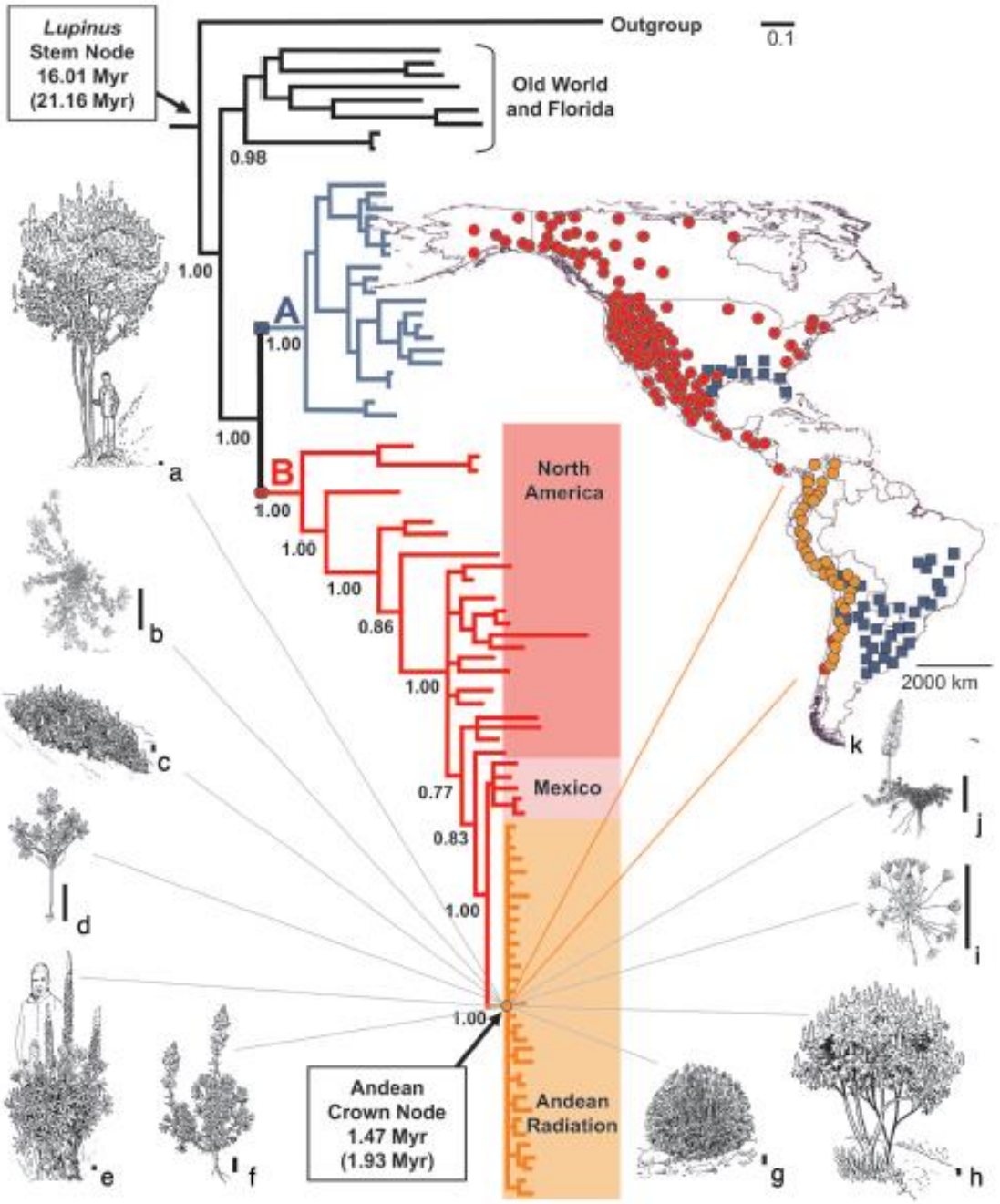


Fig. 3. Phylogeny of *Lupinus*. Fifty percent majority rule Bayesian tree from analysis of the combined ITS/*LEGCYCIA* data sets. Posterior probabilities of major clades are shown below nodes; all nodes had posterior probabilities >0.5. This tree is congruent with the strict consensus derived from parsimony

Mimořádně vysoká diverzifikace druhů *Lupinus*

2,5 – 3,7 druhu /milión let

Valeriana
0,8 – 1,3

Gentianella
1,7 – 3, 2