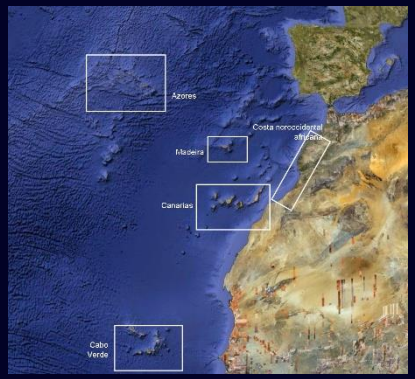
Integrating data repositories with multi-disciplinary analyses to address practical conservation questions using updated science: examples from Macaronesia and the Mediterranean

4th Mediterranean Plant Conservation Week

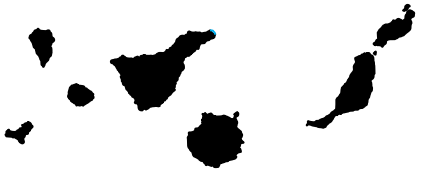
VALÈNCIA | 23-27 OCTOBER | 2023

Dr. Juli Caujapé Castells

Departamento de Biodiversidad Molecular y Banco de ADN. Jardín Botánico Canario "Viera y Clavijo"-Unidad Asociada al CSIC, Cabildo de Gran Canaria & IUCN *Macaronesian Islands Plant Specialist Group, IUCN Species Survival Comision*

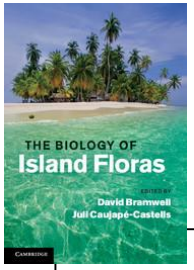


Origins of the Canarian Flora



The Canaries have been sampling biodiversity various regions since the mid-Miocene till now

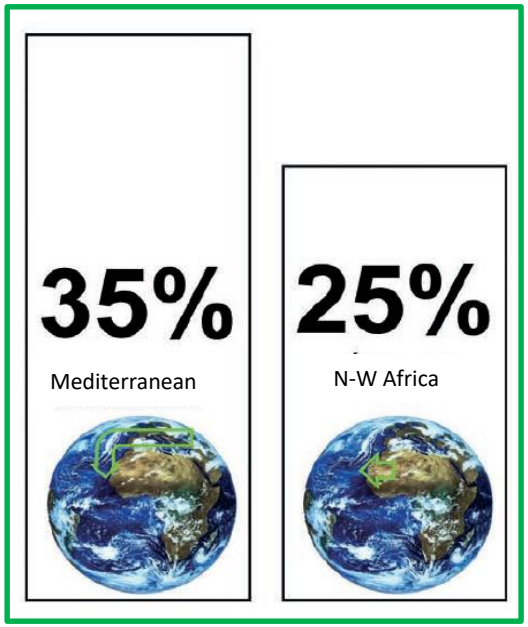
Canarian endemic flora = imperfect representation of the historical floristic links between the archipelago and the Mediterranean region



12

Jesters, red queens, boomerangs and surfers: a molecular outlook on the diversity of the Canarian endemic flora

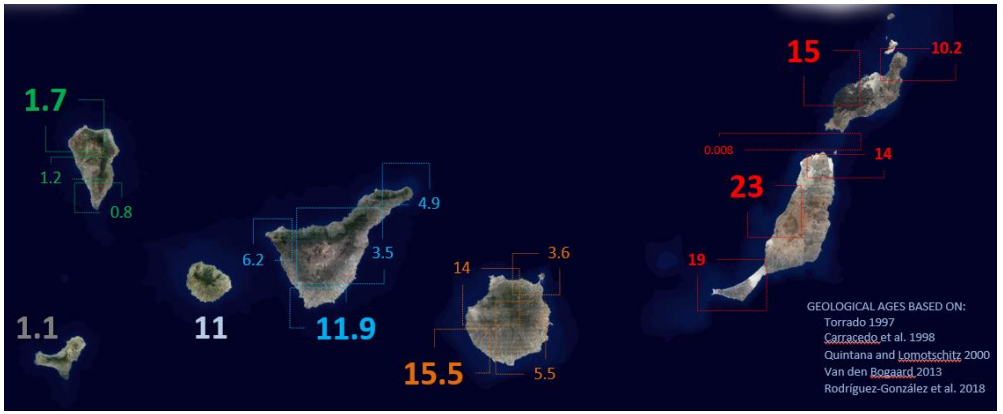
JULI CAUJAPÉ-CASTELLS



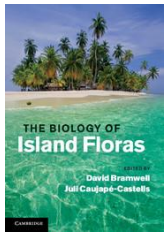
American Journal of Botany 91(7): 1070–1085. 2004.

RELATIONSHIPS OF THE MACARONESIAN AND MEDITERRANEAN FLORAS: MOLECULAR EVIDENCE FOR MULTIPLE COLONIZATIONS INTO MACARONESIA AND BACK-COLONIZATION OF THE CONTINENT IN *CONVOLVULUS* (CONVOLVULACEAE)[1]

MARK A. CARINE,[2,5] STEPHEN J. RUSSELL,[2] ARNOLDO SANTOS-GUERRA,[3] AND JAVIER FRANCISCO-ORTEGA[4]



Contrasting views across a 30-year gap



Perspectives in Plant Ecology, Evolution and Systematics 27 (2017) 9–22

Contents lists available at ScienceDirect

Perspectives in Plant Ecology, Evolution and Systematics

journal homepage: www.elsevier.com/locate/ppees

Review

Island ontogenies, syngameons, and the origins and evolution of genetic diversity in the Canarian endemic flora

Juli Caujapé-Castells[a,*], Carlos García-Verdugo[a], Águedo Marrero-Rodríguez[a], José María Fernández-Palacios[b], Daniel J. Crawford[c], Mark E. Mort[d]

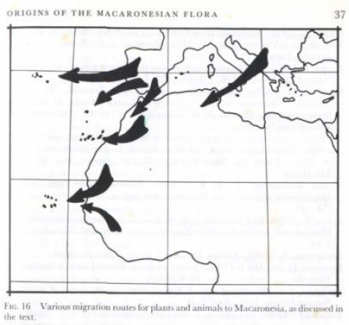
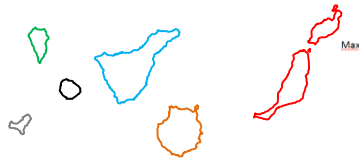


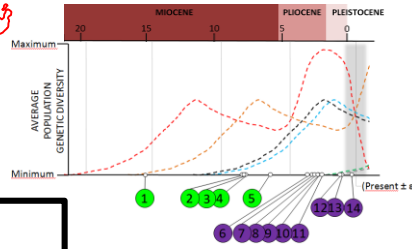
Fig. 16 Various migration routes for plants and animals to Macaronesia, as discussed in the text.

- Low probability of island colonization
- Diverse continental origins
- Islands are evolutionary sinks
  - -Low or null inter-island/archipelago migration?
  - -No island-mainland flow (but Carlquist 1974…)

- Colonizers of multiple origins…in different times…
- Back-colonization of the mainland (Westerlies)…
- Within-island migration and diversification…
- Recurrent and frequent Island hopping… Extinction… …recolonization….hybridization

Sunding P (1979) Origins of the Macaronesian flora. Pp. 13-40 In D. Bramwell (ed.) *Plants and Islands.* London, Academic Press .





Thorough geographical sampling + DNA sequence regions + genomic data…

Better resolution of relationships, intra- and inter-island colonizations, and overlooked taxa

Tolpis (Asteraceae, Gruenstaeudl et al. 2012, Mort et al. 2015)
Olea (Oleaceae, García-Verdugo et al. 2009)
Ruta (Rutaceae, Soto et al. submitted)
Dorycnium (Fabaceae, Jaén-Molina et al. 2015 & in prep.)
Periploca (Apocynaceae, García-Verdugo et al. 2015, 2017)
Scrophularia (Scrophulariaceae, Valtueña et al. 2016)
Micromeria (Lamiaceae, Puppo et al. 2014, 2016, Curto et al. 2017)
Echium (Boraginaceae, García-Maroto et al. 2009)
Euphorbia (Euphorbiaceae, Villaverde et al. 2018)
Lotus (Jaén-Molina et al. 2021)
Solanum (Gramazio et al. 2021)
Ruta (Soto et al. 2022)
……

On all oceanic archipelagoes…

-Geographic features (ecological zones, ravines, the sea)

-Processes (dispersal, colonization, speciation, extinction)

-Patterns (high % of SIE, radiating lineages)

-Problems (conservation, management)


Perspectives in Plant Ecology, Evolution and Systematics 12 (2010) 107–129

Contents lists available at ScienceDirect

Perspectives in Plant Ecology, Evolution and Systematics

journal homepage: www.elsevier.de/ppees

ELSEVIER

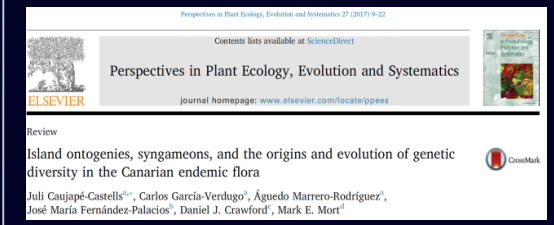
Review

Conservation of oceanic island floras: Present and future global challenges

Juli Caujapé-Castells [a,*], Alan Tye [b], Daniel J. Crawford [c], Arnoldo Santos-Guerra [d], Ann Sakai [e], Katy Beaver [f], Wolfram Lobin [g], F.B. Vincent Florens [h,i], Mônica Moura [j], Roberto Jardim [k], Isildo Gómes [l], Christoph Kueffer [m]

“Previsualization” of biodiversity evolution and of conservation strategies in other areas of the planet

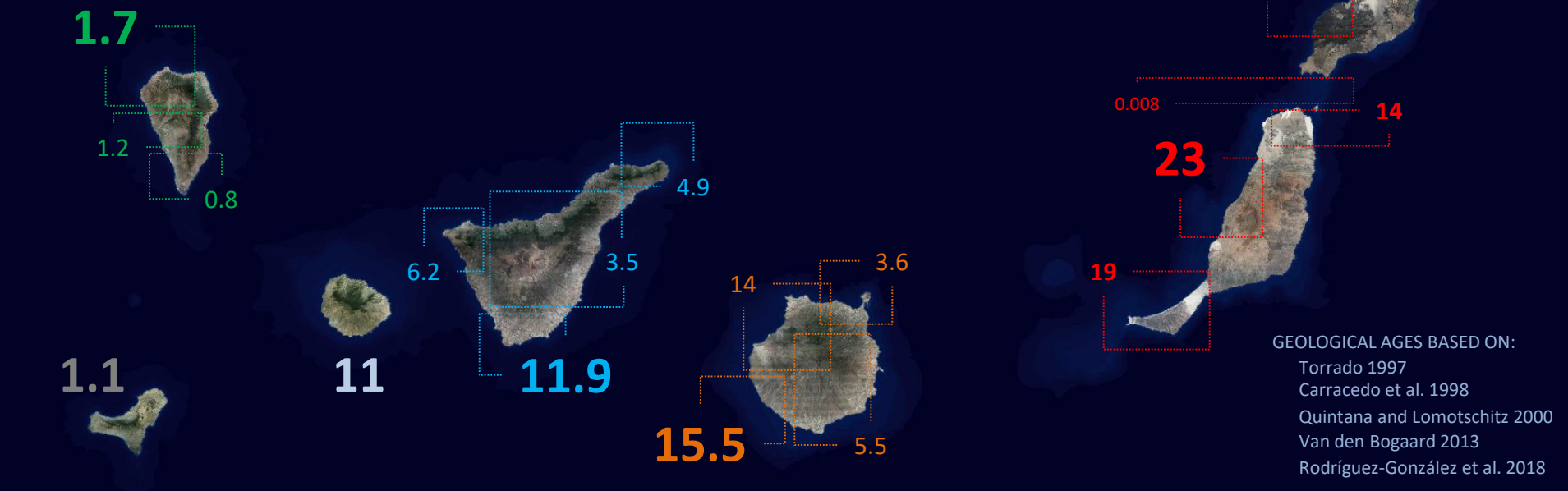
The "ontogenetic mismatch", an enhancer of genetic diversity in multi-island archipelagoes



Past

Plenty of opportunities for extinction, migration among and within islands, retrocolonization, hybridization, speciation…in the same and different spaces

Present ± ε



GEOLOGICAL AGES BASED ON:

Torrado 1997
Carracedo et al. 1998
Quintana and Lomotschitz 2000
Van den Bogaard 2013
Rodríguez-González et al. 2018

Curto *et al. BMC Evolutionary Biology* (2017) 17:198
DOI 10.1186/s12862-017-1031-y

BMC Evolutionary Biology

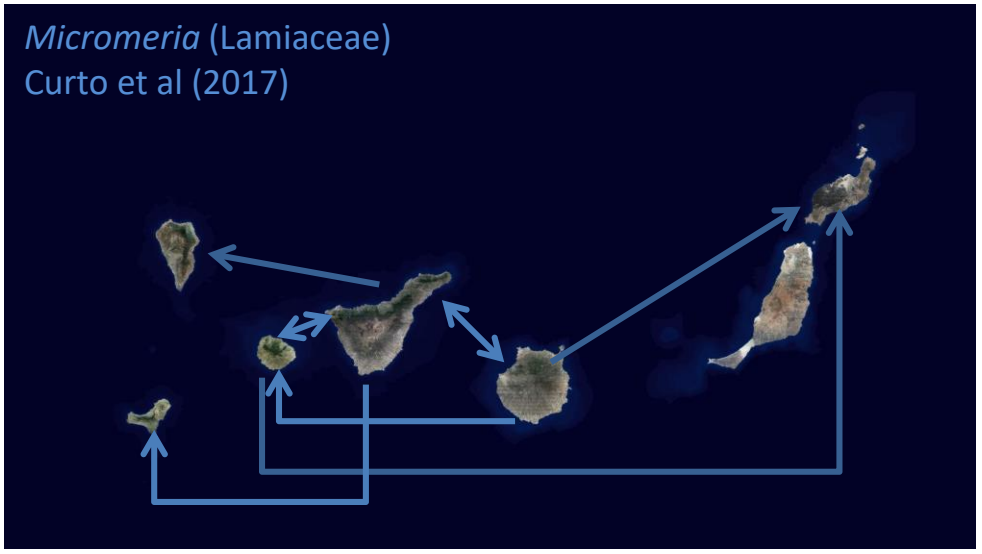
RESEARCH ARTICLE Open Access

Genetic diversity and differentiation patterns in *Micromeria* from the Canary Islands are congruent with multiple colonization dynamics and the establishment of species syngameons

M. Curto[1,2*], P. Puppo[2], S. Kratschmer[1] and H. Meimberg[1]

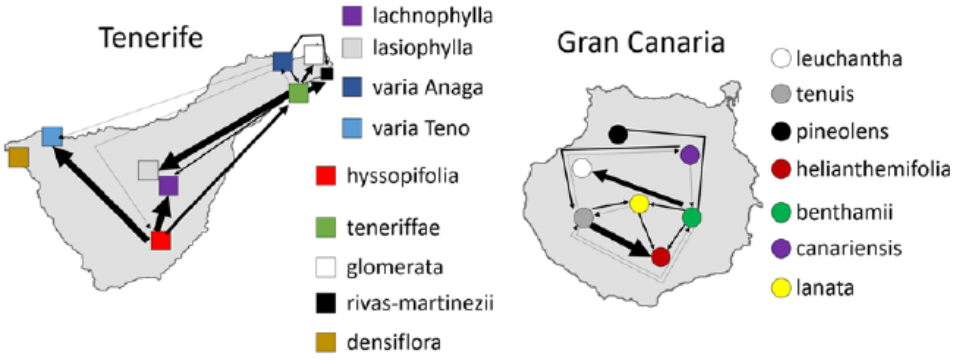
16 microsatellite markers

Extremely abundant past and contemporary gene-flow entailing hybridization within and between islands

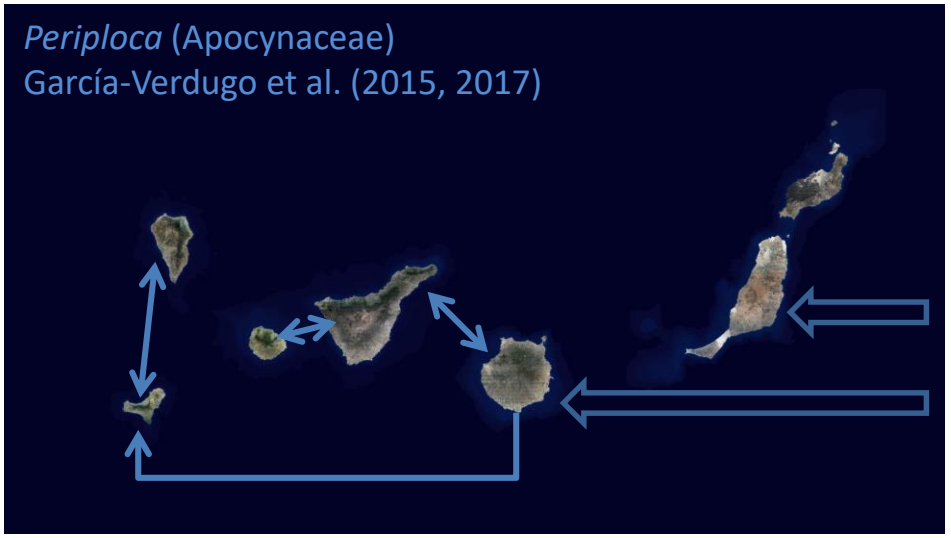


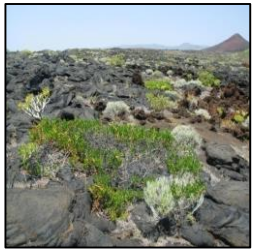
Progression Rule rejected:
Retro colonization of older islands from younger islands.

Detection impossible with other markers despite thorough geographical sampling, because of limited genetic sampling & polymorphism



Periploca (Apocynaceae)
García-Verdugo et al. (2015, 2017)



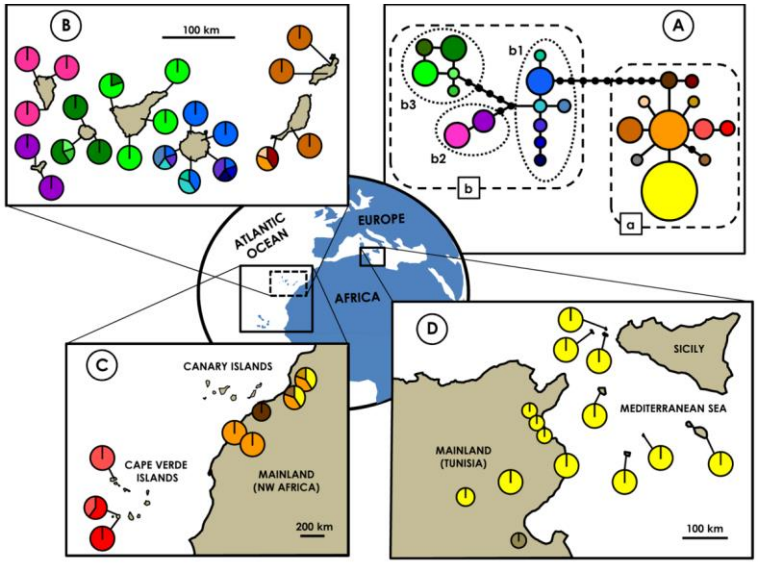


ORIGINAL ARTICLE

WILEY Journal of Biogeography

The loss of dispersal on islands hypothesis revisited: Implementing phylogeography to investigate evolution of dispersal traits in *Periploca* (Apocynaceae)

C. García-Verdugo[1] | M. Mairal[2] | P. Monroy[1,3] | M. Sajeva[4] | J. Caujapé-Castells[1]



Progression rule rejected

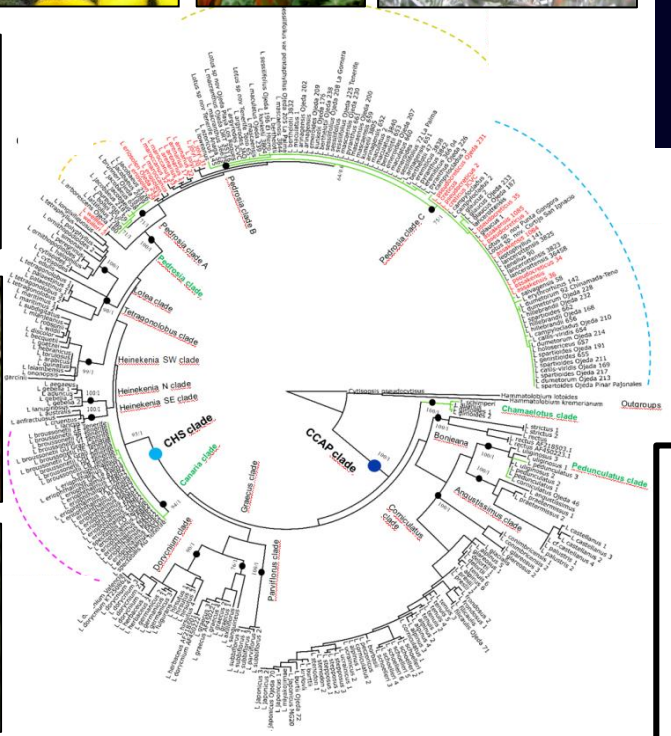
- Two well-differentiated lineages associated with multiple colonization waves
- Colonization routes within the western lineage not compatible with an east-to-west pattern

Dispersal ability may be favored on islands, possibly because traits enhancing wind dispersal are positively selected when habitat availability is high.









Lotus (Fabaceae)
Jaén-Molina et al. (submitted)

Molecular Phylogenetics and Evolution 154 (2021) 106970

Contents lists available at ScienceDirect

Molecular Phylogenetics and Evolution

journal homepage: www.elsevier.com/locate/ympev

Molecular phylogenetics of *Lotus* (Leguminosae) with emphasis in the tempo and patterns of colonization in the Macaronesian region

Ruth Jaén-Molina [a,*], Águedo Marrero-Rodríguez [a], Juli Caujapé-Castells [a], Dario I. Ojeda [b]

Multiple founder events

Independent colonizations of the same island, followed by hybridization

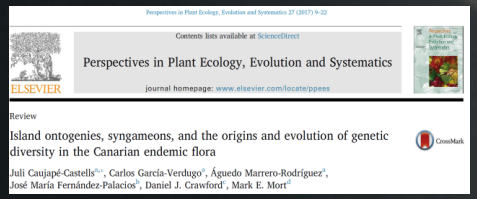
Multiple habitat shifts

Progression rule rejected:

-Colonization of older islands from younger islands

-Mainland back colonization

Biodiversity is constantly taking shape on islands


Perspectives in Plant Ecology, Evolution and Systematics 27 (2017) 9–22

Contents lists available at ScienceDirect

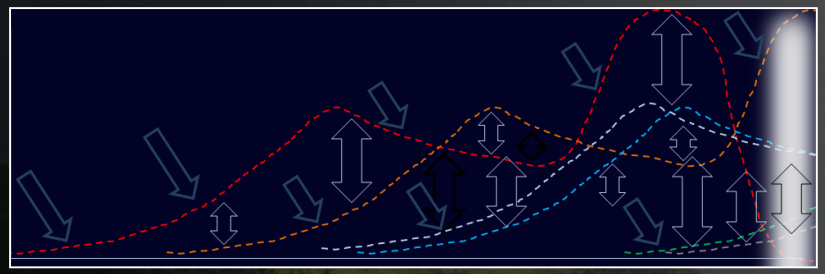
Perspectives in Plant Ecology, Evolution and Systematics

journal homepage: www.elsevier.com/locate/ppees

Review

Island ontogenies, syngameons, and the origins and evolution of genetic diversity in the Canarian endemic flora

Juli Caujapé-Castells[a,*], Carlos García-Verdugo[b], Águedo Marrero-Rodríguez[a], José María Fernández-Palacios[b], Daniel J. Crawford[c], Mark E. Mort[d]



EVOLUTION IN ACTION

- Recurrent cycles of gene flow burts and interruptions develop symbiotically with geological ontogeny and biological interactions increase genetic diversity, especially in multi-island archipelagos with an ontogenetic mismatch, like the Canary Islands
- Application of molecular tools and taxonomy keep revealing overlooked and cryptic species, and incipient speciation processes
- Islands are still being colonized and neoendemics are generated in older and newer islands

Messages of research for conservation and management

1 The population is the natural conservation unit for reinforcements and reintroductions, even in the absence of genetic data.

- **1.1.** Reinforcing populations with genetic material from other islans is by no means advisable
- **1.2.** Plant nurseries should have a strict traceability of the individuals that they grow
- **1.3.** Reproductive biology studies keep beiing necessary to detect and correct demographic shortfalls

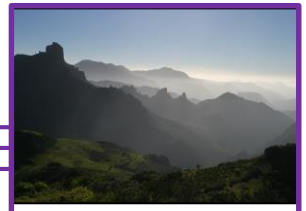
Messages of research for conservation and management

Neoendemics

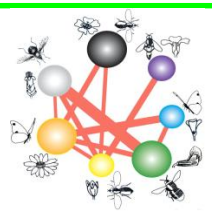
Palaeoendemics

ECOSYSTEM SERVICES
- Provisioning
- Regulation
- Support
- Cultural management

ASSISTED MIGRATION



HABITAT CONSERVATION



ENFORCE MUTUALISMS

Perspectives in Plant Ecology, Evolution and Systematics 12 (2010) 107–129
Contents lists available at ScienceDirect
Perspectives in Plant Ecology, Evolution and Systematics
journal homepage: www.elsevier.de/ppees

Review

Conservation of oceanic island floras: Present and future global challenges

Juli Caujapé-Castells [a,*], Alan Tye [b], Daniel J. Crawford [c], Arnoldo Santos-Guerra [d], Ann Sakai [e], Katy Beaver [f], Wolfram Lobin [g], F.B. Vincent Florens [h,i], Mónica Moura [j], Roberto Jardim [k], Isildo Gómes [l], Christoph Kueffer [m]

CONCEPTS AND QUESTIONS

Reconciling conflicting perspectives for biodiversity conservation in the Anthropocene

Christoph Kueffer* and Christopher N Kaiser-Bunbury*

Front Ecol Environ 2014; 12(2): 131–137,

RESEARCH

REVIEW

CONSERVATION

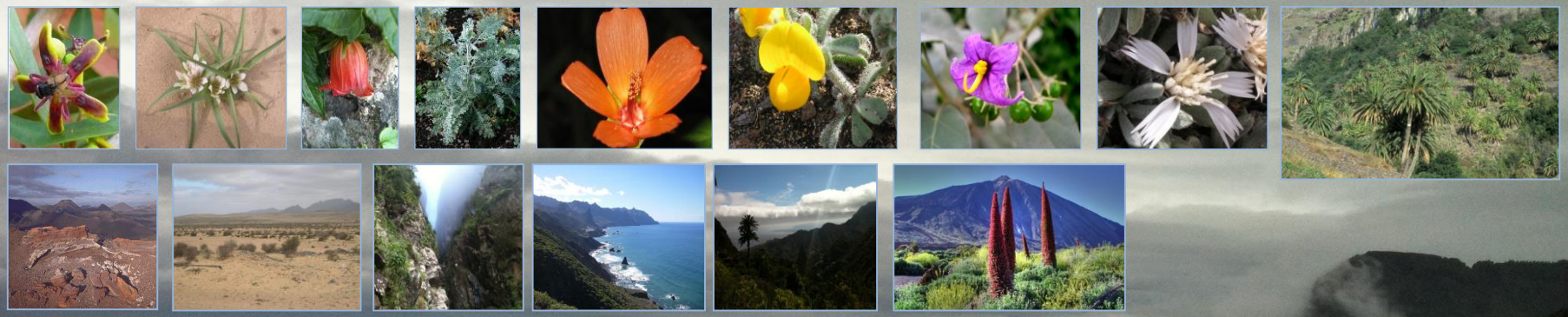
Merging paleobiology with conservation biology to guide the future of terrestrial ecosystems

Barnosky *et al.*, *Science* 355, eaah4787 (2017) 10 February 2017

- -Biodiversity coproduction
- -Parks near Natural Spaces
- -New ecosystems
- -Implication of education and touristic centres

2 Species management should consider their great chronological heterogeneity. Wide ‘time oceans’ separate the species which occupy the same space, with conservation consequences.

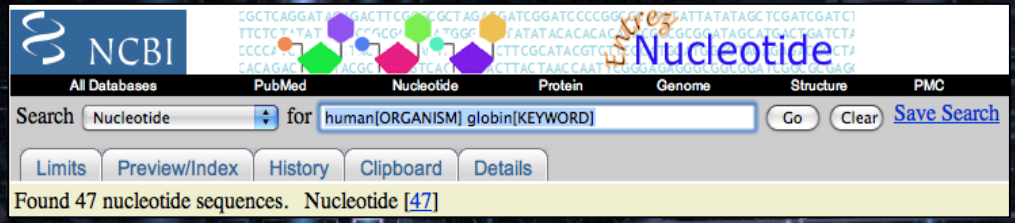
Messages of research for conservation and management



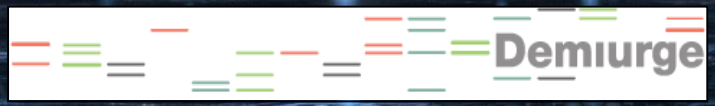
3 Strive to maintain connectivity and foster adaptation to changes to generate the endemics of the future, facilitating their adaptive and functional capacities

Mensajes de la investigación para la conservación

It is imperative to preserve all data relevant for conservation….



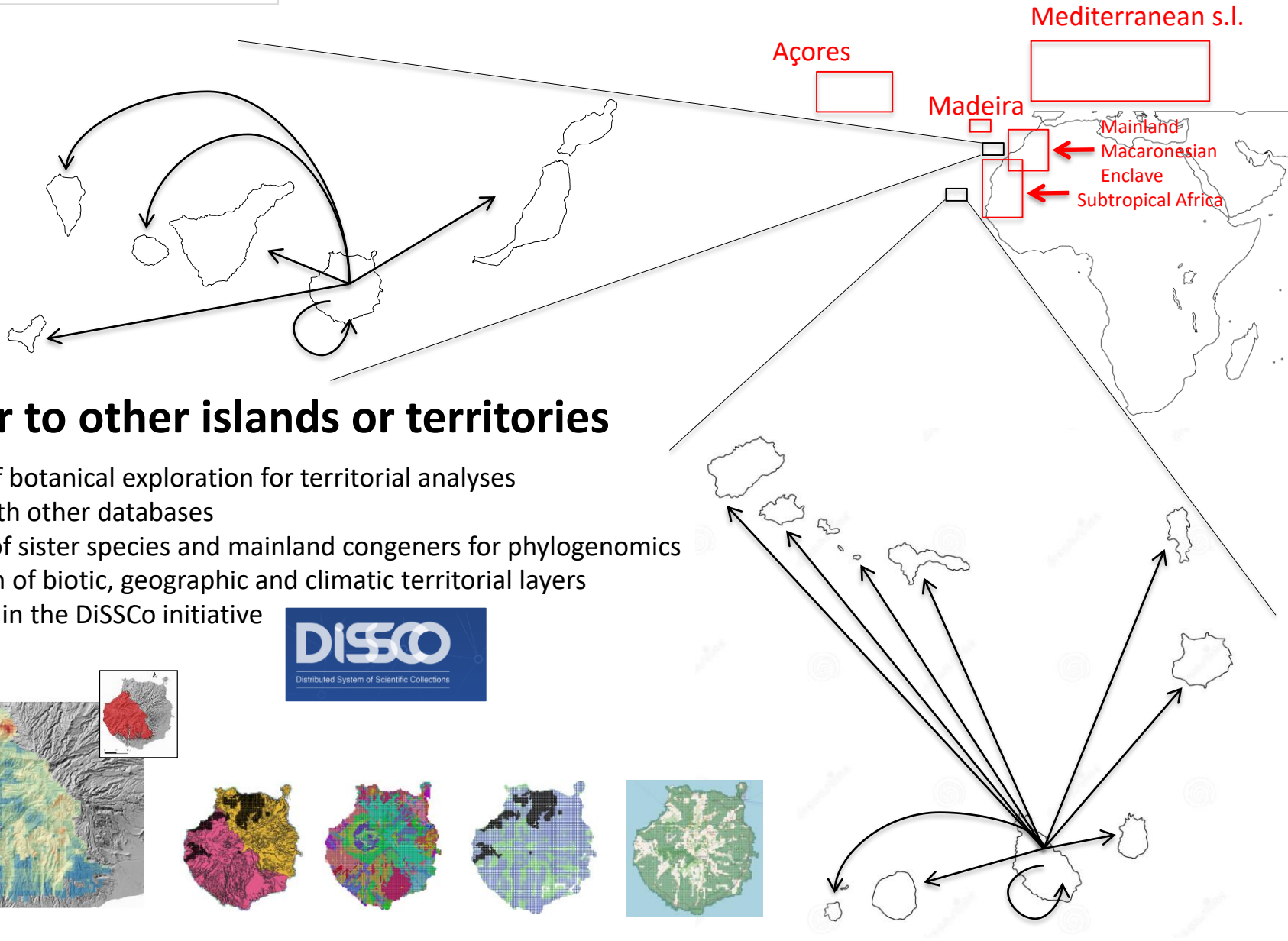
…but static data repositories have to be linked to information systems that facilitate multidisciplinary analysis through supercomputing pipelines.



- Dated molecular phylogenetics/omics of the Macaronesian floras
- Multiple abiotic and abiotic territorial data layers
- Selection of territories with suitable ecological characteristics for conservation actions
- Molecular ID of any simple (barcode sequences and soon the entire plastome)
- Information repository of genetic data and all ancillary geographic information
- Tightly linked to banks of biological samples

NEXTGENDEM
Gestión Evolutiva de la Diversidad Vegetal Terrestre Endémica de la Macaronesia

¿Future?



Transfer to other islands or territories

- Increase of botanical exploration for territorial analyses
- Linkage with other databases
- Sampling of sister species and mainland congeners for phylogenomics
- Generation of biotic, geographic and climatic territorial layers
- Integrated in the DiSSCo initiative

DiSSCo
Distributed System of Scientific Collections

Cabildo de Gran Canaria

JARDIN BOTANICO CANARIO VIERA Y CLAVIJO

CSIC UNIDAD ASOCIADA

itc INSTITUTO TECNOLÓGICO DE CANARIAS

IUCN SSC Macaronesian Island Plant Specialist Group

NEXTGENDEM
Gestión Evolutiva de la Diversidad Vegetal Terrestre Endémica de la Macaronesia

biota Banco de Datos de Biodiversidad de Canarias

THANKS!
GRÀCIES!
GRACIAS!

4th Mediterranean Plant Conservation Week

VALÈNCIA | 23-27 OCTOBER | 2023

VNIVERSITAT DE VALÈNCIA
Jardí Botànic

GENERALITAT VALENCIANA
Conselleria de Medi Ambient, Aigua, Infraestructures i Territori

CIEF CENTRE PER A LA INVESTIGACIÓ I L'EXPERIMENTACIÓ FORESTAL